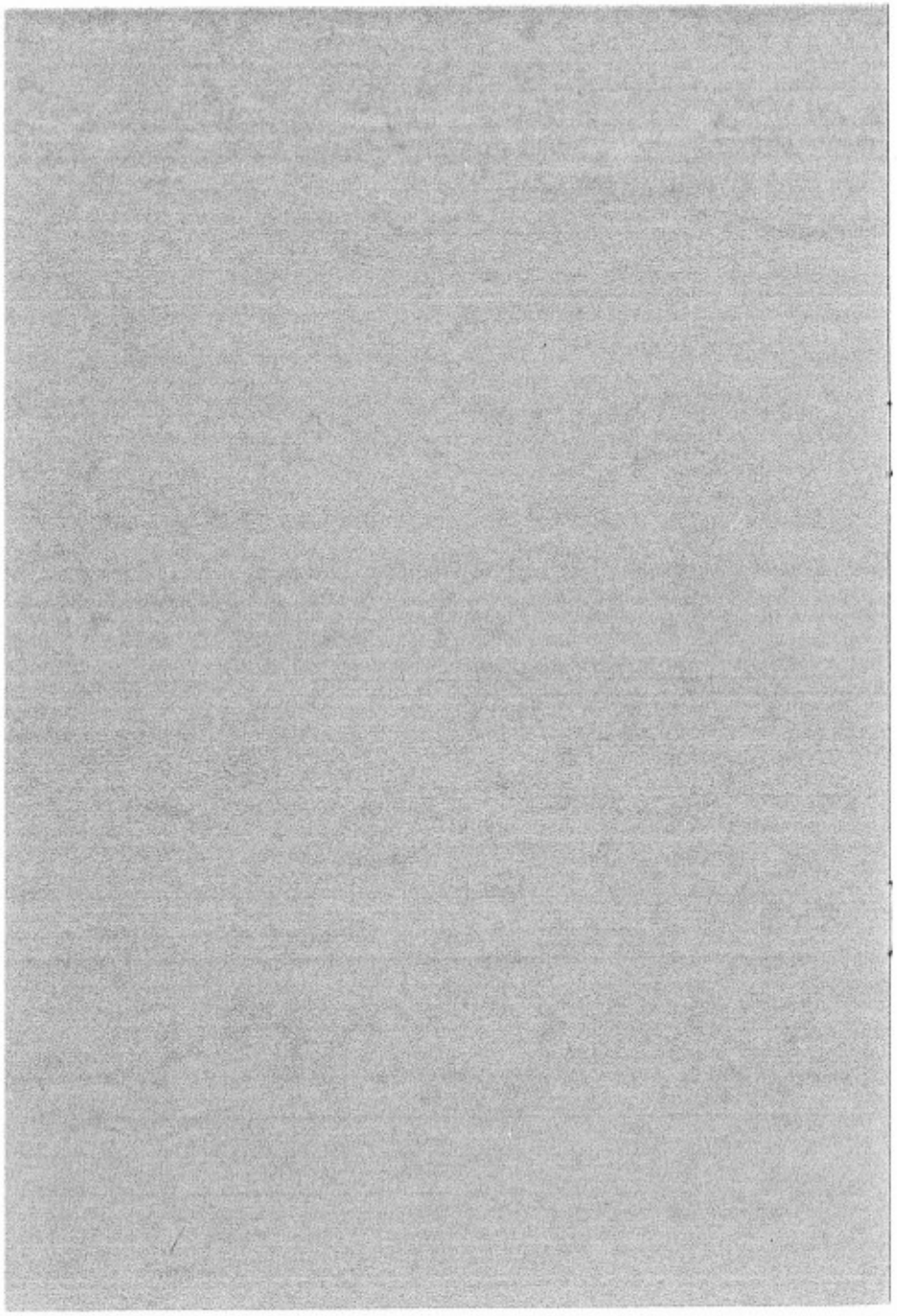

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EFFECTS OF HYPNOSIS AND BIOFEEDBACK UPON THE REGULATION OF PERIPHERAL SKIN TEMPERATURE

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Summary.—The purpose of this study was to examine the influence of hypnosis on the regulation of peripheral skin temperature. The independent variables were the presence of a hypnotic trance during the session on thermal regulation and the number of trials received. A two-factor mixed-design analysis of variance with repeated measures on one factor showed a significant main effect for trials and a significant interaction between hypnosis and trials. It may be concluded that hypnosis, in conjunction with thermal regulation techniques, exerts a significant influence over performance. The cognitive characteristics influenced by hypnosis may account for this finding.

Recent trends in hypnotic investigation have shifted from interest in factors involved in hypnotic susceptibility and its concomitant state to the influences of hypnosis on other psychophysiological processes. To date, research has yielded positive and encouraging results in every area, from behavior modification (Kroger, 1977) to treating sexual dysfunction (Alexander, 1974; Cheek, 1976) and the clinical applications of biofeedback (Daniels, 1975). The purpose of this study was to examine the influence of hypnosis on the regulation of peripheral skin temperature when using biofeedback.

Fuller (1978, p. 39) defines biofeedback as ". . . the use of instrumentation to mirror psychophysiological processes of which the individual is not normally aware and which may be brought under voluntary control." For individuals to employ biofeedback successfully, they must first be able to attend selectively to particular physiological processes. The individual must then develop various strategies of specific, sensory imagery pertinent to the specific function to extend conscious control over the process in question.

To attain this cognitive-sensory sensitivity, individuals must be able to inhibit unnecessary competing stimuli. This facet of biofeedback is similar to the salient processes involved in hypnosis. Gailbraith, London, Leibovitz, Cooper, and Hart (1970, p. 129) interpret hypnosis as ". . . a state of narrowly focused attention in which the subject must inhibit other responses that may be of a competing nature." Although there is a strong similarity between these two dynamic processes, it is presumed that hypnosis has a more potent influence and therefore may be a valuable adjunct to any application of behavioral regula-

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tion. To support this assumption we look to the areas of psychology and medicine where hypnosis alone has been successfully employed for control of phobias (Deiker & Pollock, 1975), treatment of acne (Hollander, 1958), and in therapy following myocardial infarction (Kavanaugh, 1974).

Although there have been other investigations conducted using hypnothermal regulation, many had some serious drawbacks. For example, Roberts, Kewman, and MacDonald (1973) noted that their research confounded the variables of hypnosis and auditory feedback. Still another limitation encountered is the small number of subjects tested. In many cases, the number of volunteers seldom exceed 10 (Maslach, Marshall, & Zimbardo, 1972). These individuals are usually selected on the basis of their having scored in the extreme spectrums of various hypnotic scales and other testing instruments (Roberts, Schuler, Bacon, Zimmerman, & Patterson, 1975). These facts are in no way intended to diminish the importance of these contributions, but to highlight the problems which restrict the generalizability of the findings. To compensate for or eliminate the above cited restrictions, this study has a methodological paradigm which is relatively basic.

The lowering of peripheral skin temperature was selected as the biofeedback task for two reasons. Lowering temperature involves the activation of physiological systems which are the antithesis of the apparent physical state in a hypnotic trance. If hypnosis is more than a state of physical relaxation, performance on this task may be potentiated by hypnosis. Many presume hypnosis to be merely a state of generalized relaxation without any cognitive components. It is the author's contention that relaxation is not necessary in hypnosis. If relaxation were significant, then subjects under hypnosis would not be able to perform the selected task, since it requires activating physiological systems which would be contrary to the perceived state of hypnosis. For individuals to perform the task successfully they would need to remove themselves from the trance during the process. It would then be predicted that there would be no statistically significant difference between the groups with and without hypnosis. If the aforementioned hypothesis were supported by the results, namely, if those subjects under hypnosis lower their temperatures significantly more than subjects not under hypnosis, then relaxation cannot be used to account for the results. A more tenable hypothesis would focus on the cognitive processes, such as increased concentration and greater flexibility to direct and focus this attention, which result from the induction procedure. It is important to note that the task selected for this study was in no manner to create a physiological conflict within the subjects by having them learn a response contrary to a natural state. Hypnosis is a particular cognitive set and the concomitant physiological response is dependent upon the type of imagery employed during the induction. [The interested reader should consult Kroger (1977) who presents several induction procedures in which relaxation-related imagery is not used.] The suggestions given to lower dermal temperatures were done using cold related imagery, i.e., imagine your hand in a bowl of ice water or snow, and in this manner the resulting stress, if any, was minimal.

The independent variables were the reception of an hypnotic induction prior to the thermal regulation session and the number of trials during each session. It was hypothesized that the interaction between the two variables and the effects of hypnosis alone would be significant.

Method

Subjects

Subjects were 42 undergraduate students, 27 females and 15 males. No subject had ever previously been hypnotized. All volunteered. Data for two subjects were discarded for errors in measurement of temperature during their biofeedback sessions.

Apparatus

The equipment consisted of a Narco Bio-Systems, Inc. temperature monitor, Model No., TM-301. Also, a July 1977 issue of *Psychology Today* and the Stanford Hypnotic Susceptibility Scale, Form C (Weitzenhoffer & Hilgard, 1962) were utilized.

Procedure

There were two groups, to each of which 20 subjects were assigned through a process of residual randomization. This is a process by which subjects are randomly assigned to their respective experimental groups with the aid of a table of random numbers. Each experimental group is assigned a particular number, e.g., 1, 2, 3, etc., and when that digit appears in the numerical sequence of random numbers it will determine the conditions to which subjects are assigned. Once a particular group receives the required number of subjects, its corresponding number is dropped. This process is repeated until all experimental groups are filled.

Each subject was given about 5 min. to converse with the experimenter, adjust to the situation, and generally relax before the experiment began. At this time, the thermistor was taped to the medial phlange of each subject's right middle finger. In the 8- × 10-ft. room a constant temperature of 76° was maintained.

In the control group, each subject was instructed to focus on a point on the opposite wall while the experimenter read an article dealing with the history and current uses of hypnosis in the clinical setting (Goleman, 1977). It took 15 min. to read this passage. This passage was employed to introduce a procedural control, namely, a constancy of conditions, into the experimental paradigm. Since subjects in the experimental group are to be read a hypnotic induction prior to the biofeedback session, subjects in the control group needed to be read a passage of comparable length prior to their biofeedback sessions. In this manner, more validity may be lent to consequent statistical contrasts of the two groups.

After completion of the article, the experimenter left the room, and an assistant entered to conduct the biofeedback session. On entering, the assistant turned on the temperature monitor and read the instructions to lower peripheral skin temperature from a prepared script to the subject. Communication during this session was done solely by the assistant to the subjects. All verbal interactions were read from a prepared script. The same script was employed for all subjects.

After the instructions were read, a baseline temperature was established. The sub-

jects were then instructed to turn their eyes from the fixed point on the wall to the red and blue lights on the temperature monitor at the right. The assistant sat in front of the subjects, out of immediate view. The attempt to lower temperature began. Readings were taken every 2 min. for a total of 10 min. The subjects were spoken to after Trials 2, 4, and 5.

When the thermal regulation task was completed, the subjects were instructed to remain seated in the chair with their eyes closed. The temperature monitor was turned off and the assistant exited. The experimenter returned, removed the thermistor and immediately instructed the subjects to open their eyes and refocus on the fixation point. The Stanford Hypnotic Susceptibility Scale, Form C was then administered. All 12 tasks were given and a susceptibility score calculated. The subjects were then removed from their trances and debriefed.

In the experimental group, the subjects were first administered the Stanford Hypnotic Susceptibility Scale, Form C. On the completion of the eleventh task, the subjects were given instructions to open their eyes and look at the fixed point on the wall. They were informed that they would remain in a state of hypnosis while they did this. The experimenter then explained to them that an assistant would presently enter the room and conduct the thermal regulation session. This procedure took approximately 30 min. The experimenter then left the room and the assistant entered and began the biofeedback session. The assistant, blind to the experimental condition of the subject, performed the biofeedback session using the same format and prepared script as used with the control group.

After the session, the assistant instructed subjects to close their eyes and relax. The assistant left the room and the experimenter returned. The subjects were removed from the trance and the final task (post-hypnotic amnesia) was scored. Subjects were then debriefed.

The independent variables were the reception of a hypnotic trance before the thermal regulation session and the number of trials (five consecutive trials, each of 2 min. duration).

Results

Data were analyzed by a two-factor mixed-design analysis of variance with repeated measures on one factor. There were six observations per subject (one baseline and five training) and 20 subjects per group. There were two independent groups. The analysis was executed on an IBM Digital Computer.

In the analysis two significant effects emerged, trials ($F = 8.16$, $p < .00001$, $MS = 6.4$) and the interaction of hypnosis and trials ($F = 10.97$, $p < .00001$, $MS = 8.6$). As can be seen from Fig. 1, there were significant changes in temperature over trials, with a gradual sloping of temperature upward recorded. Subjects maintained significantly lower temperatures during the first trial than on subsequent trials.

With respect to the interaction between the two variables, hypnosis and trials, subjects who were under hypnosis when receiving the biofeedback were able to maintain their temperatures at significantly lower levels than those subjects who were not in hypnotic trances at the time they entered the thermal regulation session. This indicates a significant capacity to control temperature while under a hypnotic trance over trials.

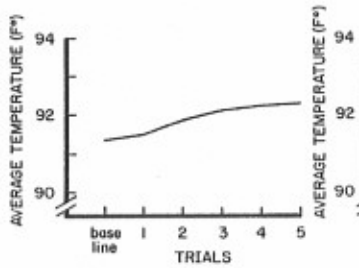

FIG. 1. Average finger temperature during biofeedback sessions for all subjects

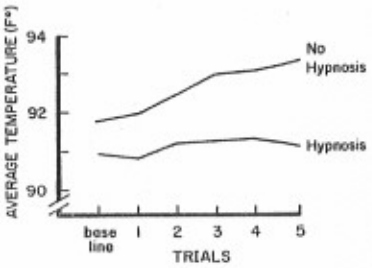

FIG. 2. Average finger temperature during biofeedback sessions for subjects, either under hypnosis or not, over trials

As can be seen in Fig. 2, there were decreases in temperature on Trials 1 and 5 for those subjects who were in a hypnotic trance. No such decreases were recorded for those who were not in a hypnotic trance while receiving the thermal regulation session. The two groups differed initially in temperature and throughout the entire experiment.

Discussion

The results suggest some interesting insights into the processes of hypnosis and biofeedback. The hypothesis that hypnosis alone would be sufficient to attain significant changes in dermal temperature was not supported by the data. This finding is in keeping with research by Edmonston and Grotevant (1975) who concluded that hypnosis alone is not a sufficient control for the removal of interfering skeletal responses encountered during instrumental autonomic conditioning. However, it may also be possible that the operational similarity between hypnosis and biofeedback may be large enough to minimize the influences of hypnosis within the experimental situation.

In a study by Maslach, Marshall, and Zimbardo (1972), it was concluded that hypnosis provides ". . . conditions which permit a greater than normal degree of generalized relaxation . . . and enhanced concentration upon a given relevant dimension" (p. 604). It is this point which serves to highlight the potent cognitive influence hypnosis exerts upon physical systems. As was illustrated by the results, subjects who were under hypnosis, although not performing in the desired direction, did maintain significantly lower skin temperatures than subjects who were not in a hypnotic state. Physiologically, relaxation brings about a dilation of the capillary network proximal to the cutaneous lining great enough to increase temperature in the dermal structures. Such peripheral increases in temperature have occurred during a "neutral" hypnotic state, i.e., the hypnotic state before any type of suggestion is given for specific changes.

Therefore, it can be concluded that the increased attention (Kroger, 1977) and the associated cognitive specificity that hypnosis precipitates enable subjects to gain increased control over their physiological systems when given the suggestion to do so.

It is interesting to note in Fig. 1 that both groups had high initial baseline temperatures, which reflect the degree of relaxation of subjects. However, the hypnosis group maintained a lower dermal temperature throughout all trials of the experiment. This further suggests that relaxation might be of little significance in initiating and maintaining a hypnotic trance. Perhaps having subjects merely sit in a comfortable chair for a period of time was sufficient to produce the observed relaxation. The cognitive arousal associated with a trance may, however, be responsible for the lower temperatures recorded for the experimental group. Being in a hypnotic trance may not necessitate being more physiologically relaxed than a nonhypnotized subject. Were this the case, then the hypnotized subjects would have higher dermal temperatures than the nonhypnotized subjects. Fig. 2 shows this is not so. It can be further concluded that nonhypnotized subjects did not go into a spontaneous hypnotic state when asked to stare at a fixed point and be read a 15-min. article, since both groups would have maintained equal temperatures. This, again, is not evidenced by the results.

Also of importance is the role of feedback within the experimental situation. The increase in subjects' ideosensory acuity, employed in biofeedback, enables them to employ more effectively their cognitions to manipulate the activities of various physiological dimensions. This factor in conjunction with the natural cognitive predisposition associated with an hypnotic state can exert a powerful influence over bodily functions. The use of hypnosis to activate cognitively various functions was employed by Maslach (1979). Through the use of post-hypnotic suggestion, subjects were able to arouse their physiological systems on cue. This fact was acknowledged by Schachter and Singer (1979) in a re-evaluation of that study during their debate concerning the effects of emotional arousal. Perhaps the use of hypnosis with biofeedback procedures may be effective in creating cognitive drive states which can monitor, control, and change any number of internal systems. The hypothesized interaction between hypnosis and trials was substantiated.

Researchers should attempt to delineate the roles hypnosis and biofeedback perform. In this manner, it may be possible to develop optimal strategies which permit individuals maximum control over their internal systems. The path to this goal presents several obstacles which must first be circumvented. Some of these difficulties will now be noted.

Maslach, Marshall, and Zimbardo (1972) suggest that feedback during thermal regulation sessions serves as a distraction and so exerts a negative effect.

Present research seems to lend some credence to this viewpoint. As was reported in Fig. 2, there were increases in temperature during Trials 2, 3, and 4 for subjects in the experimental group, although these increases were nonsignificant. During the post-experimental debriefing session, 12 out of the 20 subjects in the experimental condition reported that they did not attend to the feedback until the second trial. These subjects reported primarily employing their own imaginative sensations to accomplish the desired response. When they did attend to the feedback, they felt it distracting and felt that they could not control the temperature as well. During the final trials (4 and 5) they no longer focused on the feedback monitor and again relied on their own techniques. As a result, subjects believed that they were better able to control the temperature.

In this study, feedback was given for both increases and decreases in temperature. When feedback is given concerning increases in temperature, which is not the goal of the task, subjects might be forced to broaden their cognitive approach to the task, and this could increase the subject's stress and reduce the hypnotic influences. Another possible artifact may be the type of feedback given, i.e., auditory or visual. The type of mechanical feedback elicited by the feedback monitor could detract from the depth of the subjects' hypnotic trance. Such occurrences may arise from several factors, one of these being, requiring subjects to invest too much attention to interpreting the feedback stimuli. Although there was some feedback distraction in this study, its influences were not potent enough to dilute the effects of hypnosis completely over the thermal regulation trials.

It is probable that the type of feedback may increase the difficulty of the regulatory task for the individual in a hypnotic trance, but in no way neutralizes the effect of hypnosis over the test period. Development of feedback techniques more compatible to the hypnotic state may be required. Perhaps comparisons of various feedback procedures might yield strategies which can optimize subjects' performance and hypnotic state.

Also to be considered is the length of the feedback sessions subjects received in this study. It may be likely that the one 10-min. session is insufficient for subjects to master properly the assigned task and so lessens the hypnotic influence. It seems likely that the extension of training may produce a more distinct change since the greatest differences between the two experimental groups occurred during the last two trials.

It is the opinion of the author that hypnosis can be a valuable adjunct to thermal learning. The cognitive characteristics associated with hypnosis allow more effective performance over biofeedback training sessions. Research should focus on determining whether or not the strategies learned for thermal regulation under hypnosis will be as effective for these same individuals when they are not under hypnosis. In this manner, it may be possible to determine just

how often hypnosis needs be used in treating and controlling various psychophysiological systems.

From this study, the following conclusions can be drawn: (1) The cognitive specificity characteristic of hypnosis enables more stable performance over trials. (2) The combination of hypnosis and biofeedback can yield significantly better results than the use of hypnosis without feedback procedures. (3) The use of some types of feedback may have increased the difficulty of the thermal regulation task, as well as distracting subjects during their brief training period. (4) Relaxation is not a necessary or sufficient component in the inducement of an hypnotic state.

REFERENCES

ALEXANDER, L. Treatment of impotency and anorgasmia by psychotherapy aided by hypnosis. *American Journal of Clinical Hypnosis*, 1974, 17, 33-41.

CHEEK, D. B. Short-term hypnotherapy for frigidity using exploration of early life attitudes. *American Journal of Clinical Hypnosis*, 1976, 20, 19-26.

DANIELS, L. K. The treatment of psychophysiological disorders and severe anxiety by behavior therapy, hypnosis and transcendental meditation. *American Journal of Clinical Hypnosis*, 1975, 17, 26-33.

DEIKER, T. E., & POLLOCK, D. H. Integration of hypnotic and systematic desensitization techniques in the treatment of phobias: a case report. *American Journal of Clinical Hypnosis*, 1975, 17, 170-177.

EDMONSTON, W., & GROTEVANT, W. Hypnosis and alpha density. *American Journal of Clinical Hypnosis*, 1975, 17, 221-232

FULLER, G. D. Current status of biofeedback in clinical practice. *American Psychologist*, 1978, 4, 39-48.

GAILBRAITH, G., LONDON, P., LIEBOVITZ, M., COOPER, L., & HART, J. EEG and hypnotic susceptibility. *Journal of Comparative and Physiological Psychology*, 1970, 1, 125-131.

GOLEMAN, D. Hypnosis comes of age. *Psychology Today*, 1977, 11(2), 54-60.

HOLLANDER, M. B. Exosiated acne controlled by posthypnotic suggestion. *American Journal of Clinical Hypnosis*, 1958, 1, 122-132.

KAVANAUGH, T. Hypnosis and exercise: a possible combined therapy following myocardial infarction. *American Journal of Clinical Hypnosis*, 1974, 16, 160-174.

KROGER, W. S. *Clinical and experimental hypnosis*. Philadelphia: Lippincott, 1977.

MASLACH, C. Negative emotional biasing of unexplained arousal. *Journal of Personality and Social Psychology*, 1979, 37, 953-969.

MASLACH, C., MARSHALL, G., & ZIMBARDO, G. Hypnotic control of peripheral skin temperature: a case report. *Psychophysiology*, 1972, 9, 600-605.

ROBERTS, A., KEWMAN, D., & MACDONALD, H. Voluntary control of skin temperature: unilateral changes using hypnosis and feedback. *Journal of Abnormal Psychology*, 1973, 82, 163-168.

ROBERTS, A., SCHULER, J., BACON, J., ZIMMERMAN, R., & PATTERSON, R. Individual differences and autonomic control: absorption and the unilateral control of skin temperature. *Journal of Abnormal Psychology*, 1975, 84, 272-279.

SCHACHTER, S., & SINGER, J. E. Comments on the Maslach and Marshall-Zimbardo experiments. *Journal of Personality and Social Psychology*, 1979, 37, 989-995.

WEITZENHOFFER, A., & HILGARD, E. *Stanford Hypnotic Susceptibility Scale, Form C*. Palo Alto, CA: Consulting Psychologists Press, 1962.

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