SKIN TEMPERATURE INCREASE AS A FUNCTION OF INTELLIGENCE, BASELINE TEMPERATURE, AND AUTOGENIC FEEDBACK TRAINING

THESIS

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ABSTRACT

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An experiment was conducted to test the hypothesis that more intelligent Ss would produce greater increases in peripheral skin temperature using autogenic feedback training. At the completion of training, the Ss were divided into two groups by IQ scores and matched with pretraining (baseline) temperatures. The hypothesis was rejected when results opposite to those predicted occurred. Large group differences, however, prompted a *post-hoc* investigation to determine the statistical significance between group performances. This analysis revealed that the less intelligent Ss experienced greater success ($p<.05$) in increasing skin temperature. Possible explanations for these results are discussed and considerations for future investigations with biofeedback training and intelligence are suggested.

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The advances of technology in the field of physiology have created a new dimension for psychotherapy. It has been demonstrated that a person can control his autonomic processes when given immediate physiological feedback (Green, Green & Walters, 1974; Shapiro & Schwartz, 1974). This process of altering autonomic states has been labeled biofeedback. Green et al. (1974) define biofeedback as:

> The immediate ongoing presentation of information to a person concerning his own physiological processes. A patient looking at his own ongoing electrocardiographic (EKG) record is, by definition, getting biofeedback; if he trys to manipulate the heart through internal processes in some way while watching his record, using EKG feedback for guidance, he is trying biofeedback training (p.157).

Biofeedback training has occurred in the fields of electroencephalographic activity, (Paskewitz & Orne, 1973; Finley, Note 1; Kaplan, Note 2) electromyographic activity, (Budznyski, Stoyva, Adler & Mullaney, 1973; Cleeland, 1973; Wickramaskera, 1972) and vasomotor activity (Lynch, W. D., Hama, H., Kohn, S & Miller, N. E., Note 3). It appears that almost any physiological phenomenon that can be recorded by present technology can become the subject of biofeedback training. The range of literature and the scope of biofeedback training is vast. Neal Miller (1974) believes the control of peripheral skin temperature to be an especially good model for biofeedback research.

Temperature control training often used autogenic training to increase or decrease peripheral skin temperatures. Autogenic training requires that the subject concentrates on thoughts and images which help the subject to "feel" warm, relaxed and heavy. The value of autogenic training is discussed by Spoerri (1969) in that, "It is economical in every respect. It is not time-consuming nor expensive. It can be practiced in groups and the training of the therapist is modest. But, most important is the fact that there are no true contraindications " (p. 354).

A marriage of these two forms of therapy is discussed by Sargent, Green, and Walters (1972) when it is stated:

> This technique, biofeedback training, when combined with autogenic phrases, is called autogenic feedback training (AFT) and uses visual and auditory devices to show the subject what is happening to normally unconscious bodily functions as he attempts to influence

> them by use of mental, emotional, and
> somatic visualizations (p. 120).

It follows, then, that autogenic training can be an important aspect of biofeedback therapy so that, when used, whatever contributes to its success should also contribute to the total therapeutic outcome. This investigation will use AFT to bring about peripheral skin temperature control.

Biofeedback training is a new addition to the arsenal of therapeutic tools and little is known about the parameters of its applicability. Presently, it is not known which personality variables aid or impede biofeedback acquisition. The discovery of traits which might ensure rapid biofeedback acquisition would enhance the effectiveness of AFT. There exists a large number of individual differences in the ability to learn biofeedback, rates of learning biofeedback and the magnitudes of control which subjects can exert over their autonomic processes (Roberts, Schuler, Bacon, Zimmerman & Patterson, 1975, p. 272). The intent of this investigation is to provide basic research about biofeedback training which might provide one predictive variable in temperature control success.

Sargent et al. (1972) state, "It will be worthwhile to develop methods in the psychological testing to pick out those persons whom we could predict to fail or succeed [biofeedback training]" (p.124). It is possible that by isolating and investigating each potential variable independently we can better control them and ensure more efficient management techniques. Shapiro and Schwartz (1972) suggest, "At our present state of knowledge it could be argued that the first stage in clinical research should be to demonstrate significant changes with the realization other potential variables are confounded in the design, and then evaluate the separate components" (p. 181). Roberts, Kewman, and MacDonald (1973) conclude their research calling attention to the idea that "further experimental work will be needed in order to determine the degree to which learning ability is related to physiological, motivational, and personality variables" (p. 168). It may be, then, that learning ability (intelligence) needs to be investigated in a controlled experiment to discover what effects, if any, it might exert in biofeedback training.

The variable, intelligence, appears to be important in biofeedback training. It seems as though several investigators have been concerned with this variable and are interested in its application to the total therapy program. Autogenic training is an important aspect of biofeedback training and whatever contributes to its success will also contribute to the therapeutic outcome. Spoerri (1969) believes intelligence is important to the success of autogenic training. Spoerri states that the degree of success experienced in autogenic training has "limits. . .set by the capability to learn." (p. 362).

Sargent et al. (1972) cited one problem in biofeedback training success experienced by their subjects in that "in some subjects it was difficult for them to understand simple instructions." (p. 124). The patients could not follow simple instructions and did not experience successful biofeedback training. It would appear, then, that one's ability to follow instructions (intelligence) is an important predictor of biofeedback training.

Shapiro and Schwartz (1972) discuss intelligence as one of several variables thought to be influential in biofeedback training. They state,"Patient factors such as socio-economic status, intelligence, and overall personal adjustment may be important predictors of the effectiveness of biofeedback training as they are in psychotherapy in general" (p. 180).

Wickramaskera (1975) believes,"Biofeedback training in general appears to involve aspects of both operant conditioning and skill learning" (p. 345). Generally, the more intelligent persons learn faster.

Migraine headache sufferers have utilized biofeedback training probably more than any other class of patients. Intelligence, as a variable, is apparently an important consideration for a migraine sufferer receiving individualized therapy. Rees (1973) states,"The decision to employ individual psychotherapy. . .would depend on a full assessment of the patient including age, intelligence level, motivation and the psychodynamic factors relevant in the case" (p. 120). The question as to whether more intelligent patients have a better prognosis might then be investigated.

In this investigation, some definitions are in order. Intelligence will be defined operationally as the score obtained by a subject on the OTIS Quick Scoring Mental Ability Test (Form Am). Biofeedback training will be represented by temperature control, believed by Neal Miller to be a good model for biofeedback research. The mode of temperature control acquisition will be autogenic feedback training (AFT).

Biofeedback temperature training has a multiplicity of therapeutic uses. French, Leeb and Boering (1973) indicate temperature training might be an aid in prepared childbirth (LAMAZE). The LAMAZE approach involves the techniques of inducing a visual focal point, respiratory control, and husband-coached relaxation training. French et al. state, "The visual display (meter) of the hand temperature unit would provide a meaningful focal point on which the patient could concentrate" (P. 326). The reason it is said to be a meaningful focal point is that the information derived from the meter is used to develop deep muscular relaxation. The increase in temperature recorded by the meter is believed to be highly correlated with the state of deep muscle relaxation, one which is deeper than can be obtained through conventional LAMAZE training. French et al. believe biofeedback temperature training will benefit LAMAZE childbirth by providing a meaningful focal point which will help the patient achieve deep relaxation.

Green et al. (1974) mention work with alcoholics and drug dependent personalities which utilizes biofeedback training. They quote the work accomplished by Paul Kurtz who states that the real problem with these patients is their thinking that they have no control over anything. Through work with several forms of biofeedback, including temperature training, some alcoholics and drug dependent personalities learn that they can control some of their bodily functions. Consequently, the realization that patients can control some of their bodily functions may be responsible for therapeutic success.

Raynaud's Disease may be helped though the self-regulation of blood flow. Controlling blood flow appears to be the mechanism involved when a person alters his peripheral skin temperature. Roberts et al. (1973) refer to the possiblity that temperature control training can contribute significantly to the treatment of Raynaud's Disease as well as other somatic problems. They state:

> Individuals achieve a high degree of voluntary control over the autonomic processes involved in regulating peripheral skin temperature. The control appears to be of sufficient magnitude to make possible the therapeutic management of certain psychosomatic disorders, some circulatory disorders (e.g. Raynaud's Disease, migraine headache), or other disorders that might be helped by localized changes in blood flow (e.g. burns, arthritis) (p. 168)

Sargent et al. (1972, 1973a, 1973b) have published more work on migraine patients using biofeedback training than any other team to date. They first began using temperature control training for migraine sufferers after accidentally discovering that a temperature increase of 10 degrees Fahrenheit (F) accompanied the remission of a migraine headache. This remission of a migraine headache led the team to investigate the possibility that temperature training might help in treating migraine headaches as a form of therapy. In 1972, they published results showing that 74% of the migraine patients who received autogenic feedback training were improved. Other researchers have joined in using temperature training for migraine suffers (Wickramaskera, 1973; Peper & Grossman, Note 4). Some practitioners of autogenic feedback training have reported the ability to abort headaches prior to their complete development (Sargent et al., 1972) while others claim to be able to dissipate fully developed headaches (Sargent et al., 1972; Peper & Grossman, Note 4).

Temperature training is an effective and versatile therapeutic tool. As with any new form of therapy, however, it needs to be studied in the laboratory, divorced from the therapy scene, so that it can be more effectively applied for the reliable amelioration of psychosomatic problems. A review of literature indicates studies have taken basically four directions in investigating biofeedback temperature training. Temperature training has been investigated from the perspectives of hypnosis (Maslach, Marshall & Zombarde, 1972; Peters, Lundy & Stern, 1973; Roberts, Kewman & MacDonald, 1973; Roberts, Schuler, Bacon, Zimmerman & Patterson, 1975), instrumental conditioning (Christie & Kotses, 1973; Lynch, Hama, Kohn & Miller, Note 3; Taub & Emurian, Note 5), direct instructions with biofeedback (Keefe, 1975; Wickramaskera, 1973), and biofeedback with autogenic suggestion (McDonagh & McGinnis, 1973; Sargent et al., 1972, 1973a, 1973b; Peper & Grossman, Note 4).

In 1972, Maslach et al. set out to demonstrate that hypnotized subjects would be able to achieve simultaneous alterations in peripheral skin temperatures while non-hypnotized subjects would not. The subjects in this study were required to make one hand hot while simultaneously making the other hand cold. All of the hypnotized subjects were able to produce bilateral changes in skin temperatures in the hands. It appears as though changes made by control subjects were in the same direction with both hands and therefore the scores from those subjects balanced out to zero. It was noted that the hypnotic subjects had an improvement from the first to the second sessions while the control subjects did not improve. The scores between the two groups were statistically significant at the .001 level of confidence ($t=14.27$, $df=4$).

Roberts et al. (1973) initiated research to replicate the Maslach et al. (1972) study in that hypnotized subjects could alter skin temperatures. They further wanted to decide whether or not these subjects could exert enough skin temperature change to account for the vascular symptoms experienced in clinical settings. The subjects in this experiment were hypnotized, asked to make one hand hotter than the other, and they then received auditory feedback telling them how successful their efforts were in altering skin temperatures. The results of this investigation tend to support the idea that hypnotized subjects can voluntarily control peripheral skin temperatures in the hand. It further appears likely that enough control can be exercised to effect sufficient therapeutic management of some circulatory disorders. Criticism of this investigation is offered by its authors in that no control was exercised to separate the effects of hypnosis and auditory feedback. It is unknown which technique contributed to the alteration of skin temperature.

Peters et al. (1973) wanted to test the hypothesis that suggestions given to non-hypnotized subjects would lead to an increase in peripheral skin temperature while these same suggestions would have either a stabilizing or a decreasing effect on hypnotized subjects. Hypnotized subjects tended to have stable skin temperatures throughout the suggestion period while non-hypnotized subjects tended to increase skin temperatures no matter what the suggestion. This study appears to be inconsistent in its results with the Maslach et al. (1972) study and the Roberts et al. (1973) study in that the non-hypnotized subjects in this study exercised greater control in altering skin temperatures when compared to hypnotized subjects.

Roberts et al. (1975) cite previous work in the area of temperature control and set out to provide more support for hypnotic susceptibility in predicting successful temperature control. Subjects were tested for hypnotic susceptibility and placed into either a higher susceptible or a lower susceptible group for data comparisons. Subjects were required to warm skin temperatures of the hand relative to the other hand. There were no statistically significant differences in group performances. The total group, however, appeared to exercise a strong degree of control over skin temperature. Roberts et al. (1975) concludes by suggesting that the ability to alter one's state of consciousness may be the important variable in skin temperature alteration and not hypnosis, as was previously believed.

Instrumental conditioning of temperature control has shown that subjects can alter peripheral skin temperatures. Taub and Emurian (Note 5) used a variable intensity light to operantly condition small changes in skin temperature. They state that it rarely takes more than four 15-minute training sessions to produce the ability to voluntarily control skin temperature. Some subjects in this study displayed ranges of control from eight to fifteen degrees F. Transfer of control from one portion of the body to another was found to be easily accomplished.

Christi and Kotses (1973) demonstrated that vascular flow could be controlled at the cephalic site. By using lights and auditory feedback, eight male subjects successfully learned to dilate and constrict the blood flow from the cephalic area. The importance of this research can readily implement the research into migraine headaches which have been used to support the idea that temperature control can help to dissipate migraine pain. Pain has been suggested to result from the excess blood flow through the carotid vascular system, and by redirecting the excess blood flow from the carotid system, a subject can offset the overload and dissipate the pain associated with migraine headaches.

Lynch et al. (Note 3) used instrumental conditioning paradigms to try to discover the laws governing vasomotor learning and to establish that learning is mediated directly by the autonomic system exclusive of the somatic muscle involvement. They reported that vasomotor learning can become specifically localized. They also believe that while temperature training can be accomplished with many subjects, more consideration needs to be given to the individual subjects and the training paradigm.

Although it is not a case of direct research outside the therapeutic setting, Wickramaskera (1973) did use direct instructions with biofeedback to achieve temperature control with migraine patients. Two subjects who had received electromyograph training without successful amelioration of pain were given training in temperature control. Wickramaskera taught them to increase hand temperature relative to forehead temperature with direct visual feedback of the subject's progress. This was a method similar to the one used by Sargent, Green and Walters in their early studies, with the exception that Sargent et al. used autogenic phrases to help bring about temperature control. The frequency and intensity of headaches declined as the skill in raising hand temperatures increased. The two subjects rapidly acquired temperature control. Wickramaskera suggests that temperature control might be a more effective approach to treating migraine headaches than electromyographic training. The study indicates again, that individual subjects can and do exercise a large degree of control over their peripheral skin temperatures.

Keefe (1975) utilized visual and auditory feedback to help eight male subjects alter their skin temperatures. Keefe wanted to demonstrate that subjects could acquire temperature control using only direct instructions with biofeedback training. The eight subjects were randomly assigned, four to a group. One group was instructed to increase hand temperatures while the second group was instructed to decrease peripheral skin temperature. Both groups significantly altered skin temperatures in the required directions. There resulted a significant interaction which supports the idea that greater control is acquired with a longer duration of practice. This study supported its contention that a person could acquire hand temperature control without autogenic or hypnotic help. The study was criticized in that no control was enacted to separate the effects of biofeedback training and instructions.

Peper and Grossman (Note 4) trained two young girls suffering from migraine headaches to control their peripheral skin temperatures with autogenic feedback training (AFT).

Both subjects had a history of symptoms covering several years. The subjects learned rapidly and it is reported that both subjects are symptom free. The degree of control effected was so good that the subjects reported the ability to abort fully developed headaches at school or anywhere.

Sargent et al. report work with migraine headache sufferers (1972, 1973a, 1973b) where up to 80% of the subjects report improvement. They started temperature measurement between the hand and the forehead, but later experiences indicated absolute temperature differences at the skin site on the finger changed rather than the forehead, so they dropped the differential measure and began recording absolute temperatures in the selected skin site. The amount of success reported by Sargent et al. has sparked research in other journals into the etiology of migraines and the amelioration of pain by AFT.

McDonagh and McGinnis (1973) studied skin temperature elevation as a function of baseline temperature (pre-training temperature) and autogenic suggestions. Their research suggests that baseline temperatures can signal differences in the magnitude that temperatures can be increased by subjects. Subjects whose baseline temperature was below 90 degrees F exhibited a greater magnitude of temperature change than subjects possessing a baseline temperature above 89 degrees F (p. 548). Because subjects having a baseline temperature below 90 degrees F enjoyed a greater magnitude of temperature control, they suggest migraine sufferers experiencing the "cold hands/cold feet" syndrome may benefit more from AFT than those subjects not experiencing the same symptoms. Another conclusion from this research seems to indicate an upper temperature limit of 94 degrees F for those subjects controlling their peripheral skin temperatures via AFT. McDonagh and McGinnis suggest further research is needed to see if hypnosis or Yoga training might help to extend this apparent upper temperature limit to even higher extremes.

In summary, biofeedback training has shown itself to be useful in a wide variety of therapeutic situations. The field of investigation surrounding biofeedback training is incomplete in that few variables have been investigated as they apply to this training. Intelligence has been suggested by several sources to be worthy of investigation and may be a predictive variable pertinent to the success in a given therapeutic program. It is toward this end that the present investigation takes form; intelligence will be studied to ascertain what effect intelligence has on the final outcome of AFT.

Baseline temperatures have been considered predictive to therapeutic success in temperature control and need to be considered in any investigation with temperature control. The baseline temperatures in this investigation will be used as the matching variable so that both groups will have an equal chance to increase skin temperatures.

It was hypothesized in this investigation, that the more intelligent subjects would produce greater magnitudes of temperature increases using AFT.

Method

Subjects. The OTIS was administered to 42 male, introductory level psychology students. Five students withdrew from school prior to the experimental session and seven students decided not to participate in the experimental session at a later date. The 30 volunteers who completed both testing and the experimental phases of this investigation were offered academic credit for their participation.

Apparatus. The BFT 301 Temperature Trainer manufactured by Biofeedback Technology, Inc., was used to measure absolute temperature at the selected skin site in tenths of one degree F. The BFT 301 has a visual display meter which deflects to the right of center when the temperature is increased from baseline setting. The needle will deflect to the left when the temperature decreases. This highly sensitive instrument is fully transistorized; it needs no warm up period; and it is guaranteed to be accurate to within four tenths of one degree F. This temperature trainer is also capable of being connected to an audio feedback device for simultaneous visual and auditory feedback.

One BFT 240 Audio Feedback Generator produced by Biofeedback Technology, Inc. was used for auditory feedback. This model emits a tone which increases when temperature deviations increase relative to the baseline temperature. The tone decreases in pitch when a decrease in temperature toward the baseline setting is experienced. The audio output can be adjusted for tone and volume.

One Thermolinear thermister was used to measure absolute skin temperature of the index finger on the subject's dominate hand.

One Montgomery Ward's Airline Cassette Recorder, model number #GEN 3913a was used to uniformly dispense both temperature training instructions and sample autogenic suggestions.

The Otis Quick Scoring Mental Ability Test (Form Am) was used to separate the subjects into two groups by intelligence (IQ) scores.

Procedure. The thirty subjects traveled to Beverly Hills Clinic in Dallas, Texas for the required AFT. The biofeedback therapy room in the basement of the clinic was used for all training sessions. There were no vents to cause draft air movements and the temperature was maintained at about 75 degrees (±1 degree) F. The room measured eight feet by 14 feet and was furnished with the biofeedback equipment, one lounge chair for the subject, and one straight backed chair for the experimentor (E). The room was lighted to provide a relaxing atmosphere, but was bright enough to ensure easy vision of the biofeedback display meter.

The subject was met by the experimenter, taken to the biofeedback room, and instructed to lean the chair back to the first position. As the subject relaxed, the E taped a thermister to the index finger of the subject's dominate hand. The subject was told not to "trap" the thermister against the chair or against his body; that way, it could register the accurate temperature of the subject's finger. The E informed each subject that they were to listen to taped instructions which would tell them exactly how to perform this investigation. The tape would be referring to a visual display meter (the E pointed to the meter at this time) and an audible tone (at this point the E demonstrated the audible tone to be sure the subject could hear it). Any questions from the subjects would be answered after the taped instructions. The subjects were not allowed to receive biofeedback prior to the end of the taped instructions.

A baseline (pre-training) temperature was recorded 30 seconds after the subject's thermister was in place. A second reading was taken one minute later, and if stable, was used as the subject's baseline temperature for the experiment. If the reading was not stable, the E waited until the temperature showed no more than .1 degree F fluctuation for a minute interval. That recording was then used as the baseline temperature.

The subject was allowed to listen to the taped instructions (See Appendix A) after the baseline temperature was obtained. Temperature deviations from the baseline setting was recorded each minute for 26 intervals. The units of changed temperature (in tenths of one degree F) were used as the dependent variable of this investigation. The final score (highest deviation above baseline) was used to statistically ascertain differences in group performances. At the conclusion of the 26th recording, the subject was told to STOP: a debriefing then ensued where the subjects were asked to contribute any information they believed had aided them in successful temperature elevation.

This investigation was double blind in that neither the experimenter nor the subjects knew into which group the subjects would be placed for statistical treatment. At the conclusion of the entire treatment portion of this investigation, the E tabulated all the data; gave an impartial judge the list of baseline temperatures for each group; and asked him to perform a match. The temperature matches were to be within one degree F of each other. The top 15 IQ scores were classified as Group A in this investigation while the bottom 15 IQ scores were Group B. Of these 30 baseline temperatures, only 11 matches could be performed within the criteria (1 degree F) established prior to the experiment.

Results

The data used for statistical computation is presented in Table I. There were no significant differences between average baseline temperatures indicating that matching had been successfully accomplished. A t-test for IQ scores was performed for the matched groups providing a t-value of 5.67 at 10 df and a p-value of less than .05, indicating statistically significant differences in the level of intelligence between the two groups.

TABLE I

IQ SCORES, FINAL SCORES AND BASELINE

TEMPERATURES OF MATCHED SUBJECTS

PRESENTED BY GROUP

Ss	IQ	F.S.	B.T.	B.T.	F.S.	IQ	Ss
GROUP A				GROUP B			
1	131	48	89.5	89.8	42	101	19
4	119	26	77.2	76.4	160	102	17
5	116	17	76.6	76.2	89	102	16
7	115	19	84.0	83.2	94	88	28
8	114	2	92.6	92.8	26	87	30
9	113	48	89.0	90.0	43	89	27
10	112	19	92.9	93.6	23	90	25
11	108	-2	73.7	74.0	189	90	24
13	106	-14	85.5	84.6	94	99	21
14	104	-1	80.4	80.0	127	99	20
15	103	32	91.7	91.0	21	102	18
Means	113	18	84.8	84.7	83	95	

F.S. - Final Scores
B.T. - Baseline Temperatures

An analysis of the final scores presented in Table I reveal that Group B (mean=83) made the greater peripheral skin temperature alterations. This finding leads to a rejection of the hypothesis in this investigation and would normally alleviate the need for further statistical analysis. The large differences in the final scores of each group, however, prompted a *post hoc* analysis of the data to determine the existence of any statistically significant differences in group performance.

The results of this investigation were subjected to a two-tailed t-test for correlated means. A difference score of -6.49 was obtained between Group A (mean=18) and Group B (mean=83) indicating that Group B made the greatest increases in skin temperatures. A t-value of 3.2 was obtained at 10 df, which provided a p-value of less than .05. These statistics indicate that the differences in temperatures obtained by each group was statistically significant.

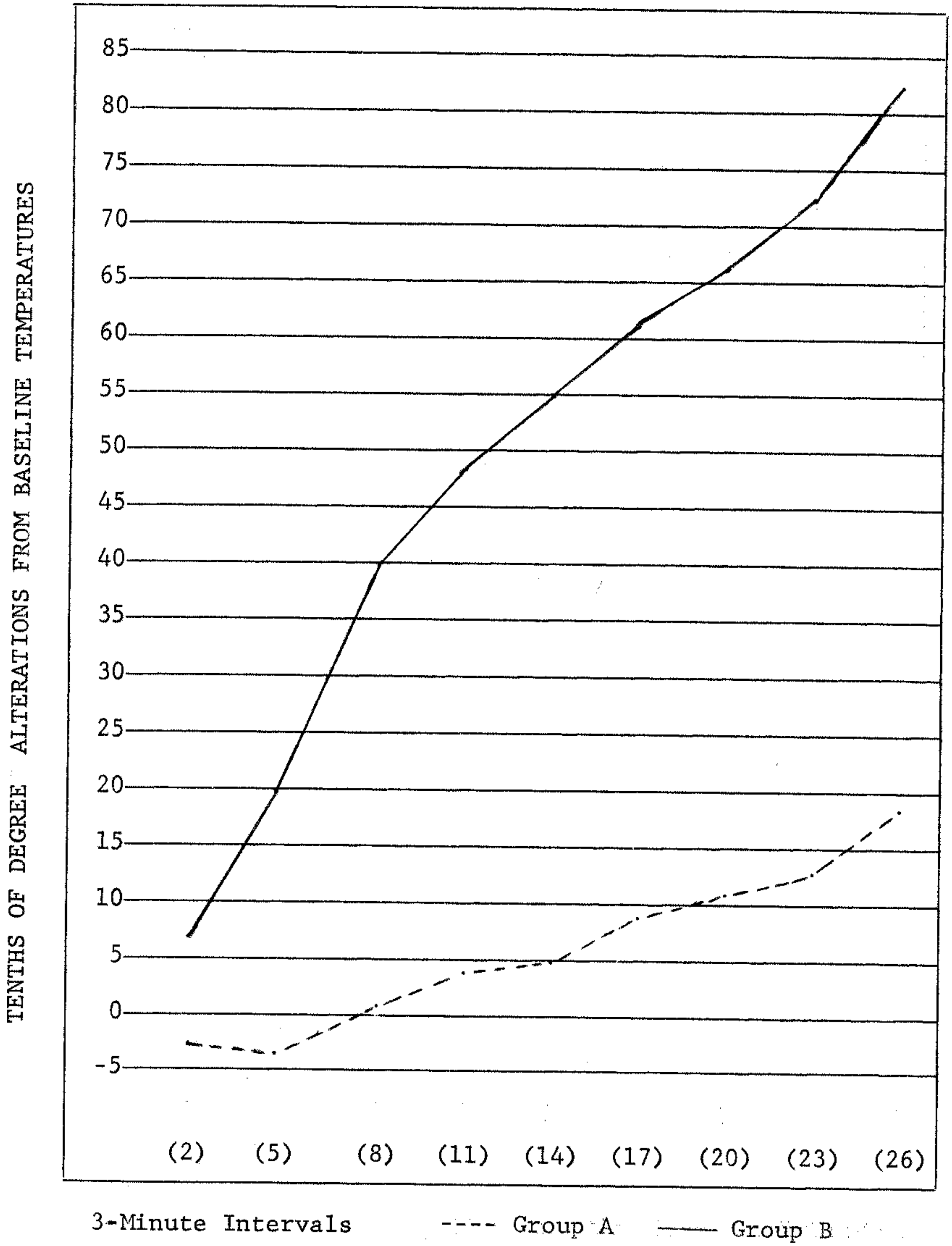
Inspection of Table I reveals that all Ss, except three from Group A, increased peripheral skin temperatures above pre-training (baseline) temperatures. This supports the belief that each group benefited from AFT. All of the Ss from Group B had final scores above the average final score for Group A (18). Nine Ss from Group A had early temperature decreases and required an average of 17 minutes to exceed the baseline temperature. Three Ss from Group A were unable to exceed the baseline temperature during the entire 26 minute session. Four Ss from Group B experienced temperature decreases, but required an average of only six minutes to exceed respective baseline temperatures. There were no Ss from Group B who failed to exceed their baseline temperatures at the end of the training session.

Three Ss from Group B experienced extreme changes over baseline temperatures. S 20 experienced an increase of 12.7 degrees F over the pre-training baseline temperature while S 17 reported an increase of 16.0 degrees F and S 24 managed an increase of 18.9 degrees F. There have been few reports of temperature alterations approaching these in magnitude. Six Ss exceeded 94.0 degrees F in this experiment, thought to be an upper limit in AFT. Three Ss from Group B recorded temperature increases of 94.3, 95.4, and 95.9 degrees F. Subjects exceeding 94.0 degrees F in Group A produced temperatures of 94.3, 94.8, and 94.9 degrees F.

The temperature increases in each group were averaged at three minute intervals to produce the graph in Figure 1. An inspection of Figure 1 reveals an overall improvement with time for both groups. The longer the sessions last, the greater the temperature increases above the baseline setting. Group A, on the average, remains below the baseline

Figure 1

AVERAGE GROUP TEMPERATURE DEVIATIONS FROM BASELINE



throughout the entire session. This graph begins at the second minute interval which is the completion of taped instructions. Figure 1 indicates that Group A lost temperature while listening to the taped instructions and Group B increased temperatures listening to the taped instructions. It seems that greater overall improvement was made by Group B as indicated by the steeper slope of its graph.

Discussion

The results of this experiment do not support the hypothesis that more intelligent Ss will produce greater changes in peripheral skin temperatures using AFT. The direction of greater success in skin temperature alteration was opposite to that predicted in this investigation. An overall lack of knowledge about the variable intelligence, together with the large differences in group performances, prompted a *post-hoc* statistical analysis of this investigation's results. The *post-hoc* analysis appears to signal the importance of intelligence as a variable in biofeedback training.

Both groups received the same treatment on the same equipment recorded by the same experimenter. The controls exercised in this study were not violated. It appears as though the differences in temperature increases by the two groups may be highly related to the differences in the level of intelligence claimed by each group.

In the post-training interview, all but three Ss reported help from using autogenic imagery. The images providing most success were sauna and steam baths, sun bathing, strenuous work in the heat, and memories or images of sexual activity. Several Ss reported a throbbing sensation. Audio feedback appears to be the favorite mode of biofeedback. Ss reported easier concentration when they shut their eyes and listened to the feedback. Ss experiencing marginal success or no success reported an inability to relax and concentrate as well as boredom as hindrances to temperature increases. One S with marginal success reported no increase until he gave up trying. After deciding he could not increase skin temperatures, he noticed a rise in temperature. He stopped trying to make his temperature increase and relaxed; his temperature continued to rise as his relaxation deepened. Most images that helped Ss to feel relaxed aided temperature increases.

It appears as though peripheral skin temperature is controlled by the blood flow in selected skin sites. When temperatures are high in an area, there is a relaxation of the circulatory system in the area, increased blood flow, and higher temperatures result (French et al., 1973). Anxiety, nervousness and tension combat relaxation and render the Ss almost incapable of increasing skin temperatures in the extremities. Initial temperature decreases by the nine Ss from Group A may indicate a "fear of failure" or type of "test anxiety". Several of the Ss reported concern over their performance in this experiment. This concern over performance appeared to follow the decrease in temperature by each S and may well indicate the fear or anxiety experienced by Ss. In an anxious or tense state, relaxation is difficult and without physical relaxation, there appears to be little chance of increasing peripheral skin temperatures. Ss experiencing great changes in skin temperature on the other hand, all reported great depths of relaxation. The incidence of test anxiety and fear of failure is not uncommon among Ss with higher intelligence levels. The Ss from Group B were greatly unconcerned about their performance in this experiment.

Neal Miller experienced great success in autonomic conditioning studies when using animals which had been paralyzed. The curarized animals seemed to receive less distracting stimuli from their environment, a type of "noise" factor. It has been suggested by Roberts et al. (1973) that hypnosis affects Ss in a similar way as curare; that is, it reduces the "noise" factor and allows Ss to concentrate more effectively on the autonomic system without as many distractions. It may be that the more intelligent a person is, the more susceptible he is to receiving extraneous "noise". More intelligent people might be more aware of their environment and give less attention to the biofeedback. If so, the more intelligent Ss might be less successful in biofeedback training because of the "noise" factor.

Three Ss from Group A reported the experiment to be boring. No Ss from Group B reported boredom. Persons scoring average to low intelligence seem to make better employees in jobs requiring menial or tedious tasks. They are bored less easily and perform better than more intelligent co-workers. If biofeedback training is tedious, then boredom could negatively affect the results obtained by subjects easily bored. It may be that the poorer performance by the higher intelligence group is a result of boredom.

In summary, the more intelligent Ss did not produce greater temperature increases. Test anxiety, the inability to relax and a distracting "noise" factor have been suggested as possible causes for the poorer performance by Group A. Boredom may also be a factor contributing to the observed differences in group performance. These traits may need to be considered in future studies with above-average intelligence Ss. A *post hoc* analysis of the data revealed significant ($p<.05$) differences between group performances. In this investigation, the low intelligence Ss had better success in increasing temperatures.

Further, in an effort to increase the effectiveness of biofeedback training, future research should focus on additional considerations. These considerations should include (a) the length of the training sessions; (b) the ability of the Ss to relax; (c) the potential distractions present during the training session; (d) audio versus visual feedback; (e) the several modes of biofeedback control (instrumental conditioning, direct feedback, or autogenic feedback training); and (f) what differences will the various intelligence levels produce in biofeedback success.

Finally, while the results of this investigation do not support the hypothesis that more intelligent Ss will produce greater changes in peripheral skin temperatures, a *post hoc* analysis of the results indicates that intelligence does appear to merit further consideration concerning its predictive value in biofeedback acquisition.

APPENDIX

Appendix A: Taped Instructions for Temperature Training

Sit back and relax. Be as still as possible, avoid unnecessary body movement. The key to increasing your skin temperature is to be as relaxed as possible. The way many people learn to increase their temperature is by imagining their hands getting warmer. Try to think about the feeling of warmth. It may help you, as it has others, to imagine yourself lying in a bathtub of hot water. Try to feel yourself getting warmer, warmer and finally hot. The idea of lying on a sunny beach has helped several people attain warmth. Try to feel warmth while the sun gets hotter and hotter as you relax on the beach. Some people report that imagining themselves working on a hot sweaty job has helped them to feel warm and increase hand temperature. There are thousands of ideas - whatever helps you to feel warm will work. When an image stops helping you increase your temperature, change to another image! The machine in front of you will let you know what is working. As your skin temperature increases, the needle will move to the right of center and the tone will increase in pitch. Many people increase skin temperature by using only the machine! Concentrate on warmth and you will become warm. Remember also that relaxing is the key. The more relaxed, calm you are, the better your chances to increase your skin temperature.

The person with you will record your temperature every minute, but will be unable to assist you further, so increase your temperature as much as you can and Good Luck.

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