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Efficacy of Imagery and Biofeedback in Hand Temperature Training

by

Suey Yee

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NAME OF AUTHOR: Suey Yee

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....
(student's signature)

71 Amherst Cres.
(student's permanent address)
St. Albert, Alberta

DATED: Dec. 4 1987.

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Efficacy of Imagery and Biofeedback in Hand Temperature Training submitted by Suey Yee in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Counseling Psychology.

Supervisor

External Examiner

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To

my Grandfather and Grandmother

ABSTRACT

Eighty-three Ss were categorized by split-median scores on the Switras Survey of Mental Imagery (SMI, Switras, 1978) as high and low imagers, and randomly assigned to one of four treatment conditions: (a) biofeedback (BFK) alone, (b) guided imagery (GI) alone, (c) combined, and (d) control. Subjects also completed an author created measure, the Self-Ratings of Imagery Ability (SRIA). All Ss in the three active treatment conditions were required to increase temperatures in the dominant hand. The BFK group received visual analogue and auditory feedback; the GI enacted audiotaped thermal imagery suggestions; the combined group received biofeedback and the same thermal imagery audiotape, while controls listened passively to an audiotape of physics definitions. The training involved five 1-hour sessions conducted on five consecutive days whenever possible (maximum span of seven days) and at the same time daily. Each session consisted of a 15-minute adaptation period, 10-minute baseline, and four 5-minute training trials.

Results indicated that a cooling trend for all subjects was evident with hand temperatures decreasing significantly from trials 1 to 4. Across sessions, training effects were greatest overall by the end of the third session, and further training did not increase thermal effects. Examination of individual groups, revealed the superiority

of the BFK condition and also suggested that low imaging ability may be an asset in thermal training. Self-estimates of imaging ability were compared with the SMI, and indicated that the laypersons' notions of imaging ability were more closely related to vividness rather than its controllability. Correlations of SRIA and SMI scales were highest in the visual modality (r= .60) and suggested a moderate overlap between the total scores on each measure (r= .59). Exploratory discriminant function analyses, although non-significant (p= .078), suggested that successful warmers were older, more likely to be female, and possessed lower baseline temperatures. Problems associated with assessing imaging ability and validation of imagery measures are discusssed. The use of standardized dependent measures, treatment of males and females as separate populations, and monitoring of EMG-correlates in future research are also discussed.

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I. INTRODUCTION

Nature of the problem

During the training phase of a major study at the University of Alberta, Edmonton, employing digital temperature biofeedback in the treatment of migraine headache, it had been noted that some subjects despite more training sessions (mean= 12), were unable to gain voluntary peripheral temperature control while other Ss with relatively fewer training sessions (mean= 8) and less home practice had developed mastery of this skill relatively easily (Sellick, 1981). As well, experience with biofeedback clients by the present writer had also suggested that acquisition of peripheral skin temperature control was highly variable and may be influenced by individual difference factors. These observations led to an interest in the area of biofeedback assisted training of vasodilation or hand warming and to the development of the following study.

A perusal of the literature suggested that the ability to self-regulate hand temperature was indeed highly variable, and that emphasis appeared to be shifting away from examination of factors associated with the biofeedback technology itself towards development of strategies that would take into account individual differences amongst subjects.

Purpose of the study

The area of interest within this dissertation has been limited to vasodilation or more specifically peripheral hand or finger temperature increases. The therapeutic value of the ability to vasodilate has been implicated in the treatment of Raynaud's syndrome (Shapiro & Schwartz, 1972; Jacobson, Hackett, Surman & Silverberg, 1973; Surwit, 1973, 1981), and migraine headaches (Sargent, Walters & Green, 1973), while some recent studies have incorporated thermal training as an adjunct to therapy for depression (Klee & Meyer, 1981) and in the alleviation of asthma (Lerro, Hurnyak, & Patterson, 1980). As well, voluntary vasodilation has been demonstrated as an important factor in the maintenance of hand efficiency and dexterity under cold conditions (Hayduk, 1980). Thus, the delineation or development of more specific strategies for acquiring peripheral temperature self-regulation would be beneficial in shortening client training and acquisition time, and in improving the cost/effectiveness of the therapist. Lastly, if thermal effects could be more consistently and readily induced, it would provide a more rigorous test of hypotheses that link vasomotor activity (both vasodilation and vasoconstriction) with specific disorders (Blanchard, 1979).

Definition of terms. Peripheral temperature, hand temperature, and finger temperature are all used synonymously in the current study. Most studies tend to quantify vasodilation in terms of hand temperature as a dependent variable since it is both objective and relatively easy to measure. However, it should be noted that the relationship between hand temperature and vasodilation is non-linear. Generally speaking, as the blood vessels in the extremities dilate temperature increases. However, since hand temperature cannot increase beyond the core body temperature (36^0 to

37^{o} C), vasodilation may continue to occur eventhough skin temperature has reached a ceiling. These distinct limitations should be kept in mind when peripheral temperature is used as an indicator of vasodilation in temperature self-regulation studies.

Overview of the study

A review of the relevant literature in the area of hand temperature and vasodilation studies with human subjects is presented in chapter II. Classical conditioning paradigms are first examined, followed by studies which link emotions and specific attitudes to physiological changes (or more specifically, hand temperatures). Afterwards, a review of pertinent biofeedback studies and a summary of findings in this area are presented. The chapter concludes with a highlight of some of the problems and limitations within the current research and proposes a number of questions that are worthy of further investigation.

In chapter III, the methodology of the current study and the statistical procedures employed to address the proposed research questions are outlined. The analysis and results of the current experiment are presented in chapter IV, while chapter V contains a discussion of inherent limitations related to this particular study and the area of imagery in general. Some guidelines and suggestions for future research are also presented.

II. REVIEW OF THE LITERATURE

Thermal regulation studies in the areas of classical conditioning, emotionality and biofeedback are examined in this chapter. Short summaries are offered at the end of each section.

Classical conditioning of vasodilation

Classical conditioning techniques have typically involved vasoconstriction (VC) rather than vasodilation (VD) since the former can be readily elicited by any aversive stimulus which maintains constant attention, and has a threat or pain value (Hayduk, 1979). In a typical classical conditioning paradigm, a neutral stimulus (such as a light or a bell) is simultaneously presented with an unconditioned stimulus (UCS, such as an ice bath or hot compass) which produces a change in the hand vasculature. After repeated pairings of the neutral stimulus with the UCS, the neutral stimulus is presented alone. If the neutral stimulus elicits a vasomotor response consistent with the UCS, then classical conditioning is said to have occurred and the status of the neutral stimulus changes to a conditioned stimulus (CS).

Only a limited number of studies have been conducted to examine the feasibility of classical conditioning of the vasodilation response, and are presented below. In general, results have not been promising, and thermal effects were reported as either non-existent or limited in magnitude and duration.

A Russian investigator, Lisina (1965), was one of the first to successfully demonstrate a VD response through an operant-respondent overlap paradigm (Keller & Schoenfeld, 1950) with human subjects.

She initially subjected her naive Ss to a continuous dermal electric shock that produced a strong VC response which was accompanied by brief periods of spontaneous VD. When VD occurred, the shocks were terminated. After 80 such terminations, a conditioned VD response was not evident. However, when subjects were allowed to view a plethysmograph of changes in their peripheral blood flow (in other words, provided with biofeedback), they were able to control their VD responses and thus able to terminate the shocks.

Menzies (1937) inadvertantly demonstrated that other factors influenced voluntary vasomotor control. In one experiment, after four subjects had been conditioned to vasoconstrict upon presentation of a CS (such as a bell, buzzer or nonsense word), they were instructed to recall or think about a visual substitute for the ice-water stimulus (UCS). Three subjects produced a VC response while one responded by vasodilating.

A later investigation by Menzies (1941) along the same themes of his earlier study, found consistent VC responses in subjects who had been conditioned through 40 pairings of a compound vocal and light stimulus with an ice-water bath, but not with subjects who had been presented with a singular-type CS (such as illuminated patterns of X's or self-produced visual imagery of the X's). It was noted that seven subjects were able to influence their hand temperatures through visual imagery of cold or warm life events. One subject reportedly increased his hand temperature by +0.4 C^o and decreased it by -0.4 C^o through imagery.

A more recent study by Hayduk (1979) also incorporated an operant-respondent overlap training procedure in teaching six normal subjects to vasodilate. The CS consisted of two aspects, involving warm imagery and a nonsense word "wek." The UCS was a rubber glove complete with drainage holes which was worn over the hand and had warm water flushed through it at appropriate moments. Subjects while wearing this glove, were asked to cognize images related to warmth, and then say "wek." Immediately afterwards, warm water was flushed through the glove. Thus "wek" and mental imagery were supposedly conditioned to physical sensations of warmth. The conditioned vasodilation episodes lasted approximately 20 seconds and produced temperature changes in the order of 1/2 C^{o}. Hayduk also found that self-generated warm imagery resulted in longer periods of VD (which coincided temporally with the imagery) although the magnitude of temperature change was much smaller (approximately 1/4 C^{o}). The classical conditioned VD response was later used as a starting point for biofeedback training for hand warming (Hayduk, 1980). Subjects were trained over a period of days or weeks until an unbreakable plateau had been reached. In addition to the biofeedback training, Ss were also encouraged to "play around" with finger temperature, to practice frequently throughout the day without feedback, and to later engage in finger movements and manual dexterity tasks while simultaneously maintaining high hand temperatures. An incidental attempt to determine the magnitude of temperature control was made at the conclusion of training and indicated a mean temperature change of +3.16 C^{o} (range 2.0 to

4.2 C^{0}, SD= 0.77). Hayduk (1980) suggested that these results should not be considered as a maximum as initial hand temperatures were high (mean= 30.8^{0} C, range 26.1^{0} to 33.4^{0} C, SD= 2.5 C^{0}) and training effects were therefore limited by a ceiling effect. Self-reports of handwarming strategies were highly idiosyncratic and revealed only one common theme related to imagery. That is, most subjects used either self-induced thermal imagery or imagery of the glove during the conditioning phase of the experiment.

Wiedel (1983) attempted to replicate aspects of Hayduk's (1979) study but also controlled for the influence of somatic maneuvers on hand temperature by monitoring EMG levels on the forearm flexor area. (Studies, reviewed later in this chapter, have implicated muscular activity as a possible mediator of peripheral temperature regulation.) In Weidel's study, 25 normals were placed into either a biofeedback group or one of two classical conditioning groups. The biofeedback group consisted of nine subjects who each received five days of training using an ABAB design. A daily session consisted of five training trials of four minutes each, interspersed with 4-minute baselines. On days 3, 4 and 5, no feedback was provided on the last trial. Feedback consisted of a visual meter and auditory beeps for changes in the positive direction. One classical conditioning group (CCI, n=9) received a 1000 Hz tone for four seconds (CS) followed by a 2-minute application of a 120^{0} F heating pad. Five trials were conducted per day over four days. Assessment of the conditioning effects took place on trial 5 and on days 3 and 4 when the CS was presented alone. On day 5, the CCI group was provided with biofeedback, but the CS was presented prior to each trial. The other classical condition group (CCII, n=7) was allowed to chose a word (CS) which was presented on a slide projector before and during a four minute application of a heating pad. Trials varied over four days and a multiple baseline ABAB design was also utilized.

Wiedel (1983) found no evidence for CS-CR associations for any of the subjects in the classical condition groups, and the addition of biofeedback on day 5 did not result in temperature increases. These results are in contrast to Hayduk's (1979) findings and Wiedel suggests that more pairings may be required to obtain a stronger CS-CR effect. The biofeedback group, on the other hand, by day 3 produced consistent increases in temperature of +1 F^{o} or more above baseline. These increases occurred at trials 1 or 2, but would not increase further within the session. A similar increase in temperature in the non-dominant hand was noted while EMG decreased. Other differences between Wiedel's (1983) and Hayduk's (1980) results may be related in part to differences in the extent of biofeedback training following the conditioning period. Hayduk's subjects were trained until a plateau was reached while Wiedel did not attempt to maximize temperature training following the conditioning phase, although some extended training with four subjects in the biofeedback group another five days did not produce any additional learning effects.

Summary: Classical conditioning studies

Evidence in the above studies to support the efficacy of classical conditioning of the vasodilation response is rather limited. It would appear that respondent conditioning at best produces only small order temperature increases which are episodic in nature rather than sustained. These minimal episodic thermal effects are likely to restrict the clinical utility of classical conditioning paradigms. Other limitations, such as the physical characteristics of the conditioned stimulus may also hinder the transference of learning effects to an environment outside of the laboratory (Taub, 1977). Thus, other approaches to thermal regulation need to be considered. Interestingly, many of these studies indicate, at least indirectly, the usefulness of imagery in assisting or possibly mediating thermal effects.

Emotions

Psychological interest in peripheral skin temperature predates the advent of biofeedback technology. Earlier investigators were interested in the physiological correlates associated with various emotions (Sternbach, 1966) and the effects of hypnotic suggestions, autogenic (AG) training and cognitions (either singularly or in various combinations) on peripheral skin temperature.

Mittlemann and Wolff (1939, 1943) noted that skin temperatures of patients (with Raynaud's syndrome or undergoing psychotherapy) dropped when emotionally ladened topics were discussed. Initially, 203 observations were made on a sample of 47 subjects (19 males, 28 females) and it was found that emotional stress produced a decrease in all but three observations with two subjects (Mittlemann & Wolff, 1939). Temperatures were recorded by a Hardy radiometer on the dorsal side of the phalanges. A second report based on five patients who had received 50-minute interviews five times per week produced similar results (Mittlemann & Wolff, 1943). Patients in the second investigation were also asked what emotions they had experienced during the interviews. The greatest decreases in temperature were associated with simultaneous frustrations related to mate, psychoanalyst, or parents. Other emotional stress, such as, anger, humiliation, embarrassment and joy with anxiety were also associated with peripheral temperature drops, while temperature increases were reported when subjects expressed sexual excitement.

D. Graham (1955) and his associates (D. Graham, Stern & Winokur, 1958; Stern, Winokur, D. Graham & F. Graham, 1961; D. Graham, Kabler & F. Graham, 1962; D. Graham & Kunish, 1965) have also sought to delineate the physiological correlates of various emotions or "attitudes." An attitude was defined as having two components. The first consisted of a subject's self-perception of a given life situation and the second component involved their course of action in regards to that situation (Stern et al., 1961). It was hypothesized that each attitude had its own specific set of physiological correlates and that the attitude associated with Raynaud's disease was "hostility," hives with "mistreatment" and eczema with "frustration" (D. Graham, 1955). D. Graham (1955) working with 19 outpatients with various skin disorders (Raynaud's disease, eczema, hives) found during 32 experimental interviews a mean decrease of 0.8 C^o associated with the attitudes of frustration (range 0.6 to 1.2 C^o), and hostility (range= 0.3 to 1.2 C^o), while apprehension/tension (associated with reactive hyperemia) produced a mean decrease of 0.6 C^o (range 0.3 to 0.7 C^o).

D. Graham et al. (1958) tested the hypothesis that each attitude produced its own specific set of physiological changes. More specifically, a hives attitude would produce a rise in skin temperature, a Raynaud's disease attitude would produce a decrease in skin temperature and a hypertension attitude should be accompanied by an increase in diastolic blood pressure (BP). An original sample of 22 paid normal males was used but this was later reduced to eight due to experimental guidelines which deleted trials when original hand temperatures were below 30^o C or if hand temperatures had decreased by 1.5 C^o prior to the start of the experimental manipulation. Measurements included a sphygmomanometer on the right arm, thermistors on the forehead and dorsum of the left hand, pulse rate, and respiration rate. Trials began with a 10-minute relaxation period, followed by 10 minutes of hypnotic induction (via the ocular fixation method) and ended with 10 minutes of physiological recordings of the induced attitude. For example, the hives attitude was induced by first recalling a situation where one felt mistreated but had no recourse. Then this imaginary situation was described for the subject and the induction was completed by telling the subject that he was about to be burned by a match (at which point, the authors/experimentors would touch him with an unlit match) whilst repeating "you will feel mistreated...you just have to take it" (p. 449). Twenty two experimental sessions were completed and 41 attutude suggestions were made.

Results based on the slopes of graphs indicated that the hives attitude tended to be associated with a rise in hand temperature (but not significantly above control levels); the Raynaud's attitude produced a stable flattish slope whereas the slope of the hypertensive attitude was somewhat inbetween the slopes for the hives and Raynaud's attitudes. No significant differences were noted for systolic blood pressure (SBP), pulse rate (PR) and respiration rate (RR). The mean hand temperature change was +0.11 C^{o} at nine minutes while the Raynaud's attitude produced a decrease of -0.29 C^{o}. Temperature changes measured on the forehead were not considered important because of minimal variance.

This study is fraught with methodological and conceptual weaknesses. Although hypnosis was used, the effects of depth of trance was not considered. Decreases in temperature, after a rise during the relaxation period, were likely due to a startle or orienting response (Soholov, 1969) initiated by the experimenter and could account for decreases as well as increases in observed temperature changes. If an inadequate period of time had transpired before measures were taken, the habituation process may account for increases in hand temperature. A cooling effect might be observed if the startle reflex had not yet stablized. As well, the operational definition of hives is somewhat suspect and the conceptual relationship of specific attitudes to skin disorders is questionable.

Stern et al. (1961) also tested a similar hypothesis relating psychological attitudes (emotions) and specific physiological symptoms. Three attitudes associated with hives, Raynaud's disease, and essential hypertension were tested. Hives and Raynaud's attitudes were used to attempt temperature reversals. Besides temperature, other physiological variables such as SBP, PR, and RR were again monitored. Each session began with a 10-minute relaxation baseline, followed by 10 minutes of hypnosis and attitude induction, another 10 minutes of relaxation and finished with 10 more minutes of hypnosis and attitude induction. Hypnosis was considered only as a technical aid in this experiment. Although 45 hypnotic sessions were conducted with 22 normal males, the final data analyzed was limited to 18 subjects and 28 hypnotic sessions. Results indicated a lack of relationship between SBP, PR and RR with the three attitudes tested. Attempts to produce an absolute rise in hand temperature in opposition to a falling trend were unsuccessful. The hives group could reverse a falling trend but were unable to exceed control temperature levels.

D. Graham et al. (1962) again attempted to further test variations of their earlier specificity of attitude hypothesis for psychosomatic disease. Attitudes tested were associated with hives and essential hypertension. The experimental sessions consisted of a 20- to 45-minute baseline, 10 to 25 minutes of hypnotic induction, 10 minutes of relaxation instruction (a control period), followed by another 10 minutes of hypnotic induction and ending with a second 10-minute control comparison period. During the hives induction, subjects were told that they felt mistreated but were powerless to do anything about it. In addition, they were also told that they would also be burned by a match and were then touched with an unlit match by the experimenter. Apprehension was felt to be characteristic of hypertension and subjects received hypnotic suggestions that they "might be attacked or hurt at any instant" (p.161). Treatments were presented in a counterbalanced order, with half of the Ss receiving the hives attitude induction first, followed by the hypertensiosn induction, while the other half received their treatment in a reversed order. Exclusion criteria (which included: [a] a drop of greater than 1.5 C^{0} in skin temperature during the first baseline prior to induction, [b] a skin temperature drop to less than 30^{0} C, [c] claims of not being hypnotized during inductions, and [d] sudden rises in temperature) resulted in five fewer subjects (with a final sample of 15).

Results indicated very modest changes in temperature (maximim changes of 0.119 C^{0} and 0.043 C^{0}, with a mean temperature change of +.023 and -0.07 C^{0}). The authors felt that temperature increases were minimized due to the relatively high initial skin temperatures. No differential effects any instant" (p.161). Treatments were presented in a counterbalanced order, with half of the Ss receiving the hives attitude induction first, followed by the hypertensiosn induction, while the other half received their treatment in a reversed order. Exclusion criteria (which included: [a] a drop of greater than 1.5 C° in skin temperature during the first baseline prior to induction, [b] a skin temperature drop to less than 30° C, [c] claims of not being hypnotized during inductions, and [d] sudden rises in temperature) resulted in five fewer subjects (with a final sample of 15).

Results indicated very modest changes in temperature (maximim changes of 0.119 C° and 0.043 C°, with a mean temperature change of +.023 and -0.07 C°). The authors felt that temperature increases were minimized due to the relatively high initial skin temperatures. No differential effects were noted for SBP, HR and RR. Weaknesses within this study were similar to those noted in their earlier studies (D. Graham, 1958; Stern et al., 1961) where hypnosis was not considered as an influential variable, exclusion criteria were questionable and the conceptual validity regarding specific attitudes and physiological variables was suspect.

F. Graham and Kunish (1965) later addressed the role of hypnosis in attitude suggestion in two experiments. They attempted to replicate earlier studies but compared the performance of hypnotized and non-hypnotized Ss under the attitudes associated with hives and hypertension. Earlier findings had indicated a small increase in skin temperature and diastolic BP during hives and hypertension inductions, respectively.

In their first experiment 20 normal males were subjected to a 45-minute stablization period (during which the left hand was immersed in a 33° C water bath) then hypnotized. The usual exclusion criteria of a drop of 1.5 C° prior to treatment and a hand temperature below 30^{o} C were used. Although the only measure which differed significantly was systolic BP, the authors contend that the results from this experiment did suggest that waking and hypnotized subjects displayed differential responses in relation to the treatment. The authors indicated that the mean temperatures of the control group was very high (>34^{o} C) and may have diminished the treatment effects. Maximum rises recorded under hypnosis were +.043 and +.199 C^{o} for hypertension and hives, respectively, while under waking conditions, maximum rises were .088 and .109 C^{o}, respectively.

In their second experiment (F. Graham & Kunish, 1965), volunteers for a hypnosis experiment were compared to volunteers for a non-hypnosis experiment. Sessions consisted of a relaxation period, hives induction, a second relaxation period and ended with a hypertension induction. In this study, the hives induction did not include the use of the "burning match suggestion." Results indicated no differences between the two groups. Maximum rises with waking subjects were +.086 and +.177 C^{o} for hypertension and hives, respectively.

A more recent look at the relationship of cognitively induced emotions and hand temperature was conducted by Crawford, Friesen and Tomlinson-Keasy (1977). Hand temperatures of 40 normals (who had been randomly assigned to either an anxiety or pleasant condition) were monitored during their discussions of anxiety producing or pleasure related topics. Results indicated a significant decrease in hand temperature for the anxiety group (mean= -4.3 F^{o}, range +0.1

to -9.5 F^{o}) when compared to the pleasant group (mean= -1.7 F^{o}, range +2.8 to -4.8 F^{o}). The magnitude of temperature change was unrelated to subjects' self-ratings of the intensity of anxious or pleasure related topics.

Summary: Emotions

As pointed out earlier, the series of studies conducted by D. Graham and his associates were fraught with conceptual and methodological shortcomings. The conceptual validity of specific attitudes being associated with particular psychosomatic disorders is questionable. For example, how was the relationship between hives and the attitude of frustration derived? Use of warm water baths influenced baselines and may have caused ceiling effects. Attrition of subjects due to drops in initial hand temperatures and below a specified baseline also served to limit the variance of the data collected. In addition, the role of hypnosis had been largely neglected, and despite the latter study (F. Graham & Kunish, 1965), its influence in affecting physiological changes remains unclear. However, these studies concerning emotions do suggest that hand temperature can be influenced indirectly through the cognitive manipulation of emotions.

Biofeedback studies

Biofeedback training of peripheral thermal regulation has not generally been a matter of simply providing subjects with feedback and allowing them to procede on their own accord. Feedback from peripheral skin sites owes its clinical applications to a serendipitous finding that recovery in a patient during a migraine headache was accompanied by a rapid and large increase in hand temperature (Sargent, Green & Walters, 1973). The method developed by the Menninger group called autogenic feedback therapy, consisted of autogenic (AG) training (Luthe, 1965) in conjunction with temperature biofeedback. The autogenic training component involved passive concentration on AG phrases which focused sensations such as heaviness and warmth to various parts of the body. Thermal imagery which often occurred spontaneously during AG training was also frequently incorporated into the overall training as well.

The general goal in peripheral skin temperature control has been to produce temperature increases that are large enough to be clinically significant and therapeutically useful. Early research involved differential temperature monitoring or simultaneous recording of temperatures from two sites (for example, right and left hands, or hand and forehead) where subjects were required to raise or lower the temperature of one site relative to the other. Later research has focused primarily on temperature regulation from a single site, usually the hand or finger. Difficulties in demonstrating reliable temperature training effects has encouraged research aimed at evaluating the biofeedback process and the contribution of various components to the acquisition of voluntary control. This review attempts to partial out factors that are thought to enhance training effects and concludes by discussing some of the current problems in the area.

A. Instructional variables

A number of studies have examined the relationship between a variety of instructional sets, biofeedback and thermal changes. These include hypnosis and related phenomena, response-specific instructions, awareness, subject expectations and motivation.

Hypnosis and biofeedback

An early study by Roberts, Kewman and MacDonald (1973) investigated the effects of hypnosis and feedback on differential hand temperatures. Six highly hypnotically talented subjects were given 5 to 9 training sessions prior to 3 experimental sessions. In the initial training sessions, biofeedback was not provided. Subjects had warm and cold pads placed on their hands for a few minutes and were then asked to maintain hand temperature differences. Later training and experimental sessions involved tonal feedback which moved synchroneously from the left to right ear phone on the headset as temperature increases in the left or right hand occurred. Results indicated that four of the six subjects were able to accomplish this task (mean differential temperature= 1.98 C^{o}, range 0.8 to 2.96 C^{o}). However, since a variety of strategies was employed to produce the same desired differential temperature response (some subjects lowered the temperature in one hand while holding the other constant, or cooled or warmed both hands at different rates, or diverged the temperatures of both hands) the data is not readily interpretable. The authors suggest that individual differences in regulatory ability were apparent and also suggested that hypnosis or depth of trance may not be as important in learning to self-regulate physiological processes as motivational and training variables, and the ability to alter one's state of consciousness. Limitations within this study were related to a lack of non-hypnotic controls, a small and limited sample size, an absence of baselines and the non-monitoring of gross motor EMG's for possible somatic mediation.

The hypothesis that hypnotic susceptibility and capacity for absorption would enhance autonomic learning was tested in a later study by Roberts, Schuler, Bacon, Zimmerman and Patterson (1975). Hypnotic susceptibility and capacity for absorption were operationalized as scores on the Group Scale of Hypnotic Susceptibility (Roberts & Tellegen, 1973) and the Tellegen Absorption Scale (Tellegen & Atkinson, 1974), respectively. Results supported the above contentions (Roberts, Kewman & MacDonald, 1793) and indicated that peripheral temperature could be controlled voluntarily. However, no relationship was found between hypnotic susceptibility, absorption capacity, and autonomic control. The combination of auditory feedback and hypnosis together makes it difficult to ascertain the contribution of biofeedback to the overall training effects. As an aside, it was also found that somatic activity in the forearm and hand was not associated with peripheral temperature changes.

The contribution of hypnosis to thermal learning effects was further examined in a more recent study by Crossman (1980). He compared skin temperature control during hypnosis under four conditions: biofeedback alone; suggestion and imagery;

biofeedback, suggestion and imagery; and relaxation with false feedback (control). Subjects were 36 female undergraduates who were first given a video-recorded version of the Harvard Group Scale of Hypnotic Susceptibility, Form A (Shor & Orne, 1962) and then stratified according to levels of susceptibility and randomly assigned to one of the four groups. Each subject received 4 experimental treatments on 4 consecutive days when possible (maximum span 8 days). For additional incentive, two $10 rewards were announced for subjects displaying the greatest temperature control. Sessions began with a 5-minute adaptation period which involved the subjects in a distraction task (observing 5-digit numbers on a screen) and was followed by 10 minutes of hypnotic induction. Subjects then received 20 minutes of treatment appropriate to their group assignment. All treatments were designed to maximize the differential temperatures between the dominant hand and the forehead.

Crossman (1980) found that temperatures rose immediately prior to and during the hypnotic inductions, and that subjects with lower baselines tended to show greater increases in differential temperature. Both the biofeedback group and the feedback-suggestion group demonstrated better differential temperature control than the suggestion control and false feedback control groups. Hypnotic susceptibility had no definable influence on temperature control. However, a major flaw in this study involved the use of a distraction task during a very short (and inadequate) adaptation period, which could have increased autonomic arousal (orienting response) resulting in initial temperature decreases. Thus temperature changes observed during hypnotic inductions could be due to the absence of arousing stimuli and habituation to the experimental situation. Estimates from tables presented by the author show finger temperature changes on day 4 in the order of +1.5 and +0.8 F for the biofeedback alone and the feedback-suggestion groups, respectively.

Summary: Hypnosis and thermal changes

Since these studies failed to separate hypnosis related activities and biofeedback training, the individual contribution of each of these variables to thermal training is not clear. Although tentatively speaking, it would appear that hypnosis, hypnotic susceptibility and capacity for absorption are not necessary conditions for developing voluntary control of peripheral temperature.

Response-specific instructions

A number of studies have examined the influence that specific instructions (regarding the target response) might have on acquisition of voluntary skin temperature control.

Keefe (1975) attempted to clarify the specific contribution of biofeedback to thermal training. Studies to this point historically, had incorporated hypnosis, suggestion and thermal imagery (Roberts et al., 1973; Roberts et al., 1975) in conjunction with biofeedback. Two groups of four male undergraduates were instructed simply to increase or decrease their finger temperatures relative to their foreheads. As well, subjects were cautioned not to alter their respiration rates nor to engage in unnecessary movements. Feedback consisted of auditory tones and a television presentation of a thermometer which indicated increases and decreases in finger temperature. Ss received twelve 15-minute training sessions over 12 consecutive days. Training sessions consisted of a 5-minute rest period (of which the last 3 minutes were baseline) and 10 minutes of feedback. Results indicated that all subjects could regulate temperatures in the specified direction. Mean absolute temperature changes at session 12 were +1.7 F^{o} for the increase group, and -1.2 F^{o} for the decrease group. Post hoc inspection of the training sessions revealed that subjects by the end of the fourth session had developed little control over their digital temperatures, but by session 8, temperature control had become evident. In commenting on this study, Keefe (1975) suggested that control groups receiving biofeedback alone and instructions alone were required in future research.

In a subsequent study, Keefe (1978) resumed his investigation into the contributions of biofeedback and instructions to thermal self-regulation. Sixty female subjects were divided into six groups which compared the training effects of (a) response specific instructions (RI) alone, (b) RI plus biofeedback (BFK), (c) thermal suggestions (T) alone, (d) T plus BFK, (e) rest alone, and (f) rest plus BFK. Specific instructions involved describing to the subject the exact nature of the task. The thermal suggestion group was instructed to repeat an autogenic-like phrase "my right arm is warm" while the rest group was required to sit quietly. Subjects received five training sessions which consisted of a 10-minute baseline followed by a 10-minute treatment period where continuous auditory and visual temperature feedback were provided. Keefe found that groups **b**, **c** and **d** were able to produce consistent digital temperature changes after four training sessions. Magnitudes of change ranged from 1.5 to 2.0 F^o degrees.

Vasilos and Hughes (1979) also examined the role that direct instruction, autogenic instruction and relaxation played in the acquisition of hand temperature self-regulation with a male prison population. Sixty prison volunteers were randomly assigned to 1 of 6 conditions: (a) direct instruction, (b) direct instruction and biofeedback, (c) relaxation tape, (d) relaxation tape and biofeedback (e) autogenic suggestion, (f) autogenic instruction and biofeedback. Subjects received both auditory and visual feedback during two training sessions conducted over a period of 3 days. A 15-minute adaption period and a 15-minute baseline was taken prior to training. Both high and low baseline groups showed significant increases in skin temperature although no significant effects were noted as a function of either feedback or instructional sets. Peak temperature changes ranged from +3.12 to +1.49 F^o. The authors indicated that more training sessions may be needed in future research and that mean peak temperature changes were inaccurate indicators of temperature control as many subjects reached maximum temperatures early and returned to near baselines by the end of the 24-minute sessions. As well, Vasilos and Hughes suggest that initial baseline temperatures determined to some extent the magnitude of temperature increases (because of ceiling effects).

Surwit and Fenton (1980) compared the training effects of autogenic instruction alone (AG) and autogenic instruction plus biofeedback (AG+BFK) with a clinical group of 14 females with idiopathic Raynaud's disease. All subjects received six training sessions which consisted of a 10-minute adaptation period followed by a 3-minute autogenic tape and instructions to repeat an autogenic phrase every 15 seconds when signalled by a tone. Half of the subjects received hand temperature biofeedback information during the AG recitation phase of training. In addition, all subjects were provided with a copy of the AG training audiotapes and asked to practice 15 minutes twice per day. Equivalent home practice with liquid crystal thermometers was also encouraged in the biofeedback group. Results showed that hand temperatures increased for both groups during two 85-second segments while they were listening to the AG tapes, but once Ss reached the recitation phase of training, hand temperatures decreased rather than increased. Hand temperatures decreased an average of -1.6 C^o for the AG group while the feedback group, dropped by an average of -0.5 C^o. Surwit and Fenton interpreted these results as supportive of biofeedback, in that the feedback served to minimize temperature decreases by acting as a reinforcer, while greater temperature decreases in the AG group were thought to occur due to a lack of reinforcement.

Surwit and Fenton's (1980) results are difficult to interprete in the absence of a normal control group. It is quite possible that

Raynaud's disease patients react differently to autogenic instruction and biofeedback, and that the laboratory situation may have been stressful for them.

Awareness

In contrast to the Keefe studies (1975, 1978), other authors have questioned whether awareness of the target response in temperature training is a necessary condition or not. Guglielmi, Roberts and Patterson (1982) and Kewman and Roberts (1980) in their reveiw of the area suggested that awareness of the target response was not a necessary condition in biofeedback training. Towards supporting this view, they point out that the success of animals studies employing biofeedback preclude awareness as a learning factor, and that "what is true for rats also applies to humans" (Guglielmi et al., 1982, p. 117). As well, information gathered for a task force of the Biofeedback Society of America (Carlson, 1978) addressing the same issue had indicated that in the majority of studies, awareness was not necessary and in some cases, may be detrimental in the training of humans in HR, EEG patterns, GSR and finger pulse volume. Basic conclusions were that non-awareness produces results that are at least equal to or better than those obtained with awareness.

Using the above rationale, Guglielmi et al. (1982) and Kewman and Roberts (1980) employed a double-blind procedure to study the effects of temperature training on patients with primary Raynaud's disease and migraine headaches, respectively. Hand temperature increases with this experimental design were small. Guglielmi et al. reported an average of +0.537 C^{0} per session (n=36) while Kewman and Roberts reported a mean increase of 0.7 C^{0} for successful learners and 0.3 C^{0} for non-successful learners (n=34). Support for specific treatment effects of temperature training for symptom relief of Raynaud's disease and migraines was equivocal. This finding may have been related in part to the very small magnitudes of change obtained by the subjects, as post hoc regrouping of Ss by Guglielmi et al. indicated that greater symptom reduction was positively associated with increasing magnitudes of temperature change. These studies suggest that awareness of the target response may not be necessary in temperature training per se, but that temperature gains without awareness are likely quite minimal.

Expectation and motivation

The effects of task difficulty and motivation on increases in peripheral skin temperature control were examined by Bergman and McAllister (1982). Forty-seven subjects were randomly assigned to 1 of 6 conditions which involved either thermal suggestion or no suggestion (task difficulty) and 3 levels of monetary incentives or motivation ($.00, $.25 or $.50 for each 0.1 F^{0} rise). Subjects received 3 training sessions with each session consisting of sixteen 50-second trials interspersed with 10-second intertrial periods. Results of this study suggested that Ss under moderate motivation ($.25 per 0.1 F^{0}) and provided with thermal instructions (task easy condition) were able to raise finger temperatures better than a combination of no money, or $.50/0.1 F^{0} and thermal suggestion.

Support for the Yerkes-Dodson law in temperature training was suggested by the authors. However, it should be noted that methodologically, that short discrete training trials likely hinder the acquisition of thermal self-regulation (Andrasik, Blanchard & Pallmeyer, 1982) and that these results may be confounded due to inadequate training procedures.

Summary: Instructional variables

The above studies suggest that biofeedback assisted thermal training can be maximized if subjects are informed as to the exact nature of the task by direct and simple instructions. Awareness of the target response also reduces the length of the training period required to attain similar magnitudes of temperature increase when compared to unaware training conditions. Hypnosis does not appear to be a necessary instructional condition for thermal regulation. Lastly, manipulation of task difficulty (or expectations) through instructions may influence training outcomes.

B. Situational variables

Several investigators have attempted to maximize voluntary thermal control of the extremities through the manipulation of the physical properties of the feedback signal itself or the training environment. Visual, auditory, discrete, analogue and panel meter types of feedback have been examined as well as indoor versus outdoor training, varied ambient temperatures, schedules of reinforcement and length of training.

Feedback Modalities

Two experiments by Surwit, Shapiro and Feld (1976) explored the ability of normals to self-regulate hand temperature with visual feedback alone. In their first experiment, two groups of eight subjects each were provided with visual feedback from the non-dominant hand (via a panel meter) to either increase of decrease their hand temperatures. In addition, Ss received monetary incentives ($.25 per 0.1 C^0 change) for temperature changes in the specified direction. Following two baseline sessions of 45 minutes each, subjects received 5 or 9 days of training. Each training session consisted of twenty 75-second trials with a 10-second intertrial period. Verbal instructions were limited to an explanation of the biofeedback equipment, the importance of relaxing and to think of hands as warm or cool. Results indicated that the decrease group experienced more success (mean= -1.9 C^0) than the increase group, with the best decreases showing temperature changes up to -10 C^0. In contrast, increasers raised hand temperatures an average of 0.25 C^0 between initial and final training blocks, while the best increasers could produce a change of 3.5 C^0 within a single session. Additional sessions given to half of the subjects did not improve the training effects.

In discussing the weaknesses in their original experiment, Surwit et al. (1976) postulated that the ambient temperature utilized (22.5 C^0) was responsible for high initial baseline temperatures (33^0 to 34^0 C) which limited the possiblity of further increases in hand temperature because of ceiling effects. A second experiment with a reduced ambient temperature was conducted to test this hypothesis. Eight novice subjects were trained to increase hand temperatures under identical procedures and conditions as in their first experiment except with a lower ambient temperature (19.5^{0} C). Baseline temperatures associated with this lower room temperature averaged 29.9^{0} C. Results of this study indicated that no subjects had learned to train in the cooler room and that hand temperatures had decreased an estimated average of -0.8 C^{0} during training sessions. In light of these results, Surwit et al. (1976) suggested that the gains observed in experiment I were related to a habituation effect to an initial orienting response produced by the experimental situation and concluded that vasoconstriction was easier to induce than vasodilation. No sex differences were noted in temperature regulation.

Surwit (1977) further compared the effects of a simple versus a complex feedback display. One group (n=8) received analog visual meter feedback while another group (n=7) were provided with visual meter feedback as well as binary feedback in the form of both lights and tones. The latter feedback consisted of four differently coloured lights and pulsating tones that signalled increases and decreases in temperature. As well, a monetary incentive was used to sustain motivation. Both groups received two consecutive days of training. Training sessions consisted of a 30-minute baseline followed by twenty 75-second feedback trials. Although actual figures were not reported, the results indicated that most subjects were unable to increase their hand temperatures above baseline. No significant training effects for modalities were noted.

A number of limitations in Surwit et al.'s (1976; Surwit, 1977) experiments may have contributed to a negative finding regarding learning effects for vasodilation. In the first study (Surwit et al., 1976), limiting feedback to a single modality (visual) may have prevented subjects from experimenting with mediational strategies that involved having their eyes closed, while the latter study (Surwit, 1977) presented two extremes, in terms of feedback, with the possiblity that neither was optimal for training. Lastly, the use of short discrete training trials in both studies likely hindered the acquisition of temperature self-regulation (Andrasik, et al., 1982) and may have produced artifactual results which did not really address the hypotheses. Self-reports or post session questionnaires were unfortunately absent. Information related to the use of spontaneous strategies, and the utility of experimenter's verbal instructions would have been helpful in highlighting the types of difficulties that subjects encountered during training sessions.

Contingent versus yoked feedback.

Stoffer, Jensen and Nesset (1979) compared thermal training effects under contingent feedback, yoked non-contingent feekback and no feedback conditions with 24 internals and 24 external locus of control subjects (Rotter, 1966). In session 1, Ss were given a pretest involving simple instructions to increase hand temperature, followed by a cold stressor test. Then subjects were assigned to 1 of 3 conditions: contingent audio feedback (CF), yoked non-contingent audio feedback (YF), or no feedback (NF); and received 5 bi-weekly training sessions, consisting of a minimum 15-minute baseline (stablization criteria of 2 minutes at +/- 0.1 C) followed by 13 minutes of feedback. Instructions simply asked subjects to increase hand temperature by whatever mental means that they had. Session 7 post-tested the subjects' abilities to voluntarily regulate hand temperature in the absence of feedback and measured reactions to a second cold stressor test. Results indicated that both the contingent feedback and the yoked non-contigent feedback groups were superior to the no feedback group in terms of hand temperature regulation with mean net temperature changes of 0.49, 0.50 and 0.0 C^{o}, reported respectively. Although the contingent and yoked feedback groups did not differ significantly, post-test measures of voluntary hand temperature control (CF= +0.39 C^{o}, YF= +0.13 C^{o}, NF= .00 C^{o}) suggested a trend for the CF condition to be superior to the YF condition ($p < .10$) in producing hand temperature increases in the absence of feedback. No differences were noted for locus of control measures.

Hama, Kawamura, Mine and Matsuyama (1981) tested the efficacy of several kinds of visual feedback in the self-regulation of skin temperature. Twenty-eight undergraduate students were randomly assigned to 1 of 2 differential hand temperature conditions, which required subjects to either warm their dominant hands while cooling the other hand, or to warm their non-dominant hands while cooling the other hand. The seven combinations tested were: (1) no feedback, (2) flickering light, (3) panel meter, (4) light plus panel meter, (5) panel meter plus a money counter, (6) light plus money counter, and (7) light, panel meter and money counter. All subjects received each of the 7 feedback conditions in a random order over 7 sessions. Each session began with an adaptation period (criterion: 3 minutes at +/- 0.1 C^{o}), 10 minutes of training followed by a 3-minute rest period. All subjects received a monetary reward for participation in the experiment. Results indicated that subjects receiving feedback in the form of a panel meter, a light plus panel meter, or panel meter plus a money counter succeeded in regulating hand temperatures in the direction specified. It was suggested by the authors that one or two kinds of biofeedback was optimal and that feedback which is direct and detailed (as in the panel meter) would likely produce the best results.

The study by Hama et al. (1981) is somewhat limited in that no groups received only one type of biofeedback over the entire seven sessions, and the absence of auditory feedback makes conclusions regarding the efficacy of visual types of feedback rather tenuous. As well, because data was based on differential hand temperatures, meaningful comparisons between this study and other modality studies are not possible.

Wiedel and Hawkins (1980) tested the effects of white noise (60dB) on the acquisition of temperature self-regulation. Subjects were 56 right-handed undergraduates who received two one-hour sessions on consecutive days. Each session consisted of a 20-minute baseline followed by 36 minutes of feedback. Subjects were given simple instructions regarding the concept of self-regulation and were familiarized with the biofeedback equipment. The presence of white noise (WN) was not alluded to, for the subjects in the experimental condition. Eight groups corresponding to four feedback conditions (visual deflection meter and auditory feedback [VA], auditory feedback alone [A], auditory feedback plus white noise left ear [A+WNL], and auditory feedback plus white noise right ear [A+WNR]) and two instruction conditions (raising or lowering hand temperature) were compared. Peak change scores for the temperature raisers were for the VA group 2.72 F^o (mean= 1.13 F^o), the A group 1.82 F^o (mean= 0.40 F^o), the A+WNL group 3.78 F^o (mean= 1.12 F^o) and 4.67 F^o (mean= 2.08 F^o) for the A+WNR group. Decreasers obtained peak temperature changes of -5.09 F^o (mean= -4.21 F^o), +0.15 F^o (mean= +0.81 F^o), -0.9 F^o (mean= -1.12 F^o), and -1.34 F^o (mean= -1.23 F^o), respectively.

The authors conclude that temperature regulation in the presence of interference is possible and that increases in hand temperature are easier to produce than decreases. (However, a visual inspection of the their data would suggest that evidence for this latter contention is equivocal.) Weaknesses within this study are related to the limited number of training sessions, the absence of an interference condition for visual feedback, and a need to query subjects regarding self-generated strategies. In addition, the question whether white noise causes interference or forces more directed attention to the feedback signals should be asked, as subjects in the white noise conditions appeared to out-perform Ss in the auditory condition alone.

C. Feedback characteristics

Analog versus discrete

Cross, Davenport and Nickerson (1982) compared the relative efficacies of analog bidirectional feedback (ABD), with discrete unidirectional feedback (DUD) in thermal training. Cross et al. tested the suggestion made by Taub and School (1978) that temperature feedback of changes in the wrong direction be limited, so as to minimize subject discouragement or anxiety. The experimental design utilized was analogous to Carlson's (1980) study comparing analog and discrete auditory feedback in EMG training. Twenty-nine undergraduates (18 females, 11 males) received four thermal training sessions and were instructed to produce hand temperature changes in the opposite direction from baseline trends. One group (12 increasers, 5 decreasers) heard a continuous tone that increased with increasing hand temperature and decreased in pitch with decreasing temperature (ABD). The second group (10 increasers, 2 decreasers) heard a tone only when skin temperatures changed in the instructed direction (DUD). Results suggested that subjects in the ABD condition learned more quickly although the analog condition was superior to the DUD conditition only in the first session. No significant differences were noted in final learning effects (mean change= 0.9 F^{o}), although the absence of visual feedback may have contributed to this modest outcome. Gross et al. point out that their results did not parallel Carlson's (1980) finding that discrete feedback was non-conducive to EMG reductions.

Continuous versus discrete schedules

Andrasik and his colleagues (Andrasik, Blanchard & Pallmeyer, 1982; Andrasik, Pallmeyer, Blanchard & Attanasio, 1984) have made two reports comparing massed (or continuous) and distributed (or discrete) schedules of biofeedback in thermal training. Andrasik et al. (1982) divided a vascular headache sample of 18 subjects into two groups, with each group receiving twelve training sessions for hand warming. Procedures were identical for both groups, except one group was presented with 20 continuous minutes of either auditory feedback, auditory feedback or both, while the other group received 20 one-minute training trials (50 seconds feedback, 10 seconds rest). Results indicated that the continuous feedback facilitated thermal training to a modest degree (mean= +0.7 F^{o}) while a discrete schedule impaired performance (mean= -2.0 F^{o}). Patients in the discrete feedback condition reported that the frequent breaks were disruptive to concentration and progress, while many subjects in the continous feedback group indicated that the 20 minute period was too long. Andrasik et al. (1982) suggest that an optimal feedback schedule would be a compromise consisting of 4 to 5 minutes of feedback separted by 30 to 45 second breaks.

A second similar article by Andrasik, Pallmeyer, Blanchard and Attanasio (1984) comparing the efficacy of continuous versus discrete schedules of feedback in hand warming training reported very similar results. Subjects were 18 vascular headache patients who had failed to respond to Jacobsonian deep muscle relaxation. After sampling both auditory and visual types of feedback, subjects were allowed to chose the type of feedback that they preferred. Two groups were formed and each received 8 training sessions and continued with home practice with either a liquid crystal thermometer or an inexpensive thermometer. Procedures for both groups were identical with the exception that one group was presented with a single block of 20 minutes of feedback, while the other received twenty 50-second feedback trials with a 10-second intertrial period (as outlined in Taub & School, 1978). The experimenters also instructed Ss to adopt a passive volitional stance of letting, rather than forcing the response to occur. Results indicated that a continuous schedule was superior to an interrupted or discrete schedule in terms of hand warming effects. The continuous group increased mean hand temperatures by an estimated 0.7 F^{0} while the discrete group decreased hand temperatures -2.0 F^{0} over the same training period. The conclusions from this study should be treated tentatively, as the continued use of medications by all but four subjects, and the variations in feedback chosen by the subjects tend to confound the interpretation of the data. Further research with normal subjects using a similar paradigm would be benifical.

D. Training: Situational variables

Mono- versus bi-directional training

Funk and Wiedel (1981) compared thermal training effects produced by monodirectional and bidirectional finger temperature training. Although all subjects received three sessions, only the first two were focused on training. A control group of 10 Ss were instructed to raise hand temperatures only while 11 Ss in the bidirectional group raised and lowered hand temperatures on alternate training trials. Each one hour session was broken into 15 minutes of adaptation, 10 minutes of baseline, and ended with three, 10-minute training trials. All subjects were provided with both visual and auditory feedback. Ability to regulate hand temperatures with and without feedback, and under a cold stressor condition (non-dominant hand in ice water bath) was assessed during session 3. No differences were noted between groups for ability to increase hand temperatures in the absence of feedback, or in pain self-rating and immersion times during the cold stressor test. A mean peak temperature increase of 2.93 F^{0} was reported for successful trainers in both groups (six from each condition) during the final session, while non-successful trainers decreased -0.5 F^{0}. The authors conclude that bidirectional training does not lead to faster acquisition or greater control. However, since the number of training sessions employed in this study was less than optimum (Keefe & Gardner, 1979) their conclusion must be considered tentative at present.

Ambient Temperatures

Donald and Hovmand (1981) have addressed the issue of the law of initial values (Wilder, 1962) in hand temperature training or more specifically, the possiblity of ceiling effects associated with high basal hand temperatures. Others (Taub, 1977; Hayduk, 1979; Surwit, Shapiro & Feld, 1976; and Surwit, 1981) have suggested that initial baseline hand temperatures influence the magnitude of training effects. That is, lower initial temperatures allow for greater magnitudes of skin temperature increases, whereas gains at relatively high baselines are influenced by the asymptotic limits of basal body temperature. In Donald and Hovmand's study, ambient air temperature was varied about the target limb only, by means of a modified refrigerator fitted with a plexiglass door and armhole. Subjects placed their right arm into this container, and ambient temperatures were set at 10 C^o (cold condition), 24 C^o (normal), and 38 C^o (hot). Thirty subjects each received one biofeedback session under each condition, according to a Latin square design. To limit somatic mediation (see King & Montgomery, 1980) subjects' EMG levels on the extensor communis digitorum were monitored and Ss were required to maintain a criterion level of less than or equal to 5 microvolts prior to temperature training. Subjects were next familiarized with the biofeedback equipment which provided a digital display and a bidirectional analog auditory tone. Each session began with a stablization baseline (criterion: last minute at +/- 0.1 C^o) followed by four 5-minute training trials, with 2-minute intertrial baselines. Within each session, subjects were required to raise or lower hand temperatures in a counterbalanced order. Changes in hand temperature were based on differences between prior baseline and temperatures at the end of a training trial. (This procedure resulted in increased baselines prior to finger temperature decreases and decreased baselines prior to increase instructions.)

The instruction to increase led to a mean change of +0.159 C^{O} with the largest increase occurring in the hot temperature condition (approximately 0.225 C^{O}), while decrease instructions led to a mean change of -0.116 C^{O} with the largest decrease occurring in the cold condition (approximately 0.16 C^{O}). No significant interaction was noted between ambient air temperature levels about the arm and the ability to regulate skin temperature. However, Donald and Hovmand's (1981) contention that skin temperature changes "induced voluntarily or involuntarily, do not appear to conform to the law of initial values" (p. 807) may be somewhat premature as methodological and other considerations, such as the limited number of training sessions (Keefe and Gardner, 1979), the kinds of instruction and strategies provided (Keefe, 1978), the superiority of visual meter feedback to visual digital feedback (Taub & School, 1978), and the increased difficulty of learning temperature control with alternating increase and decrease instructions, may limit the implications of their study. A replication study, perhaps with a 2X3 design (increase and decrease instructions across three temperature conditions) with extended training would produce more valid results.

Number of training sessions

The number of training sessions required to develop thermal effects has been examined by several researchers in an exploratory manner (Taub & Emurian, 1977) but only one study appeared to address this question directly (Keefe & Gardner, 1979). Many studies into thermal effects have used very short training periods and as a consequence have found very limited training effects.

An example of a rather poor study into thermal training effects was carried out by Broder (1979) with 40 undergraduate females. Subjects each received one session of biofeedback and were required to raise hand temperatures during the first trial and to lower hand temperatures in the second trial. A 5-minute baseline was taken prior to the training trials and 45-second baselines were recorded between trials. Equal numbers of external and internal locus of control (LOC) subjects were placed in conditions where they were presented with no feedback, contingent feedback and non-contingent feedback. Feedback consisted of auditory beeps that increased and lowered in pitch simultaneously with temperature increases and decreases. Since the training period was inadequate, it is not surprising that the results indicated no benefits from the presence of feedback, and that increases in hand temperature were likely due to habituation effects. Results for LOC were not reported.

A better study by Keefe and Gardner (1979) examined the relationship of length of training and acquisition of peripheral temperature control. In their first experiment, 10 undergraduate males were randomly assigned to either an increase or decrease condition. Instructions were simple and response specific and both auditory and visual feedback were provided. Each subject received five 30-minute training sessions over five consecutive days. Each session consisted of a 10-minute adaption period followed by brief instructions, a 10 minute baseline period and concluded with 10 minutes of feedback. Results indicated that all subjects could control finger temperatures in the specified direction with mean changes by day 5 of +2.5 F^0 and -2.9 F^0 reported. Post hoc analysis suggested that subjects could significantly raise or lower hand temperatures by the third day of training.

A second experiment (Keefe & Gardner, 1979) with extended training was conducted to test whether more training would result in a greater learning effect. Six female undergraduates received 20 sessions of biofeedback over 5 consecutive weeks (Monday to Fridays) to increase finger temperature. Procedures were the same as in experiment I. The results indicated that overall temperature changes were small in magnitude and the maximum temperature increases were attained by day 3. Keefe and Gardner concluded that extended training in itself was not effective in improving temperature increases and that there was no evidence regarding sex differences in peripheral temperature regulation.

These studies suggest that three to five days of biofeedback training are necessary before learning effects become evident. They also suggest that more training does not necessarily lead to greater magnitudes of hand temperature change.

Adequacy of baseline

Kappes and Morris (1981) attempted to determine a minimum baseline period which they felt would be adequate for hand temperatures to stablize before the commencement of thermal training. Subjects (59 psychiatric and 57 staff) had been asked to refrain from eating, drinking, smoking and exercise one hour prior to having their hand temperatures monitored for a 30-minute period. Kappes and Morris found a 3 to 4 F^{0} rise in temperatures within the first 20 minutes of subject immobility and suggest that a 20-minute baseline period would be adequate to limit temperature increase artifacts. The authors also noted that their data was confounded by the use of medications within their psychiatric sample.

Ubiquitous drugs

Asterita, Smolnicky and Iatridis (1981) trained EMG reductions with seven subjects under three conditions. All subjects received five training sessions to reduce EMG levels and were placed in groups that received (a) no caffeine, (b) low dosage decaffeinate coffee, and (c) moderate caffeine dosages (120 to 140 mgm). Other physiological parameters such as heart rate, peripheral temperature, blood pressure and respiration rates were monitored during the training. Results indicated that baseline EMG levels were elevated by caffeine but that biofeedback training could reduce these levels significantly. Hand temperatures dropped (1.21 to 0.94 F^{0}) in the low dosage condition only, and it was noted that peripheral temperatures were higher during baselines and self-regulation periods for caffeine conditions than during the control condition.

Asterita et al. suggest that this finding may reflect the relaxant effects of caffeine on smooth muscle.

Moss, Hammer and Sanders (1984) compared the effects of cigarette smoking and mock smoking on skin conductance, heart rate and hand temperatures. Nine smokers and nine non-smokers served as subjects and two comparisons were made: (a) smoking versus mock smoking in the smoking group only, and (b) mock smoking conditions for both smokers and non-smokers. Moss et al. found their results similar to previous studies in the area (Ague, 1974; Frankenhauser, et al., 1970) and observed increases in heart rate and decreases in skin temperature. Non-smokers exhibited greater increases in skin conductance levels during mock smoking and greater lability in skin conductance levels during the post-mock smoking period, but these findings could not be readily interpreted. Of interest to thermal training is the discovery of a rebound temperature effect in smokers. Monitoring of hand temperatures following the smoking of a cigarette revealed an initial sharp decrease in hand temperature of approximately -4 F^{0}, which continued on a downward trend for 15 minutes at which point, hand temperatures began to increase. Moss et al. suggest that thermal training involving smoking subjects need to be aware of this rebound temperature effect and not to confuse it with training effects.

Summary of modalities and situational variables

The above review of the literature suggests that many of the earlier studies into learned thermal effects were weak methodologically and were therefore inadequate tests of the hypothesized relationships. However, it should be pointed out that many later studies, which examined the adequacy of training conditions, were not immune to methodological and design flaws as well. For example, some studies have limited the combinations of feedback available (Surwit, et al., 1976; Hama, et al., 1981) and have employed relatively weak training procedures and schedules to compare their relative efficacies. Thus, only tentative statements regarding a minimally adequate training environment can be advanced at this time.

With the above caveats in mind, the following guidelines are proposed. The use of visual meter feedback alone (Hama, et al., 1981; Surwit, et al., 1976) may or may not be sufficient for thermal increase effects, while overly complex feedback displays (Surwit, 1977) may be non-conducive towards developing hand warming ability. A combination of visual and auditory analogue feedback is likely the most informative and the least restrictive in terms of limiting Ss' spontaneous strategies towards producing the desired response. Bidirectional training does not produce superior training effects to monodirectional training (Funk & Weidel, 1981) and continuous schedules of reinforcement are superior to discrete training periods involving frequent starts and stops (Andrasik, et al., 1982). A 20-minute baseline has been proposed as an adequate time period in which artifactual thermal effects can be minimized (Kappes & Morris, 1981) (while Taub and School [1978] suggest that five days of baseline recordings would be more ideal), and three to five training sessions are necessary before learning effects become evident (Keefe and Gardener, 1979). Lastly, although the study by Donald and Hovmand (1981) suggests that the law of initial values (Wilder, 1962) may not apply to thermal training, it is probably judicious to choose subjects for thermal regulation investigations with hand temperatures in the normal range (85^{0} to 91^{0} F). Results from such subjects may be more representative of the general population.

E. Mediational Strategies

An exploratory study

Taub and Emurian (1976) conducted several exploratory studies in the area of peripheral thermal self-regulation. In their initial experiment, 21 subjects were provided with a variable intensity light as feedback, and trained to change hand temperatures in the direction opposite to baseline trends (resulting in 9 increasers and 12 decreasers). The experimenters conveyed positive expectancies to subjects by indicating that everyone was capable of developing thermal control, and expressed a confidence in their ability to do so as well. Utilization of thermal imagery was encouraged as well although the content of the imagery was at the subject's disposal. Monetary incentives ($.25 per 0.25 F^{0} change) were included and graphs of each session and performance were discusssed with subjects. All Ss received a minimum of four training sessions although some received more. Training involved 15 trials of 60-seconds each, with a 5-second intertrial period. Results of this experiment indicated that 19 of the 21 subjects were able to self-regulate their hand temperatures and that demonstration of this learning effect rarely required more than 4 training sessions. The mean change score based on training days 4, 5, and 6 was 2.2 F^{0} per session (range 0 to 6.5 F^{0}). It was also found that the magnitude of decreases in temperature was 0.4 F^{0} more than for increases and that monetary incentives produced a 0.7 F^{0} greater change than did flat rate payments.

Bilateral control was demonstrated in a second experiment (Taub & Emurian, 1976) by extending training in the opposite direction of the original training for the seven best subjects. Of these, four who had trained the longest, were able to alternate hand temperatures in opposite directions during successive periods on the same day. Temperature increases of up to 14 F^{0} were observed while the largest rate of change observed for any subject was 9 F^{0} within a one-minute period. Temperatures returned to baseline when subjects were asked to relax.

The effects of somatic maneuvers on hand temperature were addressed in a further experiment by Taub and Emurian (1976) who had instructed Ss to engage in various arm manipulations and movements of the ipsilateral and contralateral arms. It was found that movements of the ipsilateral arm produced minimal effects on hand temperature (for example, raising arm: mean change= 0.8 F^{0}; lowering arm: mean change= 0.2 F^{0}; forming a fist: mean change= 0.7 F^{0}; tensing hand and arm: mean change= 0.4 F^{0}; flexing arm: mean change= 0.6 F^{0}; overall mean change= 0.5 F^{0}). Similar manipulations of the contralateral arm resulted in even smaller temperature changes (mean change= 0.1 F^{0}). Based on these findings, Taub and Emurian (1976) concluded that somatic maneuvers were of limited importance in mediating hand temperature changes since highly trained subjects in their experiments could produce far greater magnitudes of temperature change.

In discussing the implications of their research, Taub and Emurian (1976) pointed out the following. First, it was postulated that biofeedback played an essential role during the training phrase, but once voluntary hand temperature control was acquired, biofeedback was no longer necessary. Second, a more or less serendipitous find, that experimentor's attitudes and interpersonal behavior (or person factor) were very influential in determining the success of temperature training. It had been observed that one experimenter with a friendly informal approach succeeded in training 19 of 21 subjects, while another experimenter who was impersonal and skeptical about the feasibility of the task, succeeded in training only 2 of 22 subjects. Lastly, little relationship was noted between subjects' reports of strategies and the degree of control acquired. In general, determination and focusing of attention was associated with less control, and thermal imagery was not an important vasomotor mediator. A relaxed attitude or "passive volition" (Green, Green & Walters, 1970) was reported to be the most conducive towards increasing and decreasing hand temperatures in the early stages of training, whereas at a later stage of training, subjects were unable to describe what they did exactly.

Major weaknesses in Taub and Emurian's (1976) work include the absence of control groups, and the confounding of several independent variables simultaneously which renders the task of interpretating the data more difficult. Thus, the results and conclusions based on these experiments should not be considered definitive, but rather as suggestive of directions for further research.

Self-induced strategies

Very few studies have focused on the types of strategies employed by subjects to raise peripheral skin temperature. Most information in this area has been gathered through self-reports that have been carried out in an ad hoc fashion. Very few studies have provided structured strategies for subjects to employ during the course of training.

Libo and Fehmi (1977) queried 20 migraine headache and 20 anxiety/tension clients regarding personal strategies. All the headache patients apparently could raise their hand temperature +1.5 F^{0} above baseline after one to four sessions while only 14 of the latter group were able to do so. Most subjects began training by focussing on the hand or on images of warmth. However, half of the subjects later shifted strategies or did not stay with any specific strategy. Many simply "just let it happen" or focussed on neutral objects. Techniques similar to meditation and autogenic training were also noted. Unsuccessful trainees tended to focus on unpleasant thoughts, to be self-critical or to will the changes desired, and were affected by performance anxiety. No differences were apparent for age, sex and geographic locations. This anecdotal report by the authors suggests that further investigations into the relative effectiveness of various vasodilation strategies might be fruitful.

Fisher and Winkel (1978) administered a post-session questionnaire regarding self-generated strategies to 24 normal male subjects who had participated in 5 operant conditioning sessions of the cephalic vasomotor response. Subjects had been assigned to either a vasodilation or constriction group (12 in each group). Feedback was provided in the form of a white light. Six Ss (5 VD, 1 VC) reported that they were unaware of how they had affected the change. The remainder indicated that concentration of thought (ranging from a girl to lectures) had been used. Eight of the 11 vasoconstrictors who had used this strategy initially, switched to a single focal point of attention by the end of the second session. VD subjects appeared to have greater difficulties in formulating a successful strategy and frequently changed focal images throughout the session. The mean number of strategy changes in the constriction group was 1.1 while the VD group reported 3.7 changes. None of the subjects in either group reported using direct somatic mediation. The authors found that operant control of vasodilation required more time than VC and speculated that the differences might be related, in part, to the formulation of a successful cognitive strategy. They believed that cognitive strategies, although not necessary, were facilitative in the modification of cephalic vasomotor responses.

Somatic mediation

As noted earlier, Taub and Emurian (1976; Taub, 1977; School & Taub, 1980) have suggested that the effects of gross motor manipulations were minimal and of limited importance in the mediation of thermal effects. More recent investigations by King and Montgomery (1980, 1981) suggest that somatic maneuvers may be more central then earlier believed in mediating changes in skin temperature. King and Montgomery in a series of experiments have contended that in the absence of somatic maneuvers, voluntary hand temperature control is not possible.

In experiment I, King and Montgomery (1980) randomly assigned 24 subjects to 1 of 4 conditions involving a pre- and post-test design and five training sessions. Six subjects in each group received (a) instructions alone, (b) contingent feedback, (c) non-contingent feedback, and (d) contingent feedback plus money, respectively. All groups were provided with specific instructions regarding the nature of the task and the possible use of thermal imagery and autogenic phrases in assisting hand temperature change, but were cautioned to avoid strategies involving physical maneuvers. All subjects were paid one dollar. Only auditory feedback was provided and subjects were trained while laying horizontally on a surgical table. Recordings of sessions from the contingent feedback group were played for the non-contigent group. Subjects in condition "d" heard a bell for every 0.25 F increase which indicated that they had earned 50 cents. Results from this experiment revealed non-significant differences between groups in terms of within session or absolute finger temperature changes.

In experiment II (King & Montgomery, 1980), all subjects (24 females, 8 males) received specific instructions regarding the nature of the task as well as three minutes of autogenic phrases and guided thermal imagery interspersed throughout the five training sessions. The four treatment conditions consisted of (a) instructions alone, (b) contingent feedback, (c) non-contingent feedback, and (d) contingent feedback plus somatic activity. The latter group was instructed to experiment with various minor somatic strategies (for example, respiration rate changes, muscle tension, and relaxation) but were not allowed to engage in gross motor activity.

Results indicated that the somatic group produced the greatest within session temperature increases during the fourth session (mean= +5.23 F^{o}) and had the greatest increase during the posttest when feedback was absent (mean= +4.35 F^{o}). No significant differences were noted between the autogenic instruction group and contingent feedback group, nor between the autogenic-like instruction group and the non-contingent feedback group. However, significant differences were noted for both the within session and absolute finger temperature changes between the contingent feedback group and the contingent feedback plus somatic activity group.

Two further group studies by King and Montgomery (1981) examined the role of somatic mediation in hand temperature control.

They tested two hypotheses, one which suggested that muscular activity in the ipsilateral arm would increase hand temperatures due to increased blood to that region of the body, and secondly, that relaxation of the target arm should produce sympathetic vasodilation and increase cutaneous blood flow. Twenty-four normals (14 females, 10 males) were randomly assigned to three conditions:
(a) contingent feedback plus instructions, (b) contingent feedback, instruction and muscular activitiy, and (c) contingent feedback, instructions and relaxation. All subjects received five training sessions and a pretest and posttest were also administered. Results from this experiment indicated that the group utilizing somatic activity was the only group to demonstrate consistent increases in finger temperature.

In a second experiment involving bilateral temperature changes, King and Montgomery (1981) postulated that contralateral static muscle contractions would be associated with decreased finger temperatures. Twenty subjects were randomly assigned to either one of two conditions: (a) feedback plus somatic activity to increase hand temperature, or (b) feedback plus somatic activity to decrease hand temperatures. Results indicated that the first group had increased hand temperatures an average of 2.93 F^{0} between pre- and posttests, while the latter group decreased hand temperatures by -1.92 F^{0}, between pre- and posttests. Self-reports by subjects indicated that intermittent muscular activity in the ipsilateral arm was used to produce temperature increases, while decreases were obtained through intermittent contralateral arm tension or sustained ipsilateral arm tension.

Short comings in the King and Montgomery (1980, 1981) studies relate to the absence of EMG monitoring for somatic maneuvers and the lack of constraints to prevent artifactual increases due to positioning of fingers towards the body, palms or other heat sources. Furthermore, the reliability and validity of self reported information has inherent limitations. However, their findings do challenge the traditional views that peripheral blood flow and skin temperature are centrally mediated through the central nervous system (for example, medulla, hypothalamus, and cortex).

Further investigations into the relationship of muscular contractions and hand temperatures lend some support to King and Montgomery's hypothesis. Donald and Hovmand (1981) found minimal temperature increases in the index finger (.2 to .3 C^O) when subjects were required to maintain integrated EMG levels of less than 5 microvolts in the ipsilaterateral forearm. Rattenbury and Donald (1982) found that decreases in hand temperatures were associated with increases in EMG levels in the ipsilateral forearm. Subjects were required to maintain various forearm tension levels for three-minute periods. Decreases of 1 C^O were associated with EMG levels of 45 to 50 microvolts, while drops of 2 C^O were recorded after two minutes when forearm tensions were approximately 200 microvolts. These researchers further argued that increases in hand temperature could also arise in situations where the baseline EMG levels were 15 microvolts or higher, and as subjects relaxed, hand temperatures would increase. In contrast, Cincirpini (1982), rather than attempting to manipulate hand temperatures directly, trained Ss to relax their frontalis muscle with the aid of EMG feedback, while monitoring concommitant changes in hand temperature. Results suggested that hand temperatures increased as frontalis EMG levels decreased (r= -.32), and that lower EMG levels (<3 microvolts) were associated with greater hand temperature increases.

Although the kinds of somatic maneuvers were rather limited in these studies relative to those reported by King and Montgomery, they do suggest that an inverse relationship exists between tension levels (in the ipsilateral forearm or frontalis muscles) and hand temperatures. In addition, these studies also suggest that EMG levels need to be monitored in thermal training studies to minimize the possiblility of somatic mediation.

F. Thermal suggestion and imagery

A number of studies have indicated that suggestions produce, or are associated with thermal effects. An early anecdotal account by Hadfield (1920) related large changes in hand temperature brought about by suggestions made to a female patient in the waking state. She was able to control hand temperature bidirectionally by first reducing the temperature of her right hand to an ambient temperature of 68^{o} F (while maintaining her other hand at 94^{o} F) and then increasing the same hand back to 94^{o} F. As well, Hadfield was able to induce blister development with this patient through hypnosis and could also control through suggestion the absence or presence of the pain and inflammation associated with the blister.

Dugan and Sheridan (1976) found a relationship between suggestion and instructed imagery on hand temperatures. Images of warm and cold hands were associated with actual warming and cooling of hands. All 10 subjects in the cooling imagery group reliably cooled at least one hand (six Ss cooled both hands, peak change = -1.91 F^{O}), while five of six subjects could warm one hand a small magnitude. This study was rather limited in that subjects were not provided with feedback and training was limited to one session.

Two experiments by Herzfeld and Taub (1977, 1980) also explored the influence of thermal suggestions on the self-regulation of hand temperatures. In their first study (Herzfeld & Taub, 1977), baseline temperatures were monitored over three non-training days and hand temperature changes during the last 4 minutes of a 15-minute period (equivalent to trial periods on training days) were also recorded to "ipsitize" the results from training days. Training involved 10 sessions, with each session consisting of fifteen 50-second trials with 10-second intertrial periods. Hand temperature changes were recorded during the final four trials of each session. Five paid subjects were trained to regulate hand temperatures in the direction opposite to their baseline trend, which resulted in two increasers and three decreasers. Suggestion was operationalized as slide projected images accompanied by a tape-recorded statement to elicit thermal reactions. For example, a warm imagery slide of a girl sunning herself on the beach was accompanied by the following verbal instructions: "Imagine (yourself) lying on the beach with the hot rays of a the sun beating down on your hands" (Herzfeld & Taub, 1977, p. 24). Subjects were to serve as their own controls and hand temperature changes on non-suggestion training days (feedback alone) were compared to those obtained on alternate suggestion days (feedback plus suggestion). Because Herzfeld and Taub (1977) contend that voluntary hand warming and cooling are equally difficult tasks, data were collected in terms of absolute temperature changes. These change scores were then ipsitized with non-training baseline days. (For example, if a subject had a rising baseline trend, he would be trained to hand cool, and his overall temperature change would be equal to the actual decrease plus the amount that he was above baseline during the non-training days.) Results from this study indicated an overall mean change of 1.8 F^{o} and that mean temperature changes on non-suggestion days averaged 1.3 F^{o}. Thus, imagery and suggestion was thought to improve training by at least 0.5 F^{o} over biofeedback alone.

A second experiment by Herzfeld and Taub (1980) tested a similar hypothesis while attempting to limit some of the problems related to the use of thermal imagery strategies by subjects on non-suggestion days, and equating treatment and control conditions. Baselines were obtained over five days, and temperature change scores were ipsitized as before. Two groups of six subjects each (9 coolers, 3 warmers) each received 8 training sessions with either thermal slides and audiotapes plus feedback, or neutral slides and audiotapes plus feedback. The neutral slides consisted of geometric patterns and were accompanied by definitions from the area of electronics. Ipsitized results indicated that the non-suggestion group averaged a mean change of 0.73 F^{0} while the suggestion group obtained a mean change of 2.01 F^{0}. The authors contend that the difference of 1.28 F^{0} is a more accurate indicator of the extent to which suggestion and guided imagery can enhance thermal biofeedback.

Although enlightening and considerate of the inherent difficulties in studying thermal regulation, the Herzfeld and Taub (1977, 1980) studies have a number of limitations. The literature generally suggests that hand warming is more difficult than cooling and if, this indeed is the case, the reporting of absolute temperature changes based on a high percentage of subjects as decreasers, would tend to inflate the magnitudes of temperature regulation. Results might be better reported separately for handwarming and cooling. Ipsitization of scores, also tends to inflate the final outcomes and although it is an attempt to take into consideration individual differences in terms of temperature variablility, one cannot be certain that hand temperatures of subjects who have not had 5 baseline days would vary in the same manner as Ss who have endured 5 days of baselines. As well, the use of discrete training trials has been found to be less conducive to thermal warming, and lengthier training trials may produce quite different results. Lastly, individual differences (such as visualization ability and cognitive styles) might also be addressed in relationship to suggestion and imagery instructions in thermal training.

Gillespie and Peck (1980) compared the efficacy of biofeedback training alone to guided imagery. Attempts were made to equalize the presentation of feedback and imagery during baseline and treatment conditions. Measures of locus of control (LOC) were also taken. All sessions including baselines consisted of ten 80-second trials with 10-second intertrial intervals. During baseline 1 conditions, subjects observed slowly changing meaningless numbers on a screen, while the second baseline was obtained while viewing geometric patterns. Temperature changes during the baseline were used to ipsitize (Taub & Emurian, 1976) temperature changes observed during training trials. Following baselines, six Ss received five sessions of digital feedback presented on a screen and six Ss received 10 slides accompanied by 10 auditory statements of warm themes. The biofeedback group were simply instructed to devise their own strategies, and perhaps to use some form of mental control.

Results indicated that biofeedback was superior to guided imagery. Although significant differences were observed (biofeedback group mean change= +0.22 C^{o}, guided imagery group mean change= -0.60 C^{o}), individual subjects in both groups were unable to demonstrate reliable hand temperature changes. High basal temperatures in three Ss (35^{o} C) and inability by one subject to increase hand temperature were cited as reasons for the limited magnitude of mean temperature change in the biofeedback group. Lastly, no relationship was found between locus of control and hand temperature regulation.

A number of shortcomings were noted in the Gillespie and Peck (1980) study. Firstly, digital feedback alone is not as effective in thermal training as analogue meter feedback (Taub & School, 1978), and perhaps not as effective as visual and auditory feedback together. Secondly, short discrete training trials are not as effective as longer continuous trials of 5-minutes or more (Andrasik et al., 1984). Thirdly, EMG levels of the target limb were not monitored for the possiblility of somatic mediation (King & Montgomery, 1981), and lastly, self-strategies used by the biofeedback group were not queried at the completion of the training.

The relationship between mental imagery ability and physiological change was examined by Proudfoot (1983). He noted in his review of the literature that the notion of imagery encompassed several dimensions (which included: verbal processes, affective states, ideation, perception, physiological states and cognitive tasks) and that existing measures of imagery ability were inadequate. It was contended by Proudfoot that higher imagery ability would be correlated with greater physiological changes during the imaging of subjects' presenting problems. The ability to image was assessed with the Survey of Mental Imagery (SMI, Switras, 1978) which includes measures of image control and vividnesss, as well as providing sensory subscales related to the visual, tactile, somesthetic and kinesthetic modalities. A sample of 72 normal females and 14 males received one treatment session in the following format: a 5-minute rest period; 2 minutes of imaging their presenting problem at its worst; 4 minutes of rest; three (30-second) muscle control conditions, and a final 2-minute rest period.

Multiple correlations indicated that the total controllability score and the total vividness score were correlated with subjects' temperatures (mean change= -.029 F^0, range -2.35 to 12.6 F^0). EMG and GSR levels were not related to SMI scores. Although voluntary control of temperature was not the aim of this investigation, it does suggest that cognitive (or imagery) abilities could play a useful role in temperature control.

Nigl (1980) investigated the effects of warm images on hand temperatures, and the relative efficacy of various stimuli to induce vasodilation. Forty-eight normals (33 females, 15 males, ages 19 to 43 years) were administered the Betts Questionnaire Upon Mental Imagery (Sheehan, 1967), the Spatial Relations subtest of the Differential Aptitude Test, the Warm Imagery Scale, and the Picture Memory Test (Marks, 1972). Three experimental groups each received six 30-minute training sessions over two weeks and were provided with auditory feedback under a normal room temperature condition, cool temperature condition (non-dominant hand in a 60^0 to 62^0 F water bath) and warm temperture condition (non-dominant hand in a 81^0 to 83^0 F water bath). General instructions to the three experimental groups were to relax and to attend to the feedback and to visualize or image warm situations or warmth experiences. No verbal (or autogenic) techniques were given. A control group which received no feedback were told simply to close their eyes and try to warm their hands. Results indicated that subjects high in imagery ability obtained greater increases in hand temperature. Performance under room and cool temperature conditions was significantly better than the warm temperature and control conditions. Although the single best predicator appeared to be the vividness of imagery as measured by the Picture Memory Test, the author indicated an uncertainty as to what constitutes good imagery ability.

To summarize, the studies in this section suggest that thermal imagery and suggestions do influence hand temperature, and that further exploration between imagery and biofeedback training is warranted. In particular, elucidation of the role of individual differences in regards to imagery ability, training strategies and learning effects would be useful from both a theorectical and clinical perspective.

Guidelines for the current study.

The review of the literature has indicated that ability to hand warm is more difficult than had been originally postulated (Taub & Emurian, 1976). In general, small order changes appear to be the norm although some individuals are capable of large magnitude increases. The influence of cognitions (emotional images, thermal images, and autogenic phrases) on hand temperatures has been eluded to in several studies, but has not been approached in a systematic manner. The current study is interested in the effects of imagery on hand temperatures, and the relationship between imaging ability, type of training, and thermal control.

At first glance, doing research in hand warming, appears to be a simple and straight forward matter. However, this current review has indicated that hand temperatures are influenced by environmental, biological/physiological, and cognitive factors. Only a few researchers have attempted to control for such factors as recent ingestion of food and drink, circadian cycles, and prior physical activity.

As well, many researchers, in this area, have confounded the interpretation of their findings by non-systematically utilizing several strategies (such as: warm imagery, passive volition, hypnosis, autogenic phrases) in conjunction with biofeedback . Furthermore, inadequate training conditions were observed in several studies (short discrete training schedules, digital feedback, absence of auditory feedback, too cool or too warm an ambient temperature, and too few sessions) which would tend to minimize learning effects and contribute to increases in type I errors.

Several guidelines to optimize the thermal training procedures for the current study were gleaned from the review of the literature. These include the following: a) use of direct instructions so that Ss are aware of the target response (TR) in the active training conditions, b) contingent analogue bi-directional visual and auditory feedback, c) five sessions of training, d) continuous 5-minute training schedules instead of short discrete training intervals, e) an ambient room temperature in the range of 22° to 24°C to minimize drift effects, f) an adaptation period to minimize differences associated with Ss' prior physical activities,

g) a 10-minute baseline period (following 15 minutes of adaptation), h) the monitoring of EMG levels to minimize somatic maneuvers, i) appointments for training at the same time each day to minimize core temperature fluctuations associated with circadian cycles, and lastly, i) prohibiting ingestion of food or drinks one hour prior to training. In addition, since the focus of the current study is on thermal training with normals, potential volunteers would be excluded from the study if they are smokers, suffer from migraine headaches, or are taking medications (vasodilators or vasoconstrictors).

Formulation of the study

Besides the studies cited in the section on thermal suggestion and imagery, the influence of imagery on hand temperature has been alluded to in several areas within this review. Menzies (1937, 1941) in his conditioning experiments reported that images of cold or hot hand baths were related to decreases and increases in hand temperatures, respectively. Hayduk (1979) found that imagery was the most common strategy utilized by his subjects during the biofeedback phase of his study. Mittleman and Wolff (1939, 1943), and Graham (1955) and his associates (Graham, Stern & Winokur, 1958; Stern, Winokur, Graham & Graham, 1961; Graham, Kabler & Graham, 1962; Graham & Kunish, 1965) have also demonstrated a link between cognitions (or emotionally ladened thoughts) and temperature responses. Later studies (Dugan & Sheridan, 1976; Herzfeld & Taub 1977, 1980; Gillespie & Peck 1980; Proudfoot, 1983; and Nigl,

1980) suggest that the relationship of imagery to thermal effects warrants further investigation.

The primary focus of the current study was on the relationship between individual differences in imaging ability (as measured on the Switras Survey of Mental Imagery: Form A [SMI, 1975]) and various approaches to thermal training. The relative efficacies of biofeedback training alone, guided imagery alone, and a combination of biofeedback and guided imagery were compared with each other and an active control group. Of additional interest, was the relationship of subjects' self-perceptions of their ability to image with scores on a standardized inventory.

Research questions

1. Which of the training methods: biofeedback alone, guided imagery alone or a combination of both, is most effective in producing warming effects in the dominant hand?
2. Are training effects influenced by subjects' imaging abilities as measured by the Switras Survey of Mental Imagery: Form A? More precisely, is there an interaction between imaging ability and type of training?
3. What is the relationship between subjects' self-estimates of imaging ability and the Switras Survey of Mental Imagery: Form A?
4. Lastly, are there variables within this study, that would help to identify subjects who are more likely to succeed at increasing their hand temperatures?

III. METHODOLOGY

The major purpose of this study was to compare the relative efficacies of three thermal training approaches (with a relaxation control group) and to examine possible interactions between the type of training received and levels of imagining ability. Of additional interest was the relationship between subjects' self-perceptions of their own imaging abilities and their scores on a standardized imagery inventory. Characteristics of subjects who successfully hand warmed were also sought, and self-reported information regarding the training was also gathered.

A. Research design

To address the above concerns, a four factor (4x2x4x5) design with repeated measures was utilized in this study. The experimental factors included: (a) four training conditions, (b) two levels of imaging ability, and (c) four trials, by (d) five sessions. Three training conditions were compared to an active control group. Group 1 received auditory and visual finger temperature feedback (BFK condition); group 2 members were asked to comply with instructions on a thermal guided imagery audiotape (GI condition); group 3, the combined (COMB) condition, listened to the same audiotape as group 2 and received both auditory and visual feedback, while group 4, the control (CONT) condition, was asked to listen passively to audiotaped physics definitions. Imaging ability was assessed with the Switras Survey of Mental Imagery: Form A (1975), with scores above the median rated as high (1) and scores below the median as low (2). Training consisted of five 1-hour sessions on five consecutive days whenever possible (maximum seven day interval), with each session consisting of a 10-minute baseline and four 5-minute training trials. Other areas of interest in this study were addressed through author created questionnaires and additional measures.

B. Measures

Fingertip temperature

The dependent measure was the finger temperature measured in degrees centigrade from the palmar surface of the distal phalange of the middle finger of the dominant hand. Hand dominance in this study was operationalized as the writing hand. Additional measures taken simultaneously with the dependent measure were EMG levels (in microvolts) from the extensor muscle on the dominant arm, middle finger temperature from the non-dominant hand, and room temperature.

Mental imagery scores

The Switras Survey of Mental Imagery: Form A (SMI, 1975) was used in the study because of its psychometric qualities. Besides having some norms, the SMI possesses high reliablilty, internal consistency, and a known factor structure (Switras, 1978). This inventory provides an index of overall controllability and vividness of imagery as well as individual scores for each of seven modalities (visual, auditory, olfactory, gustatory, tactual, somaesthetic and kinesthetic). Subjects with total overall scores above the median in both controllability and vividness were assigned to the high imager group, while those with both scores below the median were considered low imagers. Volunteers with mixed profiles (that is, with one score above and the other below the median) were excluded from the study.

Self-ratings of imagery ability (SRIA)

Before completing the SMII, subjects were asked to assess their ability to image in seven modalities. An example was provided of each modality, and subjects were to simply make self estimates, on a scale of 1 to 10, of their ability to form images in that particular modality. Seven modality scores and an overall imagery score were obtained from the SRIA (see Appendix I).

Post-session questionnaires

At the completion of each training session, all subjects completed a short questionnaire designed by the author to collect information regarding types of hand warming strategies utilized and the amount of time engaged in these activities (see Appendix IV).

C. Subjects

Recruitment of subjects from the Edmonton area occurred from April to October of 1986. Volunteers were attracted by notices posted in high traffic areas on the University of Alberta campus, and at a large training hospital for nurses. Additional volunteers were also solicited through a local radio program and via verbal appeals to several educational psychology classes and to graduate students and staff members in the Department of Educational Psychology.

Screening of applicants to eliminate smokers, people on medications, and those with cold hands occurred during an initial interview. One hundred and fifty-five volunteers met these requirements, and were then sent a package of materials (see Appendix I) which included a cover letter explaining the nature of the study, a questionnaire regarding self-estimates of one's imaging ability in seven modalities (Self-Ratings of Imaging Ability) and the Switras Survey of Mental Imagery.

Subjects were either coded as high imagers or low imagers on the basis of their SMI questionnaire scores. High imagers possessed total imagery control scores (males >235, females >234) and total vividness of imagery scores (males >324, females >317) which exceeded the median values as reported by Switras (1978). Low imagers, on the other hand, were consistently below the median value in both scores for controllability and vividness. Subjects with one score above the median and another below were classified as mixed, and were excluded from this study. Out of the 155 original volunteers, only 87 satisfied this last requirement.

A small pool of subjects gathered during the initial stages of the study were grouped into high and low imagers, and then randomly assigned to a training condition. Later assignment of subjects was based on the order of return of questionnaires. Eighty-seven subjects completed the training and were paid a stipend of $20 each for their participation. Unfortunately, due to some technical difficulties, four subjects had incomplete data records, which reduced the final sample to 83 Ss.

D. Sample characteristics

A series of one-way anovas and crosstabs were performed with the demographic data, and total controllability and vividness scores on the SMI to see if there were significant differences in the composition of the groups. Comparisons were made among the four training conditions, as well as among the high and low groupings of the four conditions which resulted in 8 smaller groupings. (See Tables 1 to 4 for a summary of this data or Appendix II for an extended version of the same data.)

Gender

Although the sample consisted of marginally more females than males, the gender distribution in the four main conditions and eight smaller groupings did not differ significantly from one another.

Age

The mean age of the sample was approximately 29.5 years with a range of 19 to 55 year. No significant differences were noted in mean age for the four training conditions nor in the eight groups.

Education

Since much of the recruiting occurred within a higher educational setting, a mean of approximately 15 (range 10 to 21) years of formal education is not unreasonable (although much higher than the population at large). The sample was composed of 6 completed doctorates, 10 graduate students, 13 nursing students, 19 education students, 16 students from other faculties, three students from institutions other than the University of Alberta, and

16 non-students that included school teachers, housewives, secretarial staff, and other non-professionals.

Imagery levels

The expected results of preselection for high and low imaging scores on the SMI were reflected in the significant differences ($p>.0001$) found between high and low imagers (Appendix II). High imagers in comparison to low imagers in all four treatment conditions possessed significantly greater scores in SMI vividness and controllability. Comparisons among the four treatment groups, containing both high and low imagers, revealed non-significant differences.

Apparatus

The experimental setting consisted of a large room (with an independent thermostat set at 21^{0} C) which housed a 8 by 8 feet acoustically sound-proofed room
(Industrial Acoustics Company, model #403). The training occurred in this sound room which was furnished with an armchair, and small tables to accommodate the biofeedback equipment. Subjects waited in a smaller room adjacent to this area during the adaptation period.

The biofeedback equipment consisted of a Biocomp 2001 (manufactured by H. Toomin, Biofeedback Institute, Los Angeles) system operated on an Apple II+, with slight modifications. Two video displays were used. One provided analogue visual feedback to subjects while the other allowed the experimenter to monitor the progress of each session. Bidirectional auditory feedback, in the form of rising and falling tones, was produced through a speaker

TABLE 1: Summary: Gender, Age, & Education by Groups (4)

Group	n	GENDER fe/male	AGE mean	s. d.	range	EDUC mean	s. d.	range
1*	20	12/8	30.20	8.85	20-55	15.75	2.95	11-21
2	20	13/7	27.45	6.92	19-39	14.25	2.38	10-21
3	22	13/9	31.14	9.32	20-47	14.77	2.86	11-21
4	21	14/7	29.24	7.52	21-52	15.14	2.46	12-21
Total	83	52/31	29.54	8.20	19-55	14.98	2.68	10-21

*(Tables 1 to 4, groups 1 = biofeedback, 2 = guided imagery, 3 = combined, 4 = control)

TABLE 2: Summary: Total Controllability, Vividness & SMI Scores by Groups (4)

Group	n	TOTC mean	s. d.	TOTV mean	s. d.	TOTSMI mean	s. d.
1	20	229.10	26.75	308.70	66.64	527.80	108.01
2	20	231.00	22.39	311.85	65.34	542.85	85.32
3	22	231.00	22.39	297.27	68.61	525.14	98.43
4	21	230.43	25.81	302.81	56.60	533.33	79.99
Total	83	229.69	26.41	304.94	63.54	532.12	92.07

TABLE 3: Summary: Gender, Age & Education by Groups (8)

Group	n	GENDER fe/male	AGE mean	s. d.	range	EDUC mean	s. d.	range
*1high	10	7/3	31.00	12.04	20-55	15.70	3.43	11-21
2high	10	7/3	26.60	6.88	19-39	13.30	1.64	10-15
3high	11	8/3	31.27	8.68	21-46	14.55	2.58	11-20
4high	11	8/3	29.18	9.57	21-52	15.00	2.28	13-19
1low	10	5/5	29.40	4.35	23-36	15.80	2.57	12-21
2low	10	6/4	28.20	7.23	19-38	15.20	2.70	13-21
3low	11	5/6	31.00	10.34	20-47	15.00	3.22	11-21
4low	10	6/4	29.30	4.90	23-39	15.30	2.75	10-21
Total	83	52/31	29.54	8.20	19-55	14.98	2.68	10-21

*(Tables 3 and 4, high = upper half of median split on SMI
low = lower half of median split on SMI)

TABLE 4: Summary: Total Controllability, Vividness & SMI Scores by Groups (4)

Group	n	TOTC mean	s. d.	TOTV mean	s. d.	TOTSMI mean	s. d.
1high	10	248.50	9.14	363.10	33.40	611.60	39.05
2high	10	249.60	8.09	368.90	29.70	618.50	34.33
3high	11	251.18	6.87	352.00	27.63	603.18	30.87
4high	11	249.18	6.13	350.18	19.26	599.36	22.04
1low	10	209.70	24.30	254.30	41.01	444.00	86.58
2low	10	212.40	14.96	258.80	29.96	467.20	38.39
3low	11	205.45	29.51	242.55	50.32	447.09	77.40
4low	10	209.80	23.15	250.70	30.78	460.50	49.25
Total	83	229.69	26.41	304.94	63.54	532.12	92.07

SCHEFFE PROCEDURE:

(*) denotes pairs significantly different at .05 level

mean	group	5	7	8	6	4	3	1	2
444.00	5								
447.09	7								
460.50	8								
467.20	6								
599.36	4	*	*	*	*				
603.18	3	*	*	*	*				
611.60	1	*	*	*	*				
618.50	2	*	*	*	*				

connected to the sounding board of the Biocomp. New reusable-type EMG sensors (silver/silver chloride, with a 20mm housing) were purchased for this study. Biocomp disc-style thermistors with 10 second time constants, and a tolerance of +/- 0.2 C were used to monitor finger temperatures. (The same thermistor was used on the dominant hand of all subjects throughout this study.) A third thermistor was attached to the inner wall of the sound chamber and monitored the room temperature. Data on all four channels was recorded simultaneously with the Biocomp. Since the Biocomp is limited to 36 data intervals per run, time intervals of 16.7 seconds during baselines and 8.4 seconds during training were employed to approximate 10 minutes, and 5 minutes, respectively.

E. Procedure

The primary intent of the researcher was to compare the relationship between different training conditions and imaging ability. Three groups (I, II and III) comprised the active conditions, while group IV served as a control. Group I, the biofeedback (BFK) alone condition, received visual feedback in the form of a bar graph on a video monitor, and bi-directional tonal feedback which paralleled increases and decreases in the S's hand temperature. Subjects in group II, the guided imagery (GI) condition, listened to a guided thermal imagery audiotape without the benefit of biofeedback, while members of group III, the combined (COMB) condition, were provided with both a guided thermal imagery audiotape and biofeedback. Subjects in group IV, the control (CONT) group, were asked to relax as much as possible while listening passively to an audiotape of physics definitions.

The training consisted of five one-hour sessions over five consecutive days whenever possible (with no interval greater than seven days). In an effort to minimize other possible influences on hand temperature, subjects were seen at the same time each day to limit normal circadian variations in body temperature and were asked to abstain from eating and drinking at least one hour prior to their laboratory participation (King & Montgomery, 1981).

Except for differences in the training conditions, an attempt was made to relate to all subjects in a similar manner during each of the five sessions. Each day, subjects sat in a waiting area for 15 minutes before the actual sessions began. The purpose of the waiting period was twofold. It allowed subjects to adapt to the experimental microenvironment and permitted time for homeostatic processes to minimize possible effects of prior activity (Yates, 1980). Subjects were then led to an acoustically sound-proofed room where instructions regarding the proper posture to assume, during the baseline and training trials, was conveyed. Ss were required to sit upright in an armchair with both feet flat on the floor with their forearms supported by the arms of the chair. The biofeedback instrumentation was connected at this time. The dominant forearm was cleansed with rubbing alcohol and a paper tissue, and allowed to dry. Electrolyte gel was then applied to the EMG sensors and attached to the extensor muscle of the forearm with adhesive rings. Thermistors were placed on the palmar surface of the distal phalange of the middle finger on each hand. After a quick check of the biofeedback equipment and sensors, Ss were reminded to assume their upright postures, and to relax during a 10-minute baseline. Following the baseline period, standard daily instructions (Appendix III) pertinent to each S's training condition were read before the commencement of four 5-minute training trials. A one-minute rest period was given between trials during which time, the biofeedback equipment was reset. At the completion of the training each day, all subjects completed a short questionnaire regarding some aspects of their training. Finally, a verbal and written reminder was given to subjects not to eat any food or drink any liquids at least one hour prior to their appointments for the following day. All subjects received 20 dollars at the end of five sessions.

F. Treatments

Group I: Biofeedback alone

After the baseline period, members of this group received auditory and visual biofeedback only, and were given standard instructions (Appendix 3) to develop strategies that would raise their dominant hand temperature. An attempt was made to allow subjects to explore and develop, on their own accord, means of raising hand temperatures without experimenter influence in the form suggestions. If subjects appeared to become discouraged with their lack of success, encouragement was offered by the experimenter. Comments regarding task difficulty, and any observations of slight gains or no drops in hand temperature were framed in a positive way. For example, if Ss appeared disappointed about their lack of immediate success, the experimenter would indicate that this was not usual and that warming effects would emerge with increased training. If slight gains were evidenced, the experimenter would indicate to subjects that they appeared to be doing something that was working for them, and that they needed to refine and develop this quality further. A short questionnaire was completed by the subjects at the end of each session (Appendix IV). At this time subjects were asked to elaborate on how they attempted to influence their dominant hand temperature.

Group 2: Guided imagery alone

Following the baseline period, this group listened to a guided imagery audiotape (Appendix III) which contained descriptive passages incorporating thermal images. Subjects were instructed to create the thermal imagery suggestions. Training passages were broken into four 5-minute segments with a one-minute resting period inbetween. No biofeedback was provided, and subjects had to rely on their self-perceptions in evaluating their success on the task. A short questionnaire was completed at the end of each session (Appendix IV).

Group 3: Guided imagery and biofeedback

The combined condition provided Ss with the identical guided imagery audiotape as group 2, as well as auditory and visual biofeedback. Subjects in this training condition would attempt to enact the thermal suggestions offered on the audiotape, whilst observing their hand temperatures.

The format each day was the same, beginning with a 10-minute baseline, followed by four 5-minute training trials with a one-minute resting period inbetween trials. At the end of each session, subjects completed a questionnaire (Appendix IV).

Group 4: Controls

Subjects in the control group also listened to an audiotape following a 10-minute baseline period. The preamble on this audiotape was identical to that given groups 2 and 3, but the training trials contained no thermal imagery. Instead, Ss were asked to listen passively to physics definitions that were read in a slow and monotonous manner. Definitions were broken into four 5-minute trials with a one-minute resting period in between trials. At the completion of each session, group 4 subjects completed a questionnaire as well.

G. Analysis

Units of the dependent measure

Since it was unexpected that Ss would be able to produce instantaneous and sustained temperature changes during the 5-minute trials, it was hypothesized that training effects would likely manifest themselves midway into each trial. Two 68-second intervals, one (interval 1) beginning 84 seconds after the start of each training trial, and the another (interval 2) commencing immediately after the first 68-second interval were used as the basis of comparison. Design restrictions on the Biocomp allow for 36 time intervals based on 37 data points. Thus a time interval of 8.4 seconds was utilized to approximate the 5-minute training trials. Mean temperatures for interval 1 and 2 were based on temperatures recorded at data points 12 to 19, and 20 to 27, respectively. The baseline (BL) temperatures were calculated on the last five minutes of the baseline period, and corresponding time intervals (BL1 and BL2) were used so that trial temperatures would be directly comparable to baseline temperatures.

Several aspects of the data were examined: actual hand temperatures and change scores. Trial, session, and baseline means were expressed in actual temperatures (or raw scores). Interval 1 trial temperatures represented the mean of data points 12 to 19, while interval 2 trial temperatures were based on the mean of data points 20 to 27 (a 68-second span in both cases). Baseline temperatures were calculated in a similar manner and represented the mean of the four scores in a comparable time interval collected during the 10-minute baseline period. Session scores were based on the mean temperatures of the four trials within each training day. Since two intervals were examined, two sets of trial and baseline scores for each session were generated.

Change scores were used in determining which subjects were "successful, unsuccessful, or mixed" in terms of hand warming. Since the literature suggested that learning effects would not emerge until the third session, and subjects received a total of 20 training trials, subjects were deemed successful if they were able to increase hand temperatures above baseline levels 11 or more times, 7 to 10 increases as mixed, and 6 or less as unsuccessful. Trial change scores (TCS) were calculated by subtracting sessional baseline temperatures from training trial temperatures obtained within each session (TCS =trial -baseline).

Research questions

The areas of interest in this study are reiterated below, and statistical approaches to answering these questions follows. In all cases, an alpha level of 0.05 was deemed to reflect significance.

1. **Which of the training methods: biofeedback alone, guided imagery alone or a combination of both, is most effective in producing warming effects in the dominant hand?**

2. Are training effects influenced by subjects' imaging abilities as measured by the Switras Mental Imagery Inventory? More precisely, is there an interaction between imaging ability and type of training?

To address the first two questions, a series of four factor analysis of variance with repeated measures was run to compare actual hand temperatures amongst the four training groups and two imagery levels across four trials and five sessions.

3. What is the relationship between subjects' self-estimates of imaging ability and the Switras Survey of Mental Imagery?

Pearson product-moment correlations were employed to test for relationships between subjects' self-estimates of their imagining ability and Switras SMI scores.

4. Lastly, are there variables that would help to identify subjects who are more likely to succeed at increasing their hand temperatures?

An exploratory series of discriminant function analyses was utilized to delineate possible variables that would help to identify subjects who were "good" or successful hand warmers from those who showed little to no training effects.

IV. RESULTS

Results of the analysis are described and discussed in this chapter according to the research questions previously formulated. A number of post hoc analyses were also performed to explore other possible relationships in the data. In all cases an alpha level of .05 was deemed to reflect significance. The terms significantly, substantially, and sufficiently are used interchangeably in this section to mean statistical significance.

The data was analyzed in terms of two time intervals. Time intervals T1 and T2, represented the 68 seconds of training prior to the midpoint and 68 seconds after the midpoint respectively of each 5-minute training trial. The data analysis indicated that the two time intervals yielded very similar results, thus only the data based on time interval 2 is reported in this section. Pertinent aspects of the data are summarized in this chapter. Extensive tables regarding the analyses of the data for both intervals T1 and T2 are reported in Appendices V and VI.

Baselines

Ten-minute baselines were collected daily prior to the training trials. Two mean scores for baselines were calculated from two 68-second intervals of the last five minutes of the baseline period. These intervals correspond to the same time intervals as used in calculating the trial means. Interval 2 baseline mean temperatures were compared among the four treatment conditions by two imagery levels across the five days. Table 5 summarizes the results of this analysis and indicates the absence of significant hand temperature

TABLE 5

Analysis of Baseline means:
Groups by Imagery Level by Sessions
(interval 2)

Source	D. F.	M. S.	F	prob.
A	3	9.706	0.290	0.833
B	1	7.805	0.233	0.631
AB	3	4.705	0.140	0.935
S within	75	33.502		
C	4	1.244	0.295	0.881
AB	12	3.090	0.733	0.719
BC	4	4.368	1.036	0.389
ABC	12	5.102	1.210	0.275
BS within	300	4.216		

SOURCE: A - Groups

BFK	GI	COMB.	CONT.
30.196	30.364	29.648	30.014

SOURCE: B - Imagery level

high	low
29.906	30.188

SOURCE: AB

	Groups:	BFK	GI	COMB.	CONT.
Imagery:	high	29.940	30.545	29.428	29.771
	low	30.452	30.182	29.869	30.280

SOURCE: C

Baselines session:	1	2	3	4	5
	30.088	29.938	30.198	29.891	30.111

TABLE 6

Analysis of Baseline means:
Imagery Level by Gender by Sessions
(interval 2)

Source	D. F.	M. S.	F	prob.
A	1	4.657	0.172	0.680
B	1	472.636	17.434	0.001*
AB	1	6.767	0.250	0.619
S within	79	27.110		
C	4	0.709	0.162	0.958
AB	4	2.838	0.646	0.630
BC	4	1.164	0.265	0.900
ABC	4	2.183	0.497	0.738
BS within	316	4.362		

SOURCE: A - Imagery level

high	low
29.913	30.158

SOURCE: B - Gender

females	males
29.212	31.412

SOURCE: AB

		females	males
Imagery:	high	29.192	31.715
	low	29.239	31.221

SOURCE: C

Baselines session:	1	2	3	4	5
	30.088	29.938	30.198	29.891	30.111

TABLE 7

Analysis of Baseline means:
Females: Groups by Imagery Levels by Sessions
(interval 2)

Source	D. F.	M. S.	F	prob.
A	3	8.988	0.220	0.882
B	1	0.369	0.009	0.925
AB	3	7.453	0.182	0.908
S-within	44	40.872		
C	4	1.570	0.274	0.895
AB	12	3.620	0.631	0.814
BC	4	5.959	1.039	0.388
ABC	12	6.010	1.048	0.407
BS-within	176	5.734		

SOURCE: A - Groups

BFK	GI	COMB.	CONT.
29.457	29.707	28.809	28.952

SOURCE: B - Imagery level

high	low
29.181	29.276

SOURCE: AB

Imagery:		BFK	GI	COMB.	CONT.
	high	29.443	30.035	28.437	28.958
	low	29.491	29.324	29.403	28.945

SOURCE: C

Baselines session:	1	2	3	4	5
	29.450	29.078	29.391	28.938	29.250

TABLE 8

Analysis of Baseline means:
Males: Groups by Imagery Levels by Sessions
(interval 2)

Source	D. F.	M. S.	F	prob
A	3	6.615	0.903	0.455
B	1	4.730	0.645	0.430
AB	3	9.223	1.259	0.312
S-within	23	7.329		
C	4	0.408	0.220	0.927
AB	12	1.217	0.656	0.789
BC	4	0.444	0.239	0.915
ABC	12	1.853	0.998	0.457
BS-within	92	1.855		

SOURCE: A - Groups

BFK	GI	COMB.	CONT.
31.303	31.583	30.861	32.136

SOURCE: B - Imagery level

high	low
31.716	31.243

SOURCE: AB

Imagery:		BFK	GI	COMB.	CONT.
	high	31.123	31.735	32.071	31.938
	low	31.412	31.469	30.257	32.284

SOURCE: C

Baselines session:	1	2	3	4	5
	31.158	31.379	31.552	31.488	31.554

differences prior to training each day.

Additional comparisons (Table 6) of baselines by gender revealed a significant temperature difference between males and females. Findings of substantially warmer hand temperatures in males (31.426° C) than females (29.222° C) supports reports in the literature of gender differences in this regard (Yates, 1980). Separate analyses of hand temperatures for males and females alone (Tables 7 and 8), revealed non-significant baseline differences over the four treatment conditions and two imagery levels.

In short, baseline hand temperatures for the four training groups by two imaging levels across five sessions did not vary significantly from each other. Expected male-female differences were found while comparisons within each gender were non-significant.

A. Research Questions 1 and 2

1. Which of the training methods: biofeedback alone, guided imagery alone, or a combination of both, is most conducive towards producing warming effects in the dominant hand?
2. Are training effects influenced by subjects' imaging abilities as measured by the Switras Mental Imagery Inventory? More precisely, is there an interaction between imaging ability and type of training?

The above research questions were addressed with a 4X2X4X5 analysis of variance with repeated measures. The four factors examined were training co[illegible] ability, training trials and sessions (or d[illegible] four factor analysis of variance with repeated measures is presented in Table 9. One main and three interactional effects were significant. (Appendix VI has an unabridged version of this analysis.)

Main Effects

Treatment, imagery level and session effects. No main effects for type of training occurred (group effects, p= 0.840) which suggests that biofeedback alone, guided imagery alone and combined training did not produce training effects that differed appreciably from one another nor from the control group (Figure 1). As well, no main effects (p= 0.540, Figure 2) related to high and low imagery ability nor sessional effects (p= .350, Figure 3) were noted.

Trials. Only the main effect for trials (p= .001, Figure 4) was significant with post hoc Scheffe contrasts indicating significantly higher hand temperatures for the whole sample on trials 1 and 2 than on trials 3 and 4. Further examination of Figure 4 would suggest that there was an overall tendency for all subjects' finger temperatures to decline across the four trials.

Interaction Effects

The analysis of the data revealed non-significant interactions for training condition by imagery level, F (3, 75) = .217, p= .885 (Figure 5), and training condition by sessions, F (12, 300) = .779, p= .672 (Figure 6). Three significant interactions were noted involving: (a) trials by sessions F (12, 900) = 2.378, p= .005 (Figures 6 and 7), (b) training group by trials, F (9, 225) = 2.405, p= .013, (Figures 8 to 12), and (c) training group by imagery level by sessions, F (12, 300) = 1.954, p= .028 (Figures 13 to 22).

TABLE 9

Groups by Imagery Level by Trials by Sessions
(Interval 2: Temperature means)

Between subject factors

A - Groups: 1= biofeedback 2= guided imagery
3= combined 4= control

B - Imagery level: 1= high 2= low

Within subject factors

C - Trials:	1	2	3	4	
D - Sessions:	1	2	3	4	5

Source	D. F.	M. S.	F	prob.
A	3	38.176	0.280	0.840
B	1	51.765	0.379	0.540
AB	3	29.649	0.217	0.885
S-within	75	136.413		
C	3	36.020	30.128	0.001**
AC	9	2.876	2.405	0.013*
BC	3	0.216	0.180	0.910
ABC	9	0.719	0.601	0.795
CS-within	225	1.196		
D	4	14.721	1.114	0.350
AD	12	10.299	0.779	0.672
BD	4	15.529	1.175	0.322
ABD	12	25.828	1.954	0.028*
DS-within	300	13.140		
CD	12	0.917	2.378	0.005**
ACD	36	0.270	0.699	0.909
BCD	12	0.162	0.420	0.956
ABCD	36	0.342	0.886	0.663
CDS-within	900	0.386		

A: Groups

1	2	3	4
29.753	29.828	29.158	29.656

B: Imagery levels

	1	2
	29.412	29.770

AxB: Groups by Imagery level

	Imagery level	1	2
Groups:	1	29.416	30.089
	2	30.035	29.620
	3	28.955	29.361
	4	29.299	30.050

C: Trials

1	2	3	4
29.874	29.756	29.526	29.199

Scheffe procedure:
(*) pairs significantly different at .05 level

mean	trials	trials 1	2	3	4
29.874	1			*	*
29.756	2			*	*
29.526	3				*
29.199	4				

AxC : Groups by Trials

	Trials:	1	2	3	4
Groups:	1	29.796	29.887	29.788	29.539
	2	30.175	30.016	29.723	29.395
	3	29.330	29.323	29.162	28.818
	4	30.230	29.836	29.472	29.088

AxBxD: Groups by Imagery level by Sessions

Group: Biofeedback

	Sessions:	1	2	3	4	5
Imagery	1	28.575	29.990	30.577	29.911	28.027
	2	30.485	29.662	29.750	30.002	30.544

Group: Guided imagery

Sessions:		1	2	3	4	5
Imagery	1	30.243	29.969	30.269	29.306	30.391
	2	28.828	29.557	29.750	30.161	29.812

Group: Combined

Sessions:		1	2	3	4	5
Imagery	1	28.866	28.673	28.552	29.190	29.493
	2	27.987	29.868	30.223	28.988	29.741

Group: Control

Sessions:		1	2	3	4	5
Imagery	1	29.994	29.488	29.781	29.201	28.029
	2	29.840	30.102	30.466	29.767	30.074

CxD: Trials by Sessions

Sessions:		1	2	3	4	5
Trials	1	29.424	29.906	30.157	29.929	29.951
	2	29.550	29.803	30.050	29.769	29.610
	3	29.307	29.606	29.881	29.409	29.430
	4	29.070	29.295	29.538	29.088	29.003

FIGURE 1

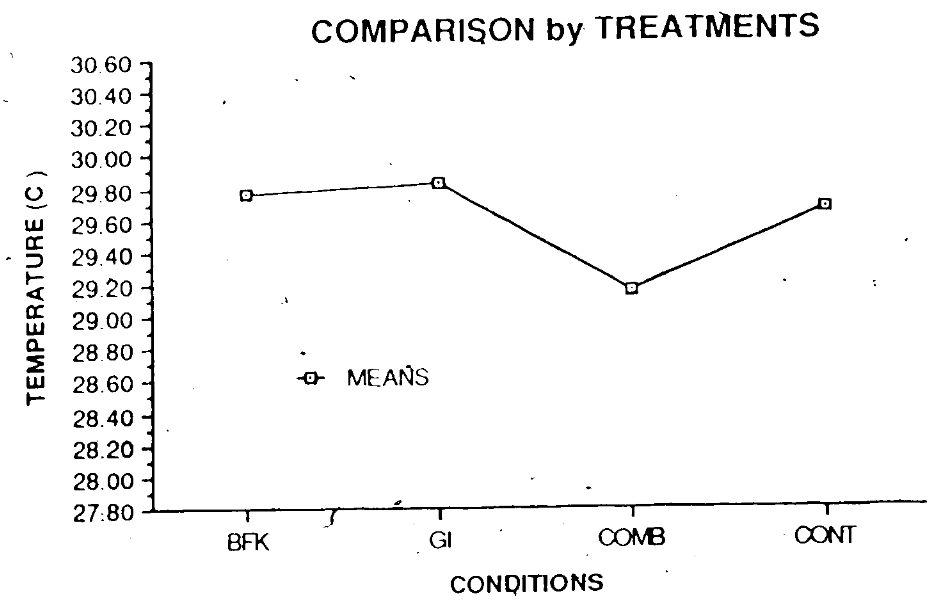


FIGURE 2

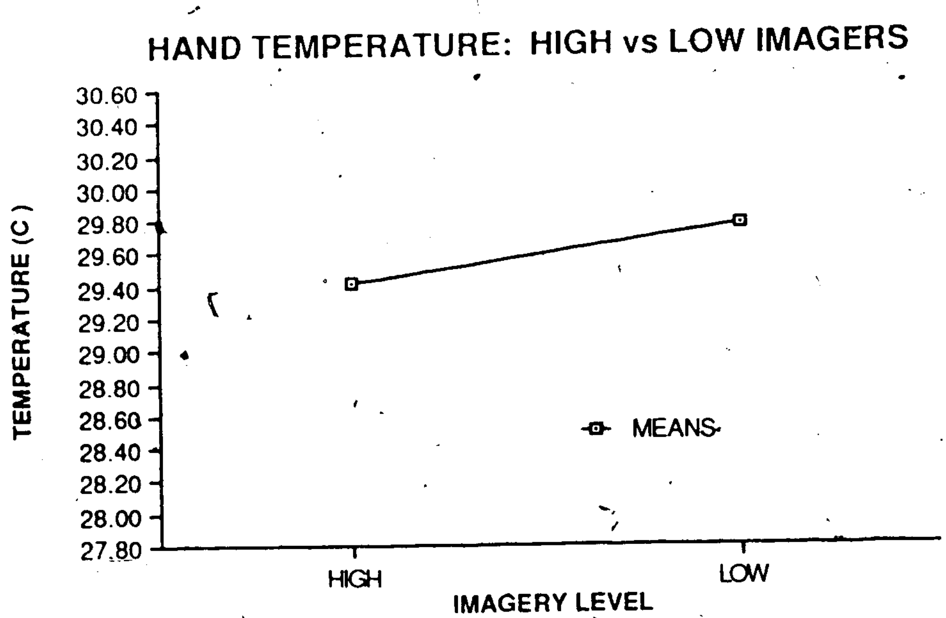


FIGURE 3

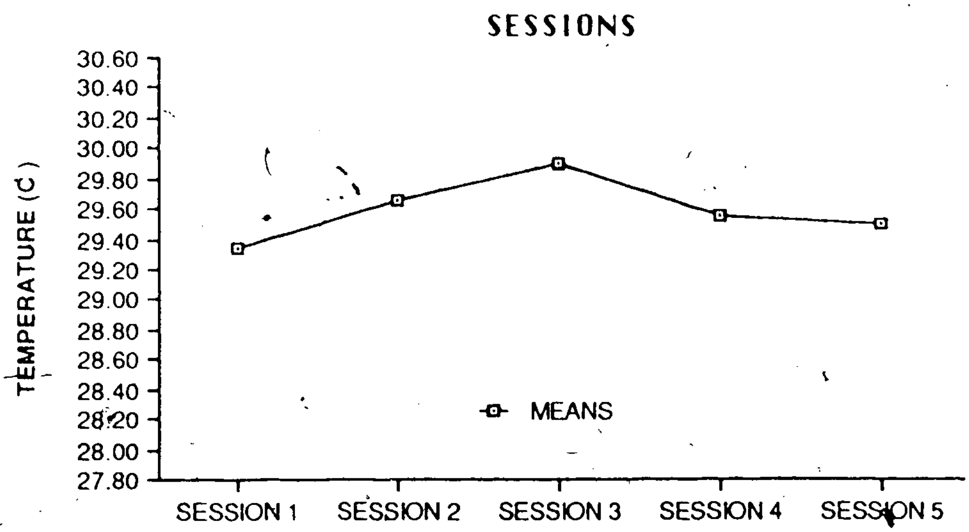


FIGURE 4

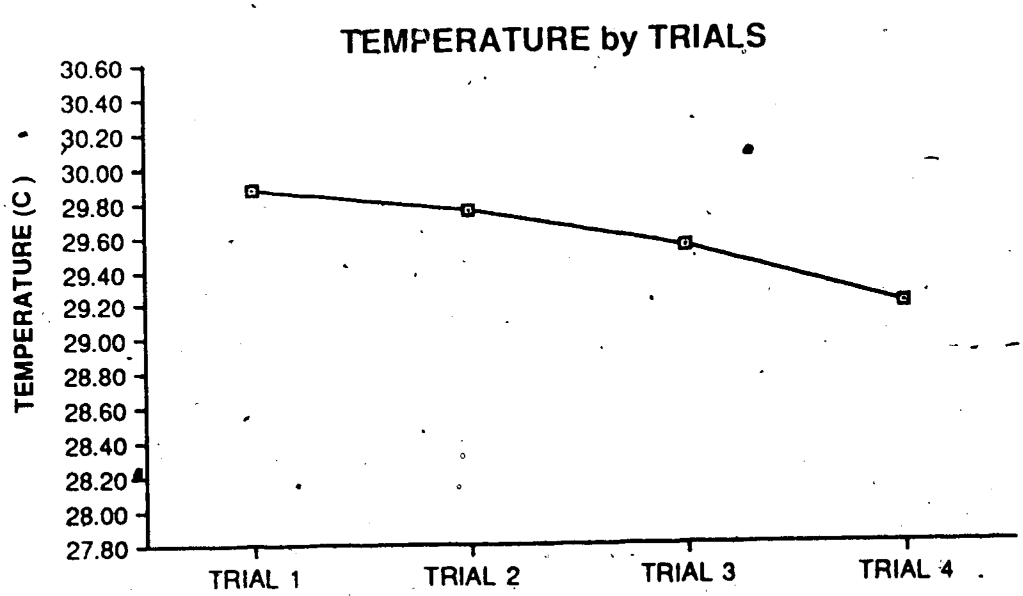


FIGURE 5

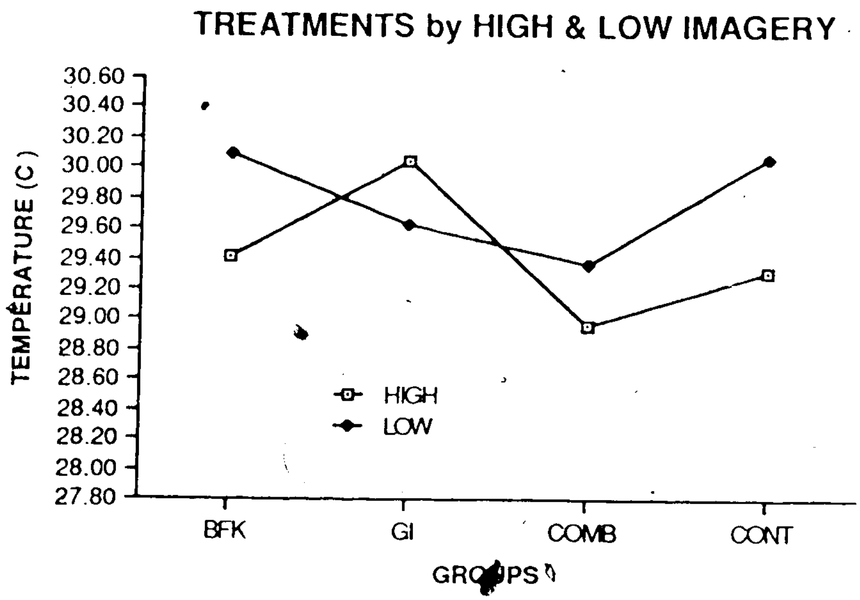
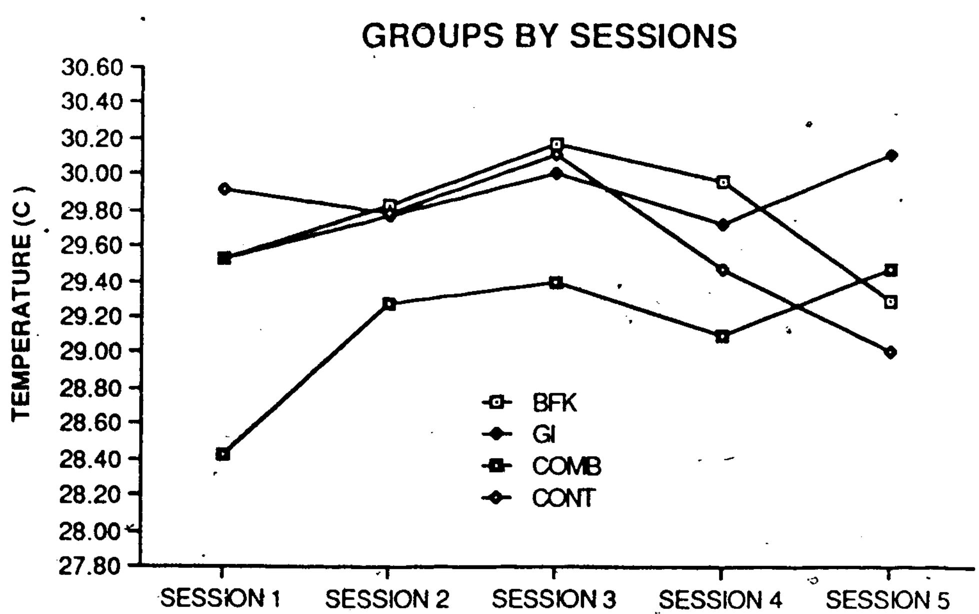


FIGURE 6



The two 2-way interactions and the 3-way interaction were broken down further and are graphically presented. Post hoc Scheffe contrasts were applied to restricted subsets or subgroupings of the data to aid interpretation (Keppel, 1973).

Training condition by imagery level or session. No significant interaction effects between type of training and imagery ability levels was noted (p= .885, Figure 5), as high and low imagers obtained equivalent hand temperatures under the four conditions. This would suggest that imaging ability per se was not associated with differential training effects over the five sessions. Training groups by sessions effects were non-significant with Figure 6 indicating relatively consistent hand temperatures from session to session for all four groups.

Trials by sessions. Figure 7 displays the relative hand temperatures on each of the 4 trials across the 5 sessions. It appears that the general performance of all Ss reached a peak by session 3, and that hand temperatures were lower during other sessions. Post hoc Scheffe contrasts indicated that temperatures during trials 1 and 2 were significantly greater than during trial 4 [illegible] session 1. The pattern in sessions 2 and 3 were highly similar to each other, with significant declines in temperature across trials noted. In both sessions, trial 1 temperatures were significantly greater than those obtained during trial 3 which was in turn also significantly greater than trial 4 (trials 1>3>4; 2>4 and 1 & 2 non-significant). By session 4, temperatures during trials 1 and 2 were similiar and significantly larger than trial 3

FIGURE 7

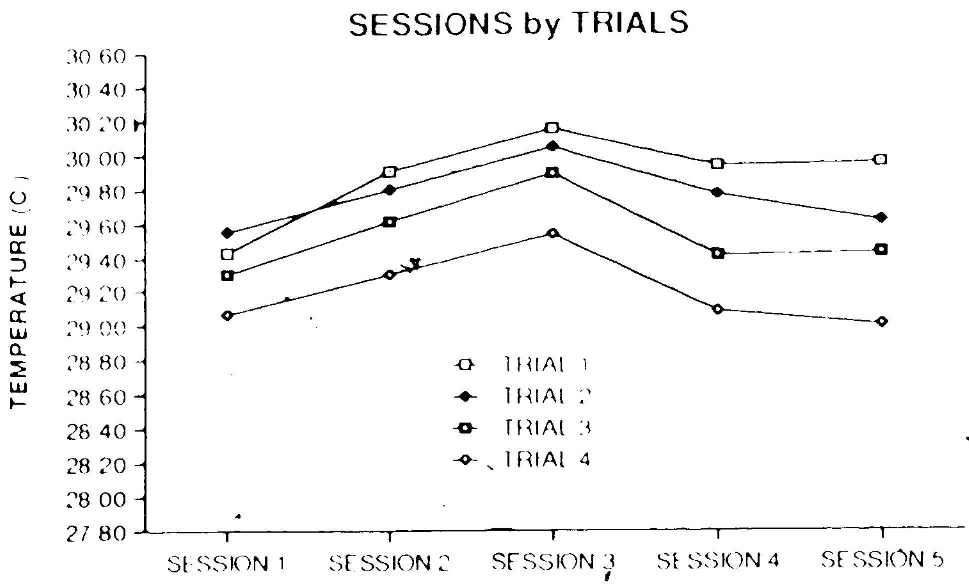
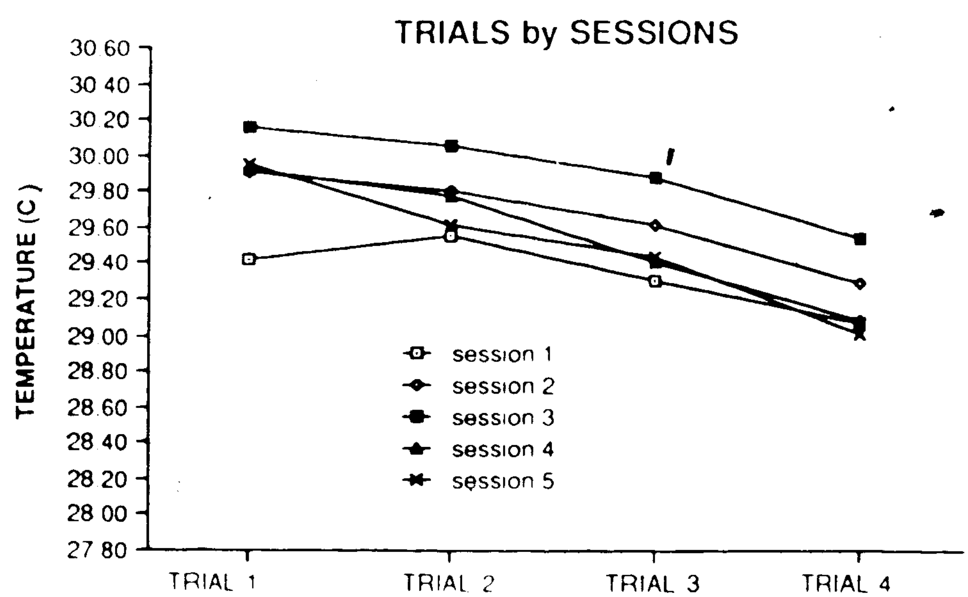


FIGURE 8



which was greater than trial 4 (trials 1,2>3>4). In session 5, trial 1 was again of greater magnitude than other training trials (trials 1>2,3>4).

Another view of the same data (Figure 8) comparing trial temperatures across the 5 sessions indicates that trial temperatures obtained during session 3 were sufficiently warmer than those obtained during the other sessions. This may suggest that at least three days of training are required before learning effects emerge. However, these learning effects may be partially due to habituational processes, as slight temperature increases in the control group from sessions 1 to 3 were also noted. A clear pattern of declines within all sessions can be seen with the exception of session 1. Since trial 1 of day 1 is the first encounter with this study for all subjects, the slightly lower hand temperatures could reflect an initial stress or orienting response to the laboratory setting.

Training groups by trials. The two-way interaction effects of training conditions by trials are represented in Figures 9 to 13. The control group, although warmest on average at the onset of each session, cooled consistently as training time increased, and had the lowest hand temperatures by trial 4. In contrast, finger temperatures of the biofeedback group were relatively consistent across the four trials and the significant difference noted at trial 4 between group 4 (control) and group 1 (biofeedback alone) were due to declines in control hand temperatures rather than increases in

FIGURE 9

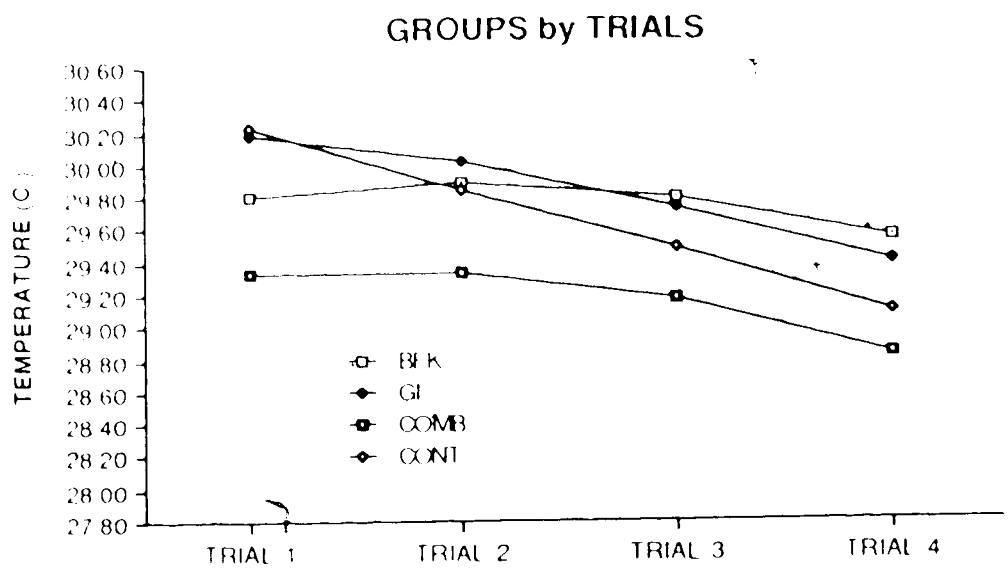


FIGURE 10

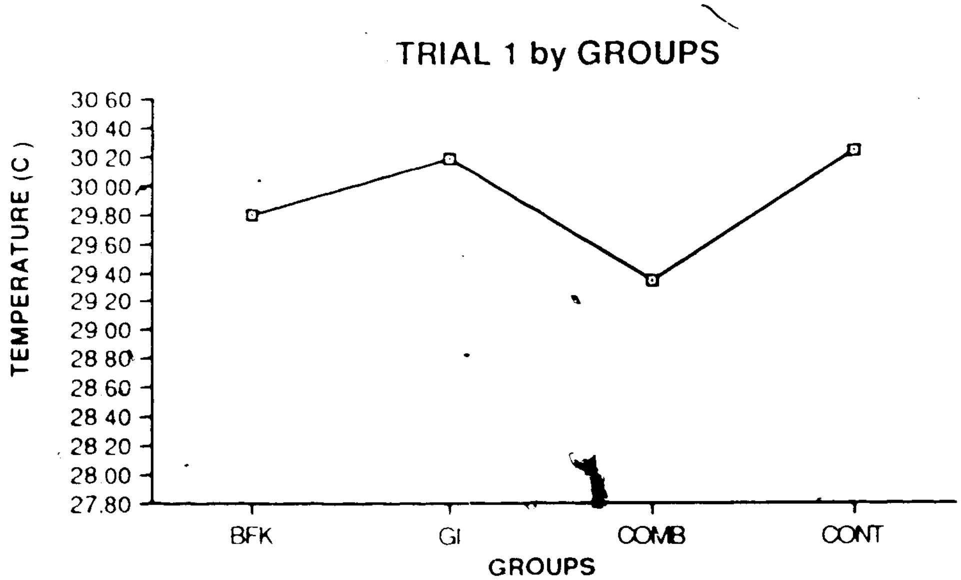


FIGURE 11

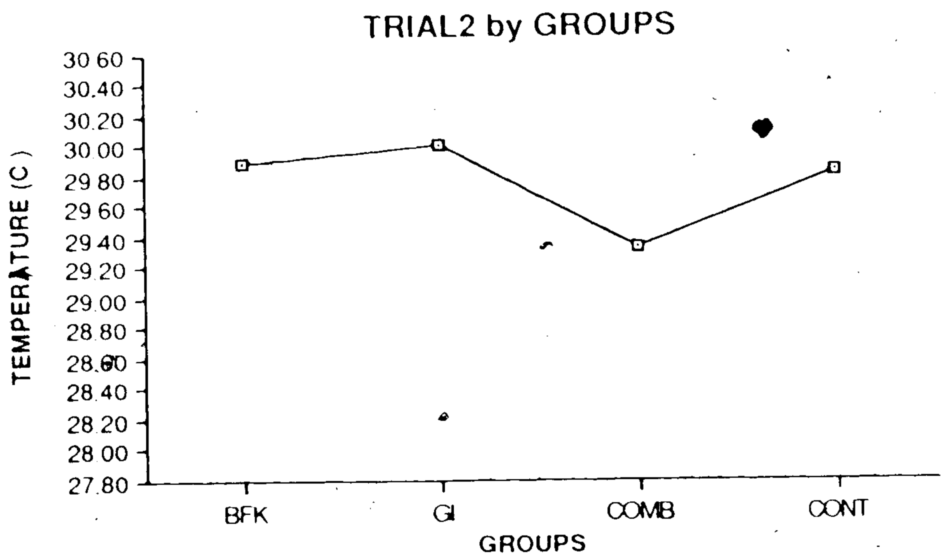


FIGURE 12

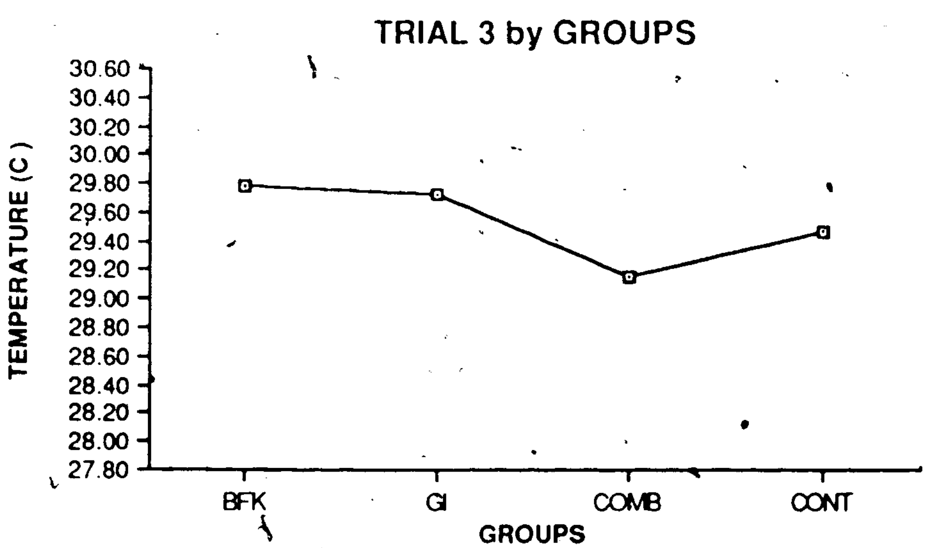


FIGURE 13

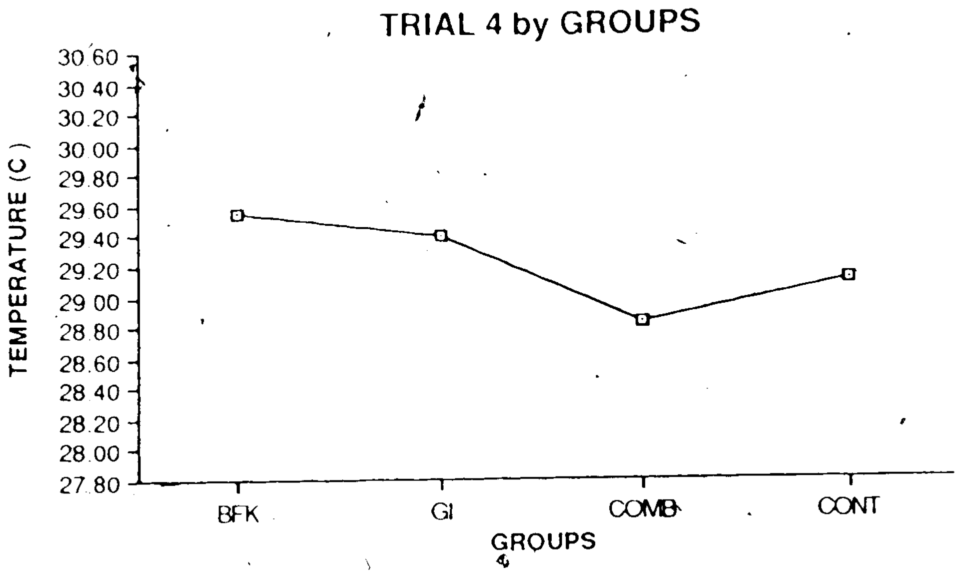
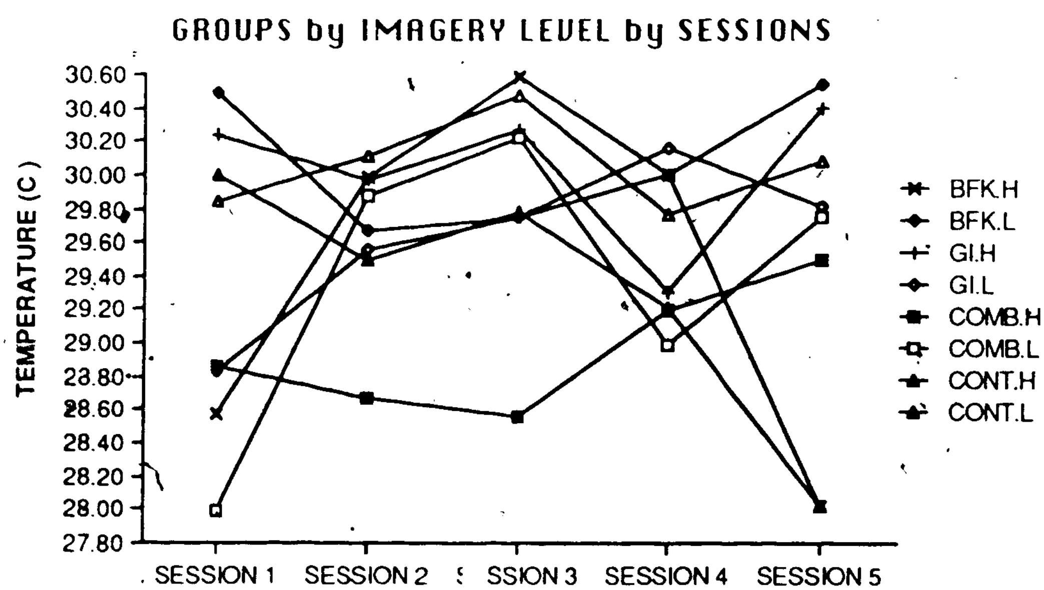


FIGURE 14



the BFK condition. (See Appendix VI for post hoc Scheffe constrasts withing significant interactions.)

Figures 10 to 13 look at the performance of groups on individual trials. During trial 1, controls were substantially warmer than the BFK group, while the combined condition was significantly lower than all of the other conditions. By trial 2, The GI, BFK and control conditions were roughly equivalent, and all were significantly warmer than the combined group. In trial 3, the BFK and GI conditions were substantially warmer than the combined group only. In the last trial, the BFK group was the only condition that was superior to the control group. The combined and control conditions were non-significant, as was the BFK and GI conditions. (See Appendix VI.)

Groups by imagery level by sessions. Since Figure 14 was rather difficult to interpret directly, this significant three-way interaction was broken into several smaller subsets: (a) all subjects labelled as high imagers were compared across sessions [Figures 15 and 16]; (b) all subjects labelled as low imagers were compared across sessions [Figures 17 and 18]; and lastly, (c) high imaging subjects were compared with low imaging subjects in the same treatment condition across sessions [Figures 19 to 22]. Post hoc Scheffe contrasts were applied to these restricted subsets. (See Appendix VI.)

High imagers. Figures 15 and 16 examine the contribution of the high imagers to the overall interaction. Inspection of these graphs and the application of post hoc Scheffes indicated no

FIGURE 15

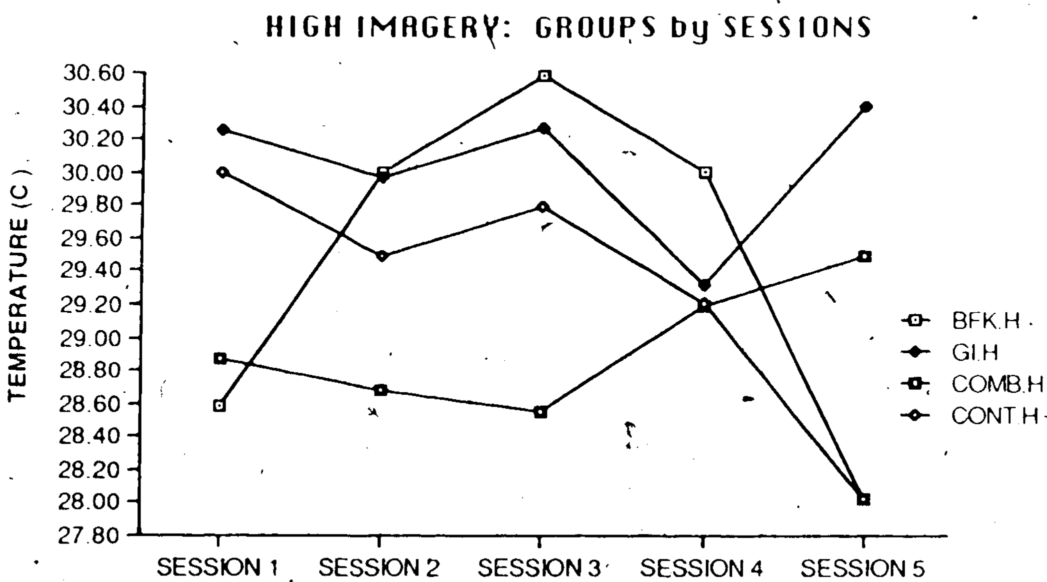


FIGURE 16

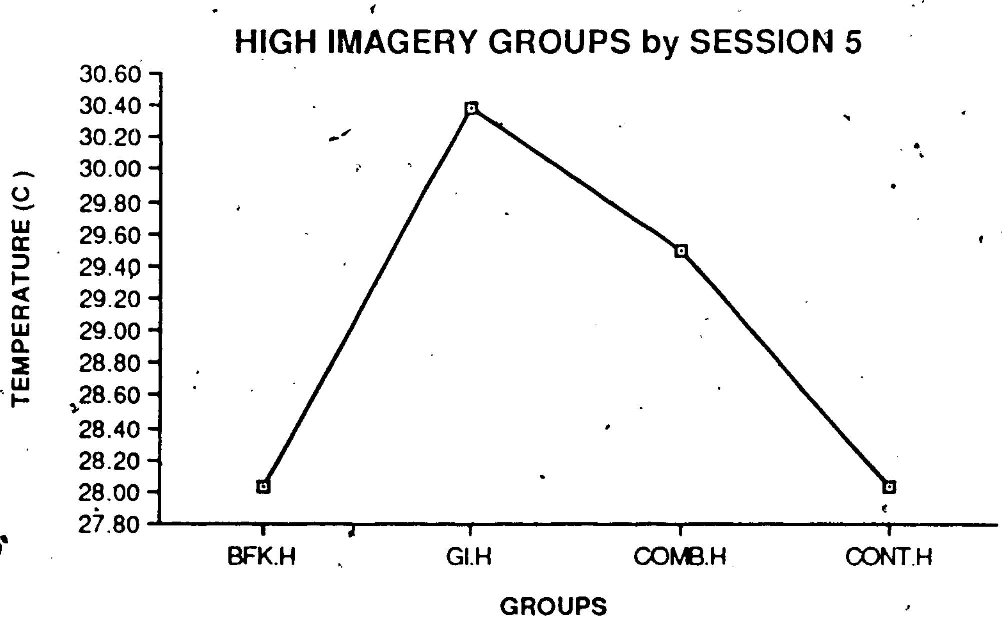


FIGURE 17

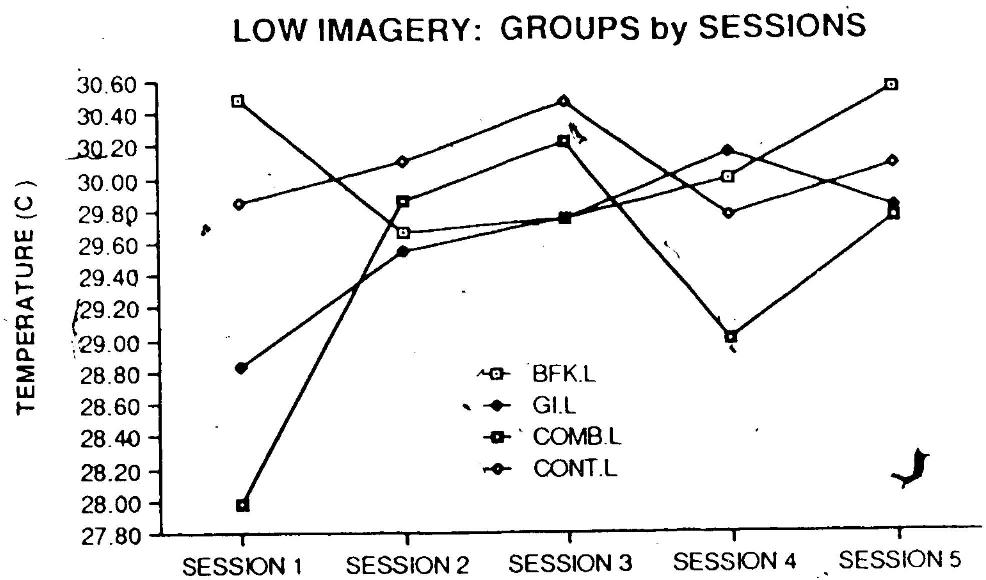
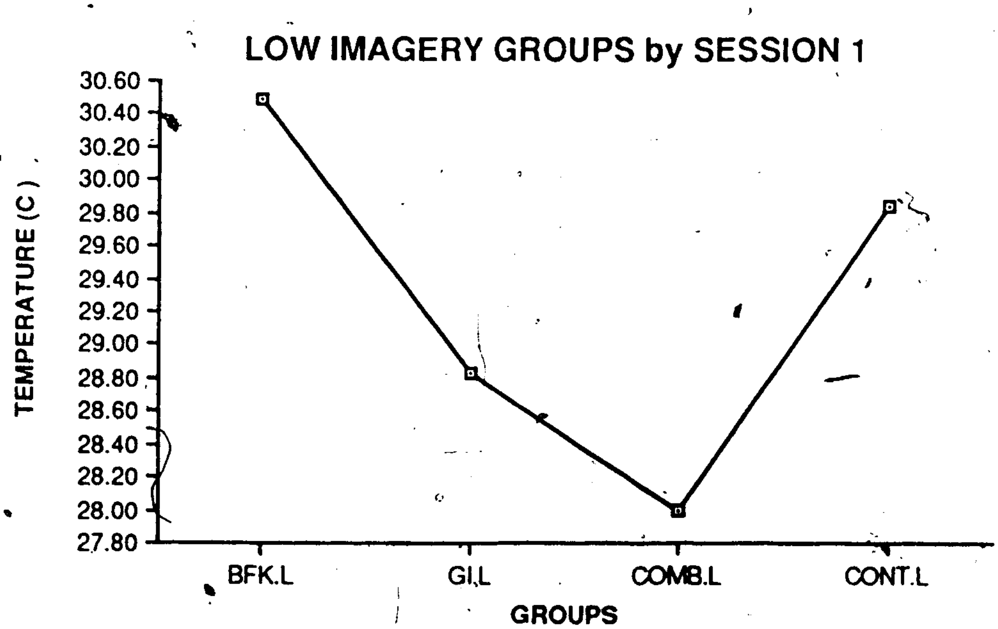


FIGURE 18



significant differences between groups during the first four sessions but by session 5, the guided imagery group was significantly warmer than the biofeedback and control conditions. This suggests that high imaging ability may indeed have some influence on hand temperatures in the absence of biofeedback.

Low imagers. Figures 17 and 18 examine the contribution of the low imagers to the overall interaction. An inspection of these graphs indicates that only the BFK condition during session 1 was significantly warmer than the combined condition and that no further significant differences were found between any groups during sessions 2 to 5. Thus low imagers did not appear to vary significantly from one another except during session 1.

High versus low imagers within single conditions. Comparisons of high and low imagery subgroups within each of the treatment conditions are presented in Figures 19 to 22. Contrasts examined differences between high and low imagers within each session, and differences across the five sessions for each of the two subgroups.

In Figure 19, the low imagers were significantly warmer than high imagers in the BFK condition during sessions 1 and 5 only. In the high imagery group a significant difference in hand temperatures was noted between session 3 and 5, while no significant differences were noted across sessions for the low imaging group.

Results of comparisons for the guided imagery condition (Figure 20) indicated no significant differences between high and low imagers on a sessional basis, nor any differences within each subgroup across the five sessions.

FIGURE 19

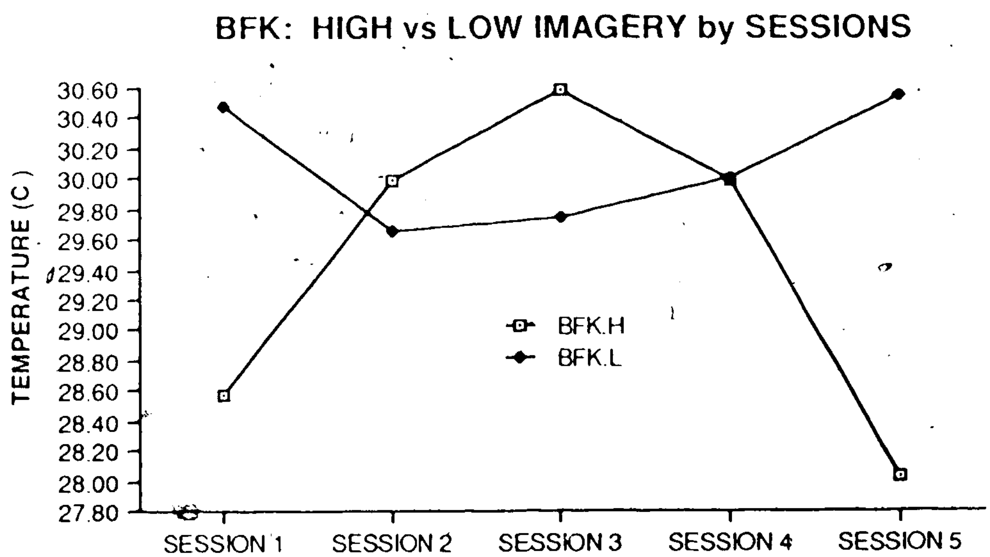


FIGURE 20

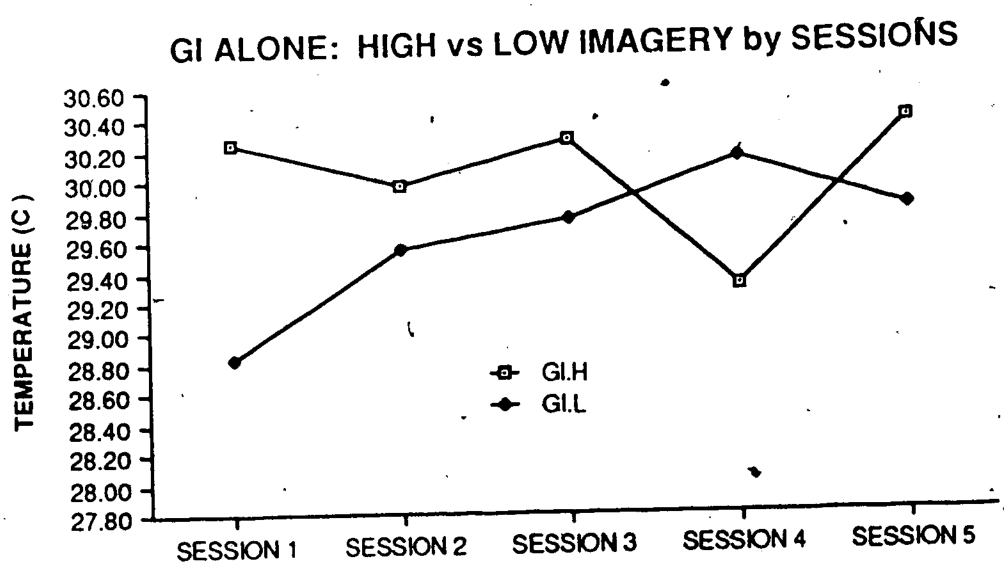


FIGURE 21

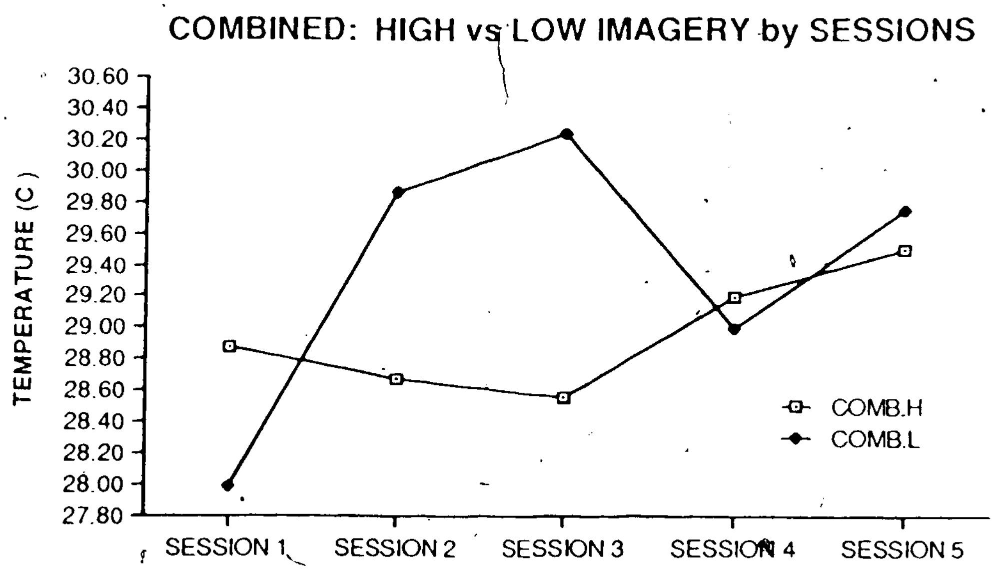
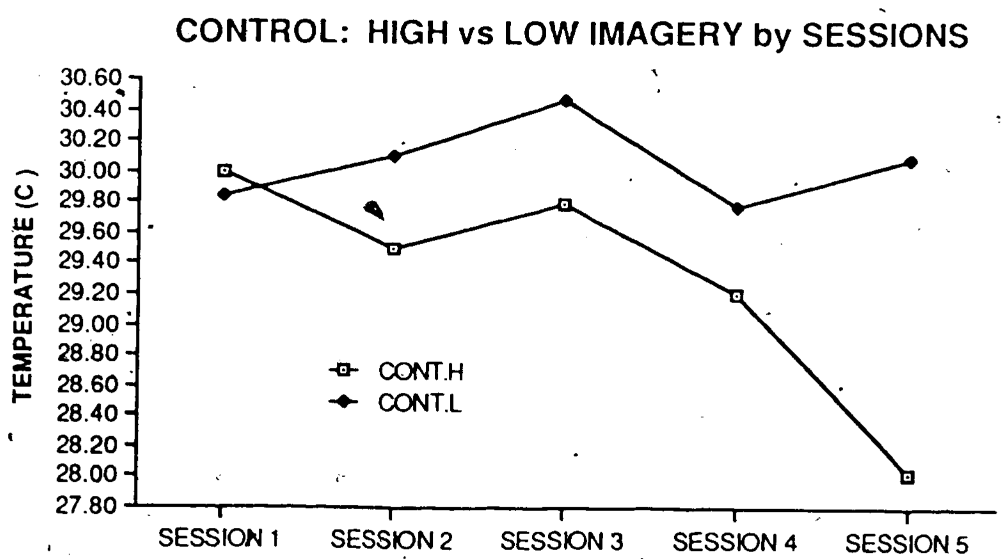


FIGURE 22



Low imagers in the combined condition were substantially warmer than high imagers during session 3 only (Figure 21). Although sessions 1 and 3 approached significance for the low imaging subgroup, no significant hand temperature differences were noted within either imagery subgrouping across the five sessions.

Lastly, low imagers in the control condition had substantially warmer hand temperatures during session 5 than did high imagers (Figure 22). No significant differences were noted across the 5 sessions for either imagery level.

Post hoc analysis: Intervals 1 and 2

Temperatures were compared between intervals 1 and 2 for all conditions to explore the relationship of time within each trial and hand temperatures. Previous analysis of the group by trials interaction had suggested that a negative correlation existed between hand temperatures and the number of trials completed (when averaged over sessions). Figures 23 to 26 show that the only condition to increase hand temperatures consistently between these two 68-second time periods was the BFK group. The combined group maintained similar hand temperatures between intervals 1 and 2 while the control group dropped approximately 0.2 C in the same time span. This suggests that biofeedback may be helping subjects in the feedback conditions to at least diminish some of the cooling effects associated with the laboratory environment or experimental procedure. Subjects that did not receive biofeedback information regarding their performance cooled in the same time spans.

FIGURE 23

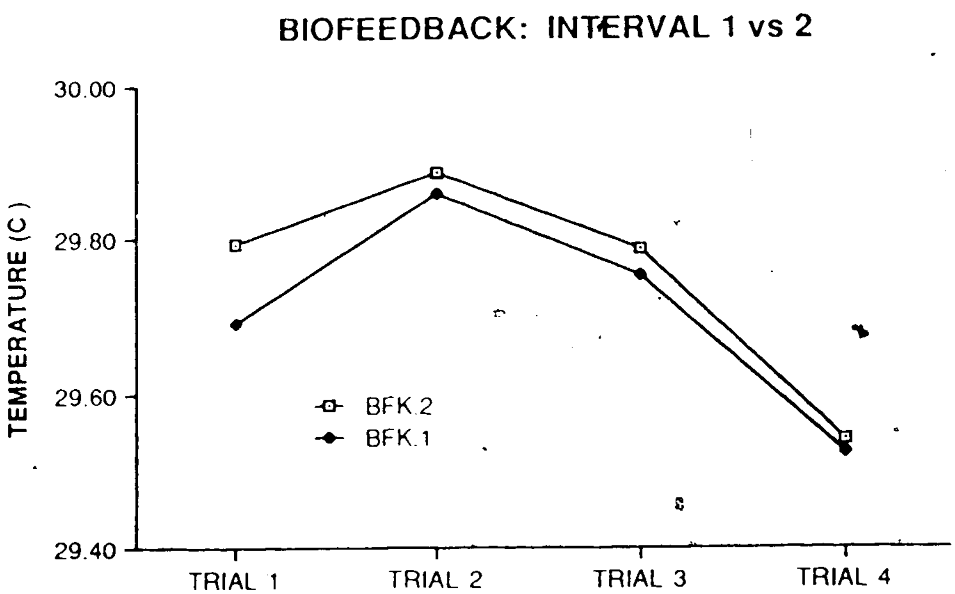


FIGURE 24

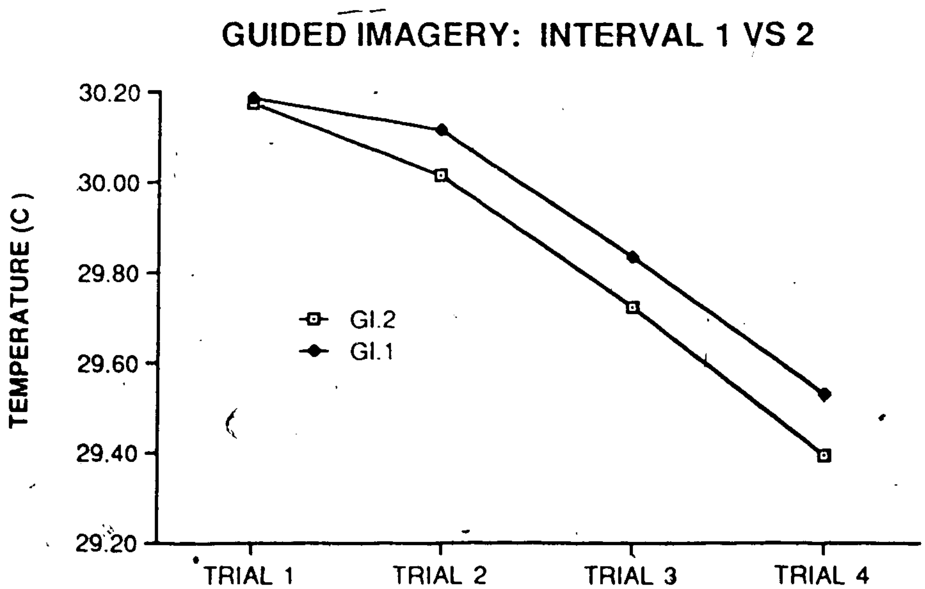


FIGURE 25

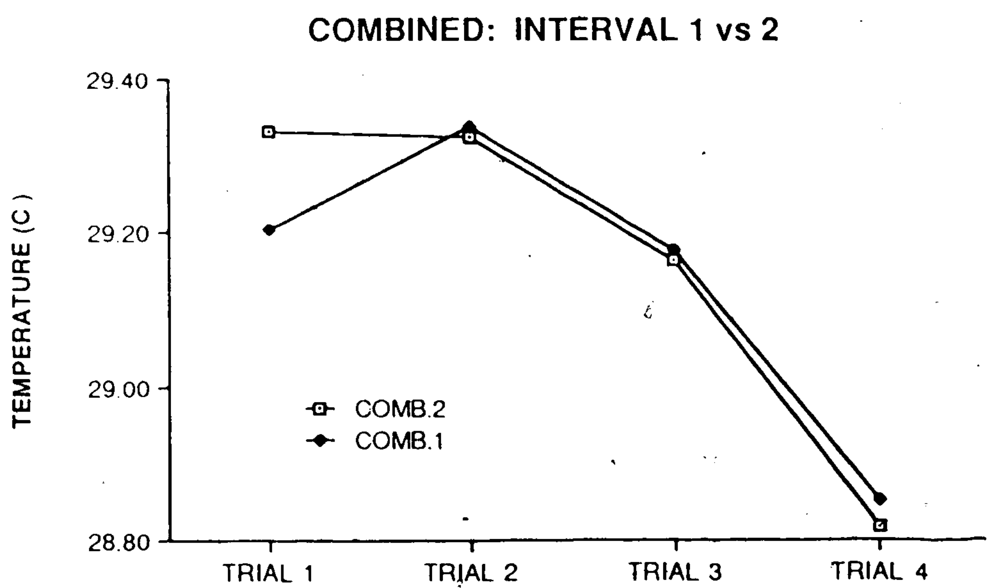
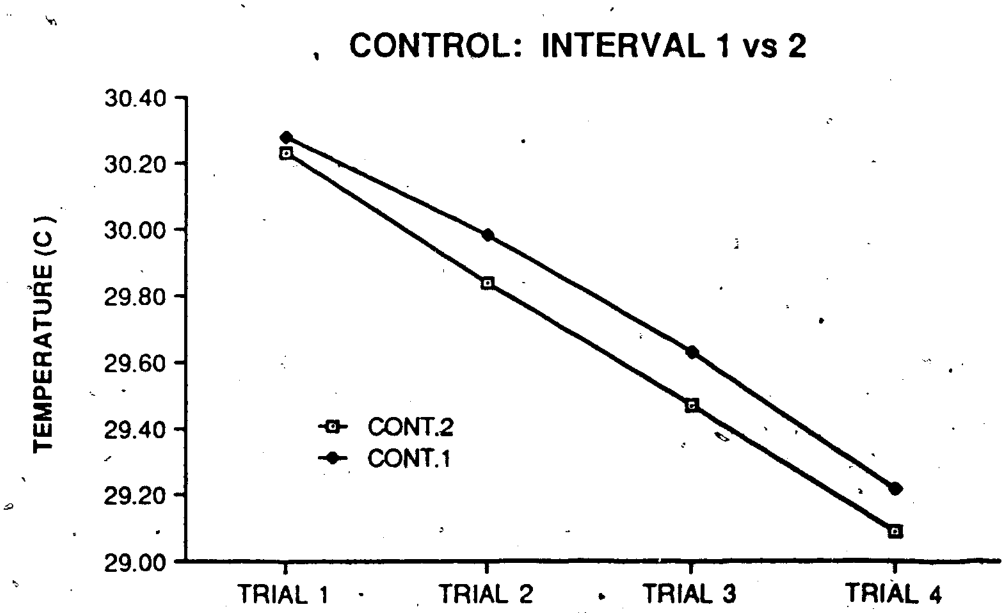


FIGURE 26



Summary: Research questions 1 and 2

If questions 1 and 2 are considered in a general sense, it would appear that treatment effects associated with the three active treatments did not differ appreciably from the control group and that high and low imagers displayed roughly equivalent results relative to one another. That is, the grand means for each of the groups were not significantly different from one another. However, an examination of the groups by trials interaction (Figure 9) suggests that biofeedback alone does contribute to thermal training. By trial 4, the BFK group was the only group with significantly warmer hand temperatures than the controls.

Mean hand temperatures in the groups by imagery levels interaction (Figure 5) did not vary substantially from one another, and suggests that imaging ability did not influence the overall treatment effects associated with the different training approaches. However, when comparing only high imagers across all conditions and sessions (Figure 16), high imagers in the guided imagery group were significantly warmer than the BFK and control groups by session 5. Low imagers on the other hand did not appear to vary significantly from one another with the exception of session 1, where the BFK group was substantially warmer than the combined group. Lastly, comparisons of high and low imagers within single treatments indicated a general superiority for the low imagers. Low imagers were significantly warmer than high imagers within the BFK condition on days 1 and 5, within the combined condition on day 3, and within the control group during session 5.

B. Research Question 3

3. What is the relationship between subjects' self-estimates of imaging ability and the Switras Survey of Mental Imagery?

Correlations of SRIA and SMI

Subjects had been instructed to first complete a short questionnaire regarding their self-estimates of imaging ability in seven modalities (Self-Ratings of Imaging Ability [SRIA], see Appendix I) before responding to the Switras Survey of Mental Imagery (SMI). Table 10 presents the correlation matrices between SRIA self-estimates of imaging ability and scores on the SMI, while Tables 11 and 12 report the intercorrelations within SRIA and SMI scores, respectively.

Relationship of SRIA and SMI An examination of correlations in Table 10 indicates that the degree of relationship between self-estimated single modalities with their counterparts on the SMI was higher for vividness than for control. This likely suggests that subjects' notions of imaging ability are more closely linked with the clarity of the image produced rather than their ability to manipulate it.

With the exception of the SRIA visual, and SMI VC and VV scores (r= .49, and .60), the correlations amongst the various scores indicate that many of the modalities overlapped to a great degree. For example, correlations of self-estimates of tactile (scale T on the SRIA) ability with other SMII scores ranged from .32 (with visual vividness) to .59 (with gustatory vividness). This seems to indicate that visual imagery is clearer conceptually for subjects in

TABLE 10

Correlations: Self-Ratings of Imaging Ability (SRIA) and Switras Survey of Mental Imagery Scales

S R I A

		V	A	O	G	T	S	K	TOT
	VC	49*	10	27**	14	15	01	11	32**
	VV	60*	30**	41*	25**	32**	10	18	45*
	AC	18	25**	23**	26**	39*	23**	27**	32**
	AV	35*	43*	34**	31**	40*	23**	22**	44*
	OC	32**	17	53*	45*	43*	30**	34**	47*
S	OV	41*	21	59*	49*	49*	35*	33**	55*
W	GC	20	27**	30**	49*	48*	28**	38*	42*
I	GV	27**	39*	38*	58*	59*	27**	40*	54*
T	TC	27**	20	31**	33**	40*	27**	33**	36*
R	TV	40*	35*	46*	41*	54*	37*	43*	56*
A	SC	15	01	34**	18	36*	48*	25**	29**
S	SV	25**	16	41*	30**	47*	50*	27**	42*
	KC	22**	14	37*	37*	37*	18	40*	34**
	KV	36*	29**	43*	40*	49*	31**	50*	55*
	CT	33**	22**	44*	43*	49*	32**	39*	47*
	VT	46*	38*	53*	49*	58*	36*	41*	62*
	SMI	44*	34**	51*	49*	57*	36*	41*	59*

**p<.05 number of subjects in all cases: 83
*p<.001 (decimal points omitted)

V= visual
A= auditory
O= olfactory
G= gustatory
T= tactile
S= somaesthetic
K= kinesthetic
CT= total control
VT= total vividness
SMI= grand total SMII
TOT= total score SRIA
C= control
V= vividness

this study than for other modalities which appeared to show more overlap or shared commonality.

Highest correlations with the total vividness score on the SMI were total score SRIA (r= .62), followed closely by tactile and olfactory self-estimates (r= .58 and .53, respectively). The overall correlations on the SRIA and SMI indicate that the common shared variance is approximately 36% and suggests that the laypersons' understanding of imaging ability relative to Switras' definitions of the seven sensory modalities only shared some limited commonality.

SRIA intercorrelations. The intercorrelations of subjects' Self-Ratings of Imagery Ability scores are presented in Table 11 and indicate much overlap amongst the seven modality ratings. Estimates of tactile imagery ability showed moderate to strong correlations with the other six modalities (ranging from r= .39 to .65) and was the best single estimate of the SRIA total score (r= .77).

SMI intercorrelations. Examination of Table 12 indicated relatively high correlations between control and vividness scores within a single modality (visual r= .79, auditory r= .82, olfactory r= .89), however, intercorrelations of apparently unrelated modalities were substantial as well (for example, VV and AC r= .62; VV and OC r= .63; AC and GC r= .67). This might suggest that these modalities are not conceptually autonomous, or that subjects who are good or bad imagers in these modalities are good and bad consistently across a related number of modalities.

TABLE 11

Intercorrelations of Self-Ratings of Imaging Ability (SRIA)

	A	O	G	T	S	K	TOT
V	43*	47*	33**	39*	18	28**	61*
A		24**	47*	57*	34**	44*	65*
O			61*	52*	50*	36*	65*
G				65*	44*	48*	71*
T					61*	59*	77*
S						60*	66*
K							69*

**p<.05 number of subjects in all cases= 83
*p<.001 (decimal points omitted)

V= visual T= tactile
A= auditory S= somaesthetic
O= olfactory K= kinesthetic
G= gustatory TOT= total score SRIA

TABLE 12

Intercorrelations of Switras Survey of Mental Imagery Scales

	VV	AC	AV	OC	OV	GC	GV	TC	TV	SC	SV	KC	KV	CT	VT	SMI
VC	79*	44*	39*	49*	45*	42*	54*	54*	51*	23**	18	51*	44*	66*	57*	61*
VV		62*	56*	63*	49*	53*	50*	50*	64*	28*	37*	53*	56*	67*	78*	76*
AC			82*	55*	59*	67*	65*	47*	51*	48*	43*	64*	55*	77*	72*	76*
AV				50*	68*	51*	60*	35*	52*	35*	47*	46*	53*	62*	78*	75*
OC					89*	66*	64*	54*	56*	43*	48*	54*	48*	81*	73*	78*
OV						60*	67*	49*	64*	45*	59*	49*	55*	75*	84*	84*
GC							88*	69*	66*	45*	42*	79*	66*	89*	76*	82*
GV								65*	77*	47*	54*	69*	70*	83*	87*	88*
TC									83*	47*	39*	74*	62*	81*	68*	74*
TV										53*	62*	64*	77*	78*	87*	86*
SC											86*	39*	43*	62*	57*	60*
SV												34**	54*	57*	70*	68*
KC													77*	84*	70*	76*
KV														72*	81*	80*
CT															88*	94*
VT																99*

**p<.05 number of subjects in all cases= 83
*p<.001 (decimal points omitted)

V=visual
A=auditory
O=olfactory
G=gustatory
T=tactile
S=somaesthetic
K=kinesthetic
CT=total control
VT=total vividness
SMI=grand total SMI
C=control
V=vividness

In summary, it would appear that subjects tended to view imaging ability in terms of its vividness rather than control, and that the greatest similarity between the SMI and the SRIA is limited to the visual modality. Subjects' self-estimates in the other modalities did not relate consistently with their SMI counterparts and may be indicative of conceptual differences in their formulation of other sensory modalities. Table 11 suggests that subjects' self-estimated ability to image in one modality appears to overlap with perceptions of imagery ability in other modalities while Table 12 in a similar vein questions the internal consistency of the various SMI scales.

C. Research Question 4

Are there variables that would help to identify subjects that are more likely to succeed in hand temperature warming?

Discriminant Analysis

A number of exploratory analyses were undertaken in order to ascertain if there were any variables that would differentiate between successful and less successful subjects. Change scores were calculated for all subjects. This involved subtracting the daily baseline hand temperatures from hand temperatures obtained during the trials on the same day (trial - baseline = change score). There was a total of 20 trials over the five days, and since the literature review suggested that learning effects would emerge after three sessions, the original cutoff point for "successful" versus "unsuccessful" groups was arbitrarily set at 11 or more trials in which hand temperatures rose above the baseline.

Scores from the Self-Ratings of Imagery Ability, Switras Survey of Mental Imagery: Form A, demographic data from the subjects' information sheets and baseline temperatures were used to derive the discriminant functions. Discriminant analyses based on these two groups were non-significant.

Following the non-significant discriminant analysis for two groups, a third category was created. Those subjects with 11 or more positive change scores were still designated as "successful", while subjects with 7 to 10 positive trials were labelled "mixed" and those with 6 or less as "unsuccessful." Table 13 presents the results of the multiple discriminant analysis. A Wilks' lambda test for differences in vector means indicated that only discriminant function I approached significance ($p = .0763$) and accounted for 66.57 percent of the variance.

In Table 14, normalized and standardized coefficients are reported for the independent variables used in the prediction equations. An examination of the weightings and correlation coefficients did not lead to any discernible clumping of the variables.

Inspection of the group means and standard deviations in Table 15, suggests that "successful" trainers tended to be have cooler baseline hand temperatures (27.815°C), favoured females (3 males, 10 females), and were slightly older (33.23 years) than subjects in the other groups (mixed: 29.31 years; unsuccessful: 28.29 years). The "unsuccessful" group contained more females (11 males, 23 females), slightly more high than low imagers (20 and 14, respectively), and

TABLE 13

Canonical Discriminant Functions

Func	Percent of Variance	Wilk's Lambda	Chi-squared	D.F.	Significance
1	66.57	0.6858912	27.147	18	0.0763
2	33.43	0.8771520	9.437	9	0.3068

TABLE 14

Normalized and Standardized Vectors for Two Discriminant Functions

	normalized		standardized	
Variables:	Func 1	Func 2	Func 1	Func 2
baseline temp	0.80537*	-0.12999	0.93310	-0.18239
sex	0.32543*	0.21394	0.02467	0.19989
SRIA.score	-0.16803*	-0.01401	-0.32632	0.24249
treatment	0.18455	0.71642*	0.31896	0.82778
age	-0.31332	0.35070*	-0.27063	0.24433
imagery level	-0.00957	0.32427*	0.16934	0.77976
eduaction	0.09007	0.32427*	-0.10425	0.24340
SMI.Control	-0.00441	-0.22427*	-0.71756	-0.27935
SMI.Vividness	0.04607	-0.19207*	1.08169	0.66591

(*variables ordered by size of correlation within function)

TABLE 15

Group Means and Standard Deviations of Predictor Variables

Groups		Baseline	s.d.	Sex	s.d.
1 (successful):	13	27.815	3.156	1.231	.439
2 (mixed):	32	30.737	1.801	1.469	.507
3 (unsuccessful):	34	30.125	2.561	1.324	.475
total:	79	29.992	2.573	1.367	.485

Group	SRIA.Score	s.d.	Treatment	s.d.	Age	s.d.
1:	50.923	9.385	2.538	1.198	33.231	7.897
2:	48.187	11.961	2.844	1.051	29.313	7.677
3:	49.088	9.992	2.176	1.086	28.294	8.902
total:	49.025	10.655	2.506	1.119	29.519	8.337

Group	Imagery Level	s.d.	SMI Control	s.d.	SMI Vividness	s.d.
1:	1.538	.519	228.308	27.666	301.000	67.067
2:	1.531	.507	228.125	26.245	305.406	63.317
3:	1.412	.500	232.615	26.683	313.147	61.834
total:	1.481	.503	230.089	26.452	308.103	62.653

Group	Education	s.d.	Treatments: (total)	BFK	GI	COMB	CONT
1:	15.000	3.830	15	4	2	5	4
2:	15.375	2.575	34	3	12	6	13
3:	14.676	2.409	34	13	6	11	4
total:	15.013	2.729	83	20	20	22	21

Crosstabulation: Outcomes by Feedback Conditions

	feedback	no feedback	
successful	9 (7.6)	6 (7.2)	15
mixed	9 (17.2)	25 (16.8)	34
unsuccessful	24 (17.2)	10 (16.8)	34
total	42	41	83

Chi-square = 13.8752 df = 2 Significance: p <.01

had higher SMI control and vividness scores. The "mixed" group had roughly equal numbers of each gender (15 males, 17 females), began with warmer hand temperatures (30.737^{0}C), and had lower SRIA scores. The "mixed" and the "successful" groups were also classified as having slightly lower imagery ability relative to the "unsuccessful" group. A significant chi-square analysis of cell distributions (X^2 [2] = 13.8752, $p < .01$), suggested that the absence or presence of feedback during training seemed to differentiate between the "mixed" and "unsuccessful" subjects. Subjects receiving biofeedback contributed disproportionately more to the "unsuccessful" group, while the "mixed" group contained more subjects who were not objectively aware of their performances. The remaining variables did not contribute markedly towards differientiation of the groups.

A graphic display of Table 16 (Figure 27) showing the mean discriminant function centroids indicates that there is considerable overlap amongst the three criterion groups. Table 17 shows the classification results based on the two prediction equations and suggests that there is a slight improvement above the prior probablity of correct classification for the "successful" group (33.3% vs 46.7%).

A third discriminant analysis was run utilizing the same predictor variables as above but involved only the two extreme groups. The results (which are not reported) of this simpler two group discriminant analysis was non-significant and did not improve the prediction power of the previous discriminant function.

TABLE 16

Group Centroids

Group	Func 1	Func 2
1	-1.07698	0.31856
2	0.43711	0.31926
3	0.00039	-0.42229

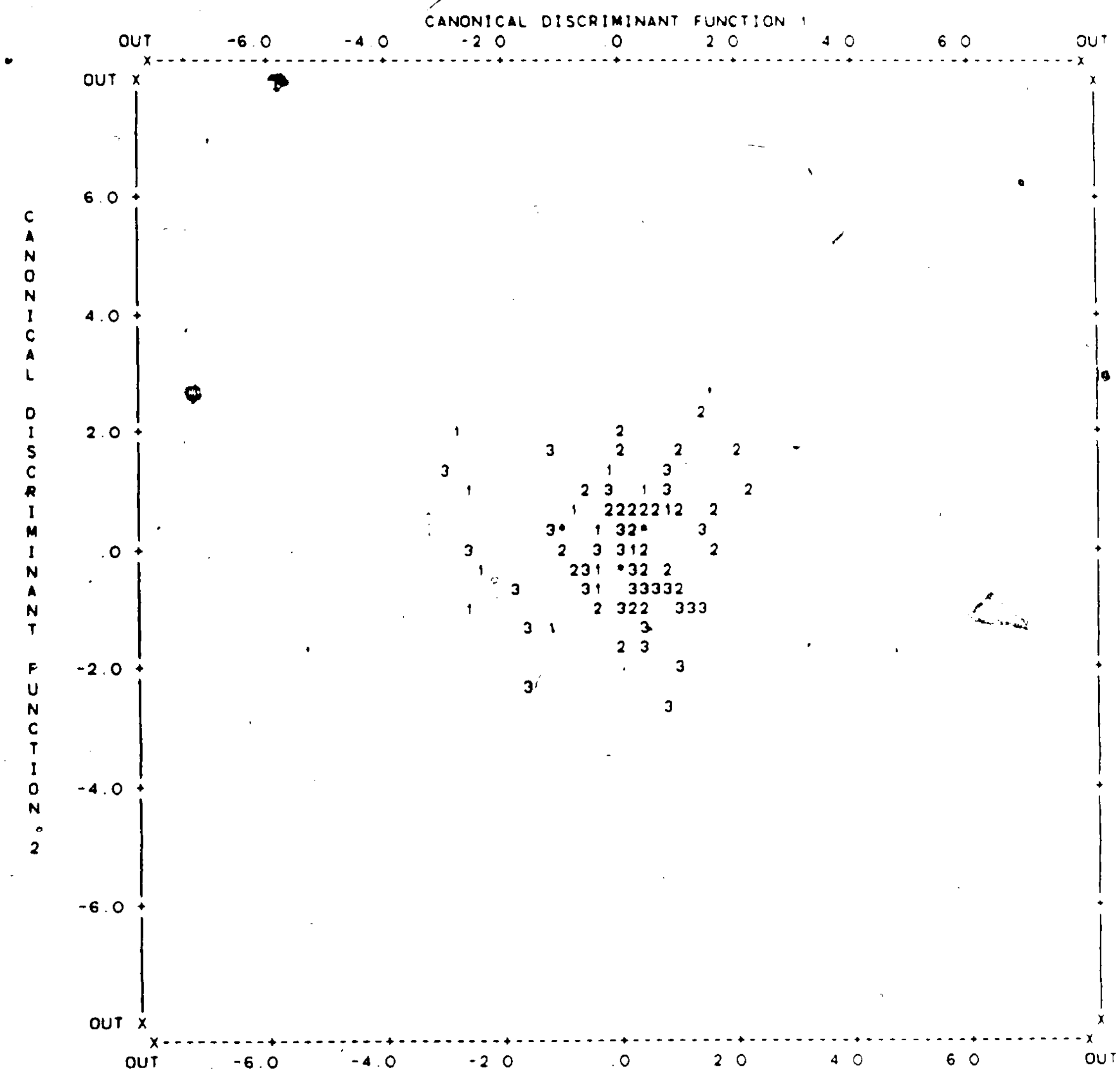
TABLE 17

Classification Results

Actual group	number of cases	Predicted Group Membership 1	2	3
1: successful	15	7 46.7%	4 26.7%	4 26.7%
2: mixed	34	5 14.7%	19 55.9%	10 29.4%
3: unsuccessful	34	7 20.6%	6 17.6%	21 61.8%

Percent of "grouped" cases
correctly classified: 56.63%

ALL-GROUPS SCATTERPLOT - * INDICATES A GROUP CENTROID



D. Post Hoc Comparisons

Two post hoc analyses were added to the study. The first examined the correlations between dominant hand temperatures with EMG levels, non-dominant hand temperatures and room temperatures. The second analysis compared self-reports on several imagery related activities by high and low imagers.

Correlates of hand temperature

Table 18 presents the relationship of hand temperatures in the dominant hand with: (a) EMG levels monitored on the extensor muscle of the dominant arm, (b) hand temperatures on the middle finger of the non-dominant hand, and (c) room temperature. These measures were recorded simultaneously along with dominant hand temperatures throughout the study. Non-dominant hand temperatures were strongly correlated with dominant hand temperatures and suggests that hand temperature training in the current situation is likely a generalized phenomenon rather than specifically limited to one hand. Subjects had been asked to refrain from creating muscle tension in their arms and to remain as relaxed as possible during all the sessions. Means from group comparisons indicated that EMG levels were maintained below the 5 millivolt level in all the treatment conditions. Weak non-significant negative correlations typified the relationship between muscle tension and finger temperatures in the current study (ranges: -.2050 to .0101 during baseline, and -.1949 to .0866 during training) and accounted maximally for approximately 3 to 4 percent of the variance in hand temperatures. Associations between room and hand temperatures were also non-significant

TABLE 18

Correlations: Dominant, Non-dominant Hand Temperatures, EMG & Room Temperatures in Active Conditions

	EMG	Non-dominant	Room Temp	Session	Trial
Dominant	.0528	.9457*	.1592	1	BL
	.0610	.9622*	.1741	1	1
	-.0188	.9478*	-.1378	1	2
	.0909	.9494*	.1424	1	3
	.1476	.9365*	.1722	1	4
Dominant	.1549	.9690*	.1276	2	BL
	-.0715	.9506*	.1079	2	1
	-.2657**	.9363*	.1484	2	2
	-.1784	.9458*	.1617	2	3
	-.2625**	.9456*	.1834	2	4
Dominant	-.2318	.9258*	-.1371	3	BL
	-.0537	.9345*	-.0762	3	1
	-.1047	.9206*	-.0803	3	2
	-.1401	.9058*	-.0479	3	3
	-.1236	.9127*	-.0242	3	4
Dominant	.0109	.9350*	.1316	4	BL
	-.0861	.9379*	.0616	4	1
	.0427	.9307*	.0804	4	2
	-.0946	.9516*	.0580	4	3
	.0974	.9610*	.0487	4	4
Dominant	-.0646	.9546*	.0401	5	BL
	-.0443	.9502*	.0608	5	1
	-.0345	.9506*	.0819	5	2
	-.1059	.9505*	.1289	5	3
	.1486	.9498*	.1472	5	4

cases= 62 ** p < .05
* p < .001

Range: Dominant hand and room temperatures
During baseline: -.1371 to .1592
During training: -.0803 to .1834

Range: EMG and Dominant hand temperature
During baseline: -.2318 to .0109
During training: -.2657 to .1486

Range: Dominant and non-dominant hand temperatures
During baseline: .9258 to .9690
During training: .9127 to .9622

(ranges: .1693 to .1388 during the baseline period, and .0618 to .1594 during training) and accounted for approximately 2 percent of the variance. Thus, in this study, EMG levels and room temperatures had a minor influence on temperatures in the dominant hand.

SMI and self-reports of imagery activity

The results of a number of one-way anovas comparing high and low imagers (as measured on the Switras Survey of Mental Imagery) on self reports of imagery activities are presented below. Data, gathered from the post session questionnaires, included subjects' self-reports on the ease of image creation, the constancy of the image, and its utility (or usefulness) in helping subjects to warm their hands. In addition, estimates of the time engaged in the three imagery modalities.

Visual, auditory and kinesthetic imagery. Table 19 summarizes the comparisons of self-estimates of ease, constancy and utility of visual, auditory and kinesthetic modalities for high and low imagers. The following Likert rating scale was used:

ease	___	___	___	___	___	difficult
constant	___	___	___	___	___	transient
very helpful	___	___	___	___	___	really not helpful.
	(1)	(2)	(3)	(4)	(5)	

The only significant differences between high and low groups appears to be the ease with which high imagers could create visual (rating 1.85), auditory (rating 1.743) and kinesthetic (rating 2.031) images ($p < .05$).

TABLE 19

Results of Oneway ANOVAs:
SMI Scores and Reported Imagery Activity

Visual Imagery

Imagery Score	n	Ease*[1]	n	Constancy[2]	n	Utility[3]
high	20	1.850	21	2.791	25	2.384
low	20	2.510	20	3.180	22	2.882

Auditory Imagery

Imagery Score	n	Ease*	n	Constancy	n	Utility
high	14	1.743	14	2.486	14	2.614
low	8	2.850	8	3.350	7	3.571

Warmth (W) & Relaxation (R) Imagery

Imagery Score	n	W-Ease*	n	R-EASE	n	Constancy
high	26	2.031	21	1.682	20	2.860
low	25	2.696	25	1.984	21	2.924

Imagery Score	n	Utility	n	Mean Strategies[4]
high	20	2.570	30	3.693
low	19	2.874	31	4.277

*$p < .05$

Likert scales:

Imagery: [1]Easy 1 - 5 Difficult
[2]Constant 1 - 5 Transient
[3]Very helpful 1 - 5 Really not helpful

[4]Average number of strategies attempted per session

TABLE 20

Oneway ANOVAs:
SMI Scores and Reported Imaging Times
(mean minutes/trial)

		Visual:		Warmth:
Imagery Score	n	time*[1]	n	time*
high	26	3.384	20	3.447
low	22	2.541	18	2.639

		Relaxation:		Auditory:
Imagery Score	n	time	n	time*
high	20	3.600	13	2.192
low	22	2.983	8	1.784

*p < .05
time[1] expressed in minutes per trial

No differences were noted in the constancy nor utility of the images. Reports of the number of different images or methods used to induce hand warming ("mean strategies") were non-significant.

Time. Self-reports of time engaged in imaging activities in three modalities were compared (Table 20). High imagers spent substantially more time ($p< .05$) involved with visual, auditory and warmth images than did the low group.

To summarize, results of the one-way anovas in Tables 19 and 20 provide some criterion-based support for the validity of the Switras Survey of Mental Imagery. High imagers did report greater ease in the creation of images and also engaged in more imagery time during the training trials. These reasonably positive findings do provide some support for the validity of the SMI. However, since self-reported data is limited by its low degree of reliability, more studies, which relate imaging scores to actual imaging behavior, are required to further substantiate the utility of the SMI as an indicator of imaging ability.

IV. RESULTS

V. DISCUSSION

The following chapter presents a synopsis of the current findings and their implications, followed by a discussion of the limitations associated with the present study, and concludes with remarks regarding problems in the assessment of imagery and possible guidelines for further research.

Research questions

The prime areas of interest in this study are reiterated below:

1. Which of the training methods: biofeedback alone, guided imagery alone or a combination of both, is most effective in producing warming effects in the dominant hand?
2. Are training effects influenced by subjects' imaging abilities as measured by the Switras Survey of Mental Imagery? More precisely, is there an interaction between imaging ability and type of training?
3. What is the relationship between subjects' self-estimates of imaging ability and the Switras Survey of Mental Imagery?
4. Lastly, are there variables that would help to identify subjects that are more likely to succeed in hand temperature warming?

Findings: Questions 1 and 2. Since main effects for treatment groups, F (3, 75) = .280, p= .840, imagery levels, F (1, 75), p= .540, and the treatment groups by imagery levels interaction, F (3, 75, p= .885, were non-significant, one might conclude that none of the treatment conditions or imagery levels were effective in producing differential thermal effects. However, these results are based on grand means, and actual learning effects could be masked by earlier sessions when skill development was minimal. These earlier sessions would diminish the statistical contribution of temperature differences amongst the treatment groups in later sessions to yield non-significant findings. Thus, examination of the two-way (groups by trials) and three-way (groups by imagery levels by sessions) interactions are more likely to reveal the existence of thermal training effects as well as providing a more realistic expectation of skill acquisition.

A main effects for trials, $F(3, 225) = 30.128$, $p = .001$, was associated with a collective cooling trend across the four trials with hand temperatures during trials 1 and 2 significantly warmer than trials 3 and 4. The trials by sessions interaction, $F(12, 900) = 2.378$, $p = .005$, indicated that trial temperatures were significantly warmer for all subjects during the third day of training and that further sessions did not improve learning effects. These analyses suggest that the general trend for all subjects is to decrease hand temperatures within all sessions, while hand temperatures increased from sessions 1 to 3.

Breaking down the significant two-way: groups by trials, $F(9, 225) = 2.405$, $p = .013$, and three-way: groups by imagery levels by sessions, $F(12, 300) = 1.954$, $p = .028$, interactions allowed a more detailed inspection of the individual contributions to the significant main effects for trials, and trials by sessions interaction.

As noted above, the main effects for trials was associated with declines in hand temperature across the four trials. Examination of individual group performances across trials (Figure 9, p. 113, Table 9, p. 104) revealed significant decreases in temperature between trials 1 and 4 for all groups except the biofeedback group. The BFK group maintained relatively consistent temperatures across the four trials. The slope associated with the cooling trend for the control group was steepest and suggests that the control group contributed disproportionately more to the decline in overall trial temperatures. The combined treatment condition appeared to be least conducive to learning thermal effects and displayed significantly lower hand temperatures than the BFK, GI and control groups during trials 1, 2 and 3. However, by trial 4, the control and the combined conditions did not differ. Despite the significant decrease in hand temperatures from trial 1 to 4, the guided imagery group performed well comparatively, and was never significantly exceeded by the other treatment conditions. In trial 4, only the BFK group was significantly warmer than the control group. This was due primarily to declines in hand temperature by the controls. Visual inspection of post hoc comparisons at an intra-trial level over four trials (Figures 23 to 26, pp. 123-124) revealed consistent declines in hand temperatures between intervals 1 and 2 for the GI and control groups only. In contrast, the BFK group increased its hand temperature within trials while the combined group maintained prior temperatures. Analyses at this level would seem to strongly suggest that the biofeedback alone condition was influential in minimizing declines in hand temperatures across trials, while increasing hand temperatures within trials.

Comparisons within the three-way interaction (groups by imagery levels by sessions) involved: (a) high imagers amongst themselves, (b) low imagers amongst themselves, and (c) high versus low imagers within single treatments. The comparison amongst the high imagers indicated that the GI condition was significantly warmer than the other groups during session 5. The comparison amongst the low imagers revealed only one significant difference. The BFK group had significantly warmer hands than the combined group during session 1 only. Comparisons of high and low imagers within single treatments revealed a general superiority for low imagers. Low imagers were substantially warmer than high imagers in the BFK condition on days 1 and 5, in the combined condition on day 3, and in the control group during session 5. No significant differences between high and low imagers were noted in the guided imagery group.

Summarizing to this point, there appears to be a cooling trend across the four trials, perhaps associated with the ambient room temperature, laboratory setting or experimental procedure. (Similar findings have been reported by Surwit [1976]). The controls appeared to be influenced most by these factors and their declines represent expected hand temperature behaviors for this particular experimental environment. Thus if none of the treatment conditions were effective, all groups would have similar declines over the four trials. However, this was not the case, as the biofeedback group declined much less, emerging as the warmest group by trial 4.

Additional support for the effectiveness of the biofeedback condition was provided by intra-trial comparisons within each group (Figures 23 to 26, pp. 123-124).

Further analyses of the interactions suggested that training effects did not become evident until after 3 days of training, and it also appears in our case that additional training did not improve learning effects thereafter. These results are similar to those reported by Gardner and Keefe (1978) and suggests that for most subjects that development of hand warming ability is a gradual process. Lack of improvement after the third session may be related to motivational aspects of subjects. Normals, unlike clinical subjects who often have some underlying disorder, may not have the same incentive to succeed and therefore after several repetitions of the treatment may lose some enthusiam about their participation.

Comparisons within the three-way interaction indicated that high imagers in the GI condition were significantly warmer than other high imagery groups during session 5. This finding is consistent with the notion that high imagers ought to benefit more from a treatment condition that utilizes their abilty to create imagery. The lower performance of the high imagers in the combined condition may be attributed to sensory overloading, as many subjects complained about having to attend to the audiotape, and the visual and auditory feedback at the same time. Amongst the low imagers, only the BFK condition during session 1 was superior to the combined condition. Again, the initial reaction to the combination of feedback and audiotape likely contributed to this result. As well, many low imagers reported feeling additional anxiety because of their inability to create audiotape images.

Comparisons of single groups within the three-way interaction revealed significantly warmer hands for low imagers in the BFK (sessions 1 and 5), combined (session 3) and control conditions (session 5), while no differences were noted for the guided imagery group. Why low imagers were superior to high imagers within these conditions is not clear? High imagers may react differently to the same stimulus conditions than do low imagers. Perhaps, high imagers are able to neurologically self-stimulate their tertiary association areas (involving the overlap of many sensory networks) and are therefore less receptive of external stimulation or information. This could account for some of the differential reaction to the same stimulus conditions by high and low imagers. These musings are highly speculative and require further investigation.

In summary, although an overall cooling trend was evident, the contributions of the various groups were disproportionate. It would appear that biofeedback alone emerged as the best treatment condition overall, and that low imagery ability may be an asset rather than a hindrance in learning to vasodilate.

Question 3.

Relationship of SRIA and SMI. Table 10 indicated that correlations of self-ratings of imaging ability (SRIA) with the Switras Survey of Mental Imagery (SMI) were higher for vividness than for control. This suggests that subjects tended to view imaging ability more in terms of its clarity rather than their ability to manipulate it. Correlations between SRIA visual and SMI visual control and vividness were moderately high (r= .49 and .60, respectively). However, moderately high correlations amongst supposedly unrelated scales (for example, SRIA tactile with SMI gustatory vividness, r= .59) were also present. The SMI total vividness score correlated highest with the total score SRIA (r=.6190), followed closely by SRIA tactile and olfactory self-estimates (r= .58 and .53, respectively).

Intercorrelations. The intercorrelations of SRIA scores presented in table 10 indicate much overlap amongst the seven modality ratings. The SRIA tactile scale showed moderate to strong correlations with the other six modalities (ranging from r= .39 to .65) and was the best single estimate of the SRIA total score (r= .77).

Although SMI intercorrelations (Table 12, p. 131) were relatively high between modality control and vividness (visual r= .79, auditory r= .82, olfactory r= .89), the intercorrelations of apparently unrelated modalities were substantial as well (for example, VV and AC r= .62; VV and OC r= .63; AC and GC r= .67).

Post hoc comparisons. Results of the one-way ANOVAs (Tables 19 and 20, pp. 142-143) provided some criterion based support for the validity of the Switras Survey of Mental Imagery questionnaire. High imagers did report greater ease in the creation of images and also engaged in more imagery time during the training trials. However, support for the validity of the SMI should be viewed cautiously as additional validation studies are required.

In summary, it would appear that subjects tended to view imaging ability in terms of its vividness rather than control, and that the best overlap between the SMI and the SRIA is limited to the visual modality. Subjects' self-estimates in the other modalities did not relate consistently with their SMI counterparts. Intercorrelations revealed that subjects' self-estimated ability to image in one modality appears to overlap with perceptions of imagery ability in other modalities while SMI intercorrelations question the internal purity of the various SMI scales. These results might suggest that these modalities are not conceptually autonomous, or that subjects who are good or bad imagers in these modalities are good and bad consistently across a related number of modalities. Post hoc comparisons of imaging activities provided some tentative support for the SMI. However, the possibility exists that subjects with high self-perceptions of imaging ability would be more predisposed to engage in imagery activities than subjects with low self-perceptions, could account for the post hoc differences as well. Further investigation relating performance differences with SMI scores appears warranted.

Question 4.

Discriminant function analyses did not reveal a combination of independent variables that were able to separate the successful, mixed and unsuccessful subjects significantly ($p= .0763$). Examination of the weightings and correlation coefficients suggested that "successful" subjects tended to be have cooler baseline hand temperatures, favoured females and were slightly older than subjects in the other groups. The "mixed" group contained relatively equal numbers of each gender, began with mildly warmer hand temperatures, and had lower total SRIA scores relative to the other groups. The "mixed" and the "successful" groups were also classified as having slightly lower imagery ability relative to the "unsuccessful" group. However, treatment condition did appear to be related to classification as "mixed" or "unsuccessful." Treatment conditions that involved biofeedback (BFK and COMB) contributed disproportionately more to the "unsuccessful" category (24 Ss out of 34), and non-feedback conditions (GI and control) contributed disproportionately more to the "mixed" category (25 of 34).

In short, non-significant indicators from the discriminant analyses suggested that females with lower initial hand temperatures and lower imagery scores were more likely to succeed at warming their hands. These findings are not surprising in light of the problem of ceiling effects associated with high initial hand temperatures. More precisely, subjects who have high initial hand temperatures during training have less room to demonstrate warming effects, while low initial hand temperatures have more room in which to demonstrate warming effects. Therefore, these results may be partially artifactual and related to the use of temperature as a measure of vasodilation. Since females tend to have lower hand temperatures on average than males, the relationship of gender and low initial hand temperatures is likely not random. Interestly, lower imaging ability as an asset in thermal training has again been implicated to a minor degree.

The absence or presence of feedback may influence classification an "mixed" or "successful." Knowing "how one is doing," may not be beneficial especially if the feedback indicates that one is not succeeding. Thus, performance anxiety in the feedback conditions (BFK and COMB) and too much feedback information (in the COMB condition) may contribute to non gains in hand temperature training.

Contributions of present study

An attempt was made in the current study to find treatment conditions that would match favourably with subjects' attributes (imaging ability) and thus enhance the training effects. Unfortunately, the expected interaction between imaging ability and the employment of guided imagery was generally not supported. Although high imagers in the GI condition performed significantly better during session 5 than high imagers in other treatment conditions, low imagers appeared to perform better under most of the treatment conditions utilized in this study.

The monitoring and maintenance of low EMG levels (< 5 microvolts) throughout the training, however, may have contributed to the relatively poor training outcomes. The current findings are consistent with other studies (King & Montgomery, 1981; Donald & Hovmand, 1981; Rattenbury & Donald, 1982) that have found small magnitude training effects when somatic maneuvers were controlled. Thus, there seems to be growing evidence that hand warming via a central mediated process may only result in minor increases in hand temperatures at best, and that greater temperature increases involve somatic mediation. On the other hand, examination of the post session questionnaires revealed that several very successful subjects (gains > 2 C^0) utilized mental imagery in raising their hand temperatures while maintaining relaxed forearms. This would suggest that the relationship between cognitive factors and thermal control is likely complex and may vary greatly at an individual level.

At this point, one cannot rule out the usefulness of using thermal imagery as an adjunct to thermal training. (It may be that the experimental design of the current study did not allow enough time for the emergence of an imaging effect or interaction.) More research, involving controls for EMG, are required to limit the role of somatic maneuvers in thermal regulation. However, the factors involved in developing voluntary thermal control may not simply be an "either/or" issue, but may involve somatic, cognitive components, and some sort of central mediation.

Limitations of the study

The problems associated with ambient temperature, dependent measures and assessment of imaging ability are addressed below.

Ambient temperature. Guidelines in the literature (Yates, 1980; Surwit, 1976; Montgomery & Williams, 1977) were followed to set the ambient temperature at a level that allowed room for subjects to demonstrate learning effects while minimizing ceiling and cooling or drift effects. An approximate ambient temperature of 23^0 C (+/- 0.6 C^0) was thought to be an adequate compromise. However, the analysis of the session by trial data represented in

Figure 9 shows an overall tendency for all groups to decrease hand temperatures within each session over time. This suggests that the laboratory environment may have had a chilling effect on most subjects, despite comments of comfort from most Ss. Comfort levels appear to be related to personal perceptions as the same ambient temperature was reported as warm and cool by various subjects. As well, attempts to control for muscle activity through prior verbal instruction and EMG monitoring may have limited the mediation of hand temperatures via muscular activity and may have also contributed to a cooling trend. This contention is supported by King and Montgomery (1981) who have reported that muscular activity was necessary in the mediation of hand warming.

The dependent measure. The mean hand temperature scores in this study were based on a larger time interval than many studies reviewed in the literature. For example, Vasilos and Hughes (1979) used a single peak temperature as his dependent measure while Herzfeld and Taub (1977, 1980) took a single temperature at the end of a specified time period. The measures in the current study are likely truer indicators of the actual performances of subjects during training since they sample a larger time interval which diminishes chance fluctuations in hand temperatures. However, a larger time interval may increase the difficulty of obtaining significant results.

Problems in the assessment of imagery. Attempts to quantitively describe imaging ability which is essentially an introspective process has met with many shortcomings. In this study imaging ability was defined as the scores on the Switras Survey of Mental Imagery (SMI) questionnaire. The SMI was employed after a perusal of the literature because it had several advantages over other existing questionnaires. It attempted to assess several imaging modalities, separated control and vividness, and offered a set of norms (albeit, a limited set). However, ceiling effects were noted in several modalities, especially visual, which failed to discriminate amongst subjects at the upper end of the questionnaire. As well, because some scales (for example, visual) utilized more items than others, their input towards the overall imagery score was disproportionate. Greater difficulty in the items, weighted scale scores and perhaps a seven point Likert scale for both controllability and vividness would increase the variability in the responses.

Since many of the SMI scores seemed to be highly correlated, one wonders about the conceptual purity of many of the scales. Instead of seven modalities other writers have suggested that only three or four modalities are relatively distinct (Bandler & Grinder, 1975).

Perhaps the greatest limitation of self-assessment questionnaire-type instruments, such as the Betts and the SMI, is the subjective factor. Subjects do not have any basis for comparison and can only rely on their own standards or perceptions of imaging ability (Kaufmann, 1981). Conceivably, equivalent imaging abilities may be judged poor or good depending on whether subjects apply stringent or loose standards in their interpretation of imaging ability.

Unless imagery scores can be validated or substantiated against some external criteria, the assessment of imagery will remain a major stumbling block to study in this area. Some attempts to quantify visual imaging ability through tasks such as mental spatial manipulations (Sherman, 1978), and image size (Kosslyn, Pinker, Smith, & Shwartz, 1979) may be reflective of visualization to some degree (but may reflect prior learning as well) but may not be as meaningfully equivalent or personally relevant as self-generated images. This difference may be important especially in psychotherapies which incorporate imagery in the process of cognitive change. To find counterparts for the other modalities is more difficult. How does one validate a high olfactory imaging score? Is the measurement of olfactorial acuity the same thing? Kinesthetic, tactile, somaesthic, gustatory, and auditory present similar problems.

Implications for future research.

It is this researcher's view that assessment and validation of imaging ability present as major road blocks in the study of imagery. If the area of imagery is considered in terms analogous to the study of intelligence, this may lead to more fruitful pursuits of its quantification. In the assessment of intelligence, constructs, thought to reflect intellect, are operationalized into objective tasks and performances in the form of an intelligence test. Scores from these tests are then tabulated and compared to a norming group appropriate to the age of the subject to arrive at an intelligence quotient. As well, extensive studies have also been conducted to test the construct validity, predictive validity, and criterion-based validity of these intelligence tests.

It is suggested that the measurement of imaging ability should be approached in a similar and rigourous manner as in the quantification of intelligence. Imagining constructs need to be operationalized, and behavioral correlates of imaging ability need to be specified. Furthermore, extensive norms need to be developed, and imaging scores from such tests and inventories need to be evaluated (or validated) against performances in areas thought to be compatiable and incompatiable with high or low imagery ability in a particular modality. This is not a simple task and would involve the same kind of effort as has been witnessed in the area of intelligence. However, without this kind of basis, much of the future research into imagery will only be speculative.

Since males and females appear to have different "normal" hand temperatures, drift effects (Yates, 1980) and cooling effects could be minimized by training males and females at different ambient temperatures. There is also some evidence to suggest that peripheral temperatures of females respond differently than males in similar temperature environments, and the study of vasodilation may yield more fruitful findings if males and females are studied as separate populations.

One problem observed in the review of the literature was the diversity of dependent measures used by various researchers. It is difficult to evaluate research findings that involve a different metric , such as peak temperature changes (Vasilos & Hughes, 1979), a single unit of measure at a given point (Herzfeld and Taub, 1977, 1980), differential temperatures (Roberts, Kewman & MacDonald, 1973), and "ipsitization" of scores (Herzfeld & Taub, 1977, 1980). The use of standardized dependent measures would facilitate direct comparisons of results across studies.

One of the possible explanations of the relatively poor performance of the high imagers relative to low imagers may involve the concept of other-directed versus self-directed imagery (Worthington, 1978). Perhaps high imagers prefer to self-initiate thermal images and find that other-directed imagery interferes with their ability to produce and become personally involved in these images.

The relationship of somatic maneuvers and peripheral hand temperatures needs to be further investigated. Taub and Emurian (1976; School & Taub, 1980) contend that the influence of muscular mediation in vasodilation is minor, while King and Montegomery (1981) suggest vasodilation is impossible without somatic mediation. There has only been a handful of studies in this regard (Rattenbury & Donald, 1982; Cincirpini, 1982; Donald & Hovmand, 1981) and the monitoring of EMG levels in future studies would be desirable.

Riley and Furedy (1985) and others (Lacroix, 1983) have suggested that learning of various physiological responses should be viewed in terms of an interplay between cognitive and non-cognitive systems. They suggest that cognitive approaches involving propositional information such as in biofeedback (and possibly imagery, as well) would be adequate in the training of target responses (TR) that are related more directly to a cognitive system (for example, EMG training), but are inadequate for training other TR's such as finger temperature which they suggest requires a non-cognitive intervention. Cognitively system-based TR's can be modified by the manipulation of cognitions while non-cognitively based TR's must be learned through doing or reacting (i.e. respondent conditioning). In other words, training of non-cognitive systems such as the sympathetic nervous system (SNS) involves actual performance. Riley and Furedy view the cognitive and non-cognitive systems not as autonomous, but as interactive, and their degree of interaction varies for various TR's. Thus, the success of cognitive interventions such as guided imagery and biofeedback for hand warming may be limited to the degree that Ss' cognitive systems interact with non-cognitve systems.

Supportive of this view, were post-session responses on questionnaires by successful subjects in the BFK group who utilized warm imagery strategies throughout their training. This suggests that the interrelations of the cognitve and non-cognitive systems may vary individually for hand warming, and that guided imagery may be effective for some subjects while not for others.

For Riley and Furedy finger temperature training would be best approached from a classical conditioning paradigm. However, reviews of classically conditioned vasodilation (Lisina, 1965; Hayduk, 1979; Weidel, 1983) indicate that finger temperature increases were of short duration, episodic, and tended to be modest as well. Thus, the conditioning of the SNS may be a necessary first step while the addition of a cognitive system approach may be necessary as a second step in extending training effects, and in its maintenance.

More research using Riley and Furedy's paradigm would likely help to delineate between TR's that are amenable primarily to cognitive interventions, as opposed to TR's that would be best approached with non-cognitive interventions, such as classical conditioning. As well, overlapping treatments involving both cognitve and non-cognitive interventions simulataneously, or successively should also be examined.

Emotive imagery as an alternative to the neutral images utilized in the current study may produce quite different results. Emotive images may have more interconnections with the autonomic nervous system than do neutral images, and therefore, may be more facilitative of physiological changes. The task in training would then be for subjects to generate their own imagery (which would likely be more meaningful) and find particular scenes or situations that are associated with temperature increases. (For example, one volunteer who was not included in this study, used images of love scenes successfully to increase her hand temperature.)

Lastly, there is a need to integrate research results within a more complete theoretical framework. Earlier theories were behaviorally oriented and too simplistic conceptually. Although

Riley and Furedy (1985) have made a considerable contribution in terms of subsuming some of the research in this area, further theory development and elaboration are still necessary. For example, the interrelationship between cognitive changes of expectancies of success (via biofeedback) need to be explained concommitantly in terms of neuropsychological and physiological changes. Mind and body are no longer considered separate, but interactive, and future theories in the area of physiological control need to address this position.

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APPENDIX I

Volunteer Materials

Suey Yee
Dept. of Ed Psych
6-101 Education North Blg
University of Alberta
Date

name
address
city

Dear (insert volunteer's name):

Thank-you for your participation in this study. Before beginning, please check to see that you have: (a) a subject information sheet, which is attached to the Self-Ratings of Imagery Ability (SRIA) questionnaire, (b) the Survey of Mental Imagery, and (c) a purple computerized answer sheet.

The subject information sheet should be filled out first, and the times that you are available for laboratory participation indicated. Secondly, complete the SRIA questionnaire regarding your personal estimates of your imaging ability, and use the descriptions provided as guidelines for each sensory modality. Lastly, read the instructions carefully for the Survey of Mental Imagery and make your responses on the computerized answer sheet only. Although this questionnaire appears quite lengthy, on average it takes about 20 minutes to complete. Make sure however, that there are minimal distractions in your environment while you are responding to these items. Odd-numbered questions refer to imagery control and have only 3 possible responses (A, B, or C) while vividness of imagery questions (even-numbers) have 5 possible responses (A, B, C, D, or E). Please note that it is not unusual to have vivid imagery in some sensory modalities while not in others. If you have any queries whatsoever, please feel free to call me (459-8961).

When the information sheet and the questionnaires are completed, please place all materials in the enclosed self-addressed stamped envelop and mail.

The study itself focusses on the physiological correlates of the relaxation response, and involves the monitoring of hand temperature and localized muscle tension. The relaxation response will be examined under 4 different conditions and after the data has been tabulated, subjects will be randomly assigned to one of four groups. I look forward to working with you and will get in touch as soon as questionnaires have been scored and groups formed. I thank-you again for your interest.

Yours sincerely,

SUBJECT DATA SHEET

THANK-YOU for volunteering! Today's date: ________

Name: ________________ Birthdate: ________ Sex: ____

Address: ____________________________ Phone: ________

____

Times available for study: (five consecutive days, if possible, at the same time each day)

(PLEASE INDICATE)

Time each day: _____ AM or _____ PM (1st preference)
_____ AM or _____ PM (2nd preference)

Mon ___ Tues ___ Wed ___ Thur ___ Fri ___ Sat ___ Sun ___

Additional information:

yes __ no __ a) smoker

yes __ no __ b) suffer migraines; if yes how frequently?
___ per year
___ per month

yes __ no __ c) suffer from very cold hands __ or feet __

females only: Oral contraceptives: yes __ no __

SINCE THIS STUDY IS LOOKING AT THE PHYSIOLOGICAL CORRELATES OF THE RELAXATION RESPONSE, **IT IS IMPORTANT <u>NOT TO EAT OR DRINK ONE HOUR PRIOR</u> TO ARRIVING AT THE LABORATORY.** THANK YOU FOR YOUR COOPERATION.

Please complete the **SELF-RATINGS OF IMAGERY ABILITY (SRIA)** below, before beginning the **SURVEY OF MENTAL IMAGERY** questionnaire. The SRIA scores are based on self-estimates of your proficiency in creating imagery in each of seven sensory areas outlined below. On the row of dots which follows each modality, place a **X** or a cirle on one of the points between "1 and 10". A "1" indicates that you feel that you have very little imagery ability in that particular modality, while a "10" indicates very strong imagery abilities in that sensory modality.

The following definitions are provided as guidelines:

Visual imagery refers to your ability to visualize or see or create a mental picture. eg picturing your house in your mind
Auditory imagery refers to your ability to hear or create sounds, voices and noises. eg hearing a police siren
Olfactory imagery refers to your ability to create or sense smells, ordours and fragrances. eg the scent of a rose in the absence of a real rose
Gustatory imagery refers to your ability to imagine tastes of various foods or substances. eg taste a lemon
Tactile imagery refers to your ability to imagine sensations that are sensed through your skin. eg imagine a warm cup pressed against your lips
Somaesthetic imagery refers to your ability to imagine bodily sensations such as hunger, numbness and other physiological sensations. eg imagine your mouth getting dry
Kinesthetic imagery refers to your ability to experience bodily movements. eg feel yourself running, drawing a triangle

SELF-RATINGS OF IMAGERY ABILITY

	WEAK									**STRONG**
	1	2	3	4	5	6	7	8	9	10
visual	.	.	.	.	.	.	.	.	.	.
auditory	.	.	.	.	.	.	.	.	.	.
olfactory	.	.	.	.	.	.	.	.	.	.
gustatory	.	.	.	.	.	.	.	.	.	.
tactile	.	.	.	.	.	.	.	.	.	.
somesthetic	.	.	.	.	.	.	.	.	.	.
kinesthetic	.	.	.	.	.	.	.	.	.	.
	1	2	3	4	5	6	7	8	9	10
	WEAK									**STRONG**

SURVEY OF MENTAL IMAGERY: FORM A

(Devised by J. E. Switras)

Instructions:

The following is a questionnaire designed to determine the type of mental images that you are able to produce and manipulate. But first, what are mental images? In the past they have been called pictures in the mind, but actually images can be tastes, sounds, feelings, sensations, as well as visual scenes. They can also be combinations of sights, tastes, feelings, etc. An image can be something that you see when your eyes are closed; something that may look as if you can just reach out and pick it up, but which is really not there. An image can be the taste of an orange when you have not actually eaten one. An image may be the smell of a flower when you try to remember what one smells like. As a last example, the picture in your mind of your home as you try to recall what it looks like is also an image. An image can be experienced as a photograph, a movie or as if you are really there and it is really happening.

In responding to this questionnaire you will be asked to imagine that a variety of things are actually happening. You may be asked to close your eyes and try to see a flowerpot, one with a large red flower growing out of it. You may be asked if you can smell the flower and maybe even water it. All this will occur in your thoughts only, but at the time may seem as real as the chair in which you are seated. For most people this is a new and exciting experience, one that proves quite interesting.

With the actual image proposals, please choose the answer that is closest to describing what it is that you are experiencing. Answer every question, even if the answers do not express precisely how you feel. Mark your answers on the answer sheet only.

Name: ____________________ **Birthdate:** ______ **Sex:** _____

Date: ___________ **Additional information:**

smoker:	yes __	no __
suffer migraines:	yes __	no __
suffer cold hands/feet:	yes __	no __
(females only) Oral contraceptives:	yes __	no __

The following sections will deal with actual images that you will attempt to produce. These will involve seeing, hearing, smelling, tasting, feeling and doing things that occur in your mind and imagination only. Respond to each test item in the following manner. First read the item, then close your eyes and try to have the proposed experience. Whatever the task indicated by the item (visualizing a picture, tasting a fruit, etc.), pay attention to 2 elements of what is occurring: (1) How well you can **CONTROL** or manipulate the image, and (2) How **VIVID** or real is the scene, taste, sensation, etc. By control is meant experiencing the scene as close to the item instructions as possible. For example, if asked to form a mental picture of a squirrel eating an acorn, you were able to do so exactly.

Each item is followed by 2 opportunities to respond. (a) Since each item is in the form of a question, it is possible to respond with either a "no" (**A**), "unsure" (**B**), or "yes" (C). On the answer sheet blacken in letter "**A**" (no) if you did not produce the proposed image; blacken in letter "C" (yes) if you produced the image. If you are really not sure if the image was there, blacken in "B" (unsure). (b) Next, 5 letters follow preceded by the word **vividness**. Each letter tells how vivid or real the image was as you experienced it. On the answer sheet blacken in the number "A" if there is absolutely no image, and all that is happening is that you are thinking of the scene, odor, sound, etc. Blacken "B" if you are uncertain of the image, if the image is indistinct, vague, ambiguous, dim, hazy, doubtful, etc. Blacken letter "C" if the image is limited or moderately clear, vivid and perceptible. Blacken in "D" if the proposed experience is reasonably unobscure, vivid, and clear. Finally, blacken "E" if the experience (image) seems as if it is really happening. Here the image should be distinct, photographic (if visual) and perfectly clear and vivid; exactly the experience proposed.

Be sure to attempt each item, and respond to both questions that follow the item.

EXAMPLE:

Q. Can you visualize a book?
   1. control: A-no B-unsure C-yes
   2. vividness: A B C D E

A. On the computerized answer sheet:

	A B C D E	
1.	0 0 0 0 0	This response indicates that an image of a book did occur.
	A B C D E	
2.	0 0 0 0 0	This response indicates that it seemed as if a real book was actually there.

Q. Can you taste sour milk?
3. control: A no B unsure C yes
4. vividness: A B C D E

A. On the computerized answer sheet:

	A B C D E	
3.	0 0 0 0 0	This response indicates that the person could not be sure that an image was there
	A B C D E	
4.	0 0 0 0 0	This reponse indicates that some indistinct, vague, trace of a taste occurred that seemed to resemble sour milk.

Begin when you are ready. Be sure to respond to each item.

VIVIDNESS SCALE:

A--absolutely no image
B--indistinct, vague, ambiguous, dim, hazy, doubtful
C--limited, moderately clear or vivid and perceptible
D--reasonably unobscure, vivid and clear
E--really happening; distinct, perfectly clear and vivid (photographic)

I. ATTEMPT THESE ITEMS WITH YOUR EYES CLOSED. TRY TO "VISUALIZE OR GET A MENTAL PICTURE" OF WHAT IS PROPOSED IN EACH ITEM.

Q Can you see the color red?
1. control: A-no B-unsure C-yes
2. vividness: A B C D E

Q. Can you see a horse standing alone?
3. control: A-no B-unsure C-yes
4. vividness: A B C D E

Q. Can you see the horse trot away?
5. control: A-no B-unsure C-yes
6. vividness: A B C D E

Q. Can you see a bird sitting on a telephone wire?
7. control: A-no B-unsure C-yes
8. vividness: A B C D E

Q. Can you see the bird jump from the wire and fly to the ground?
9. control: A-no B-unsure C-yes
10. vividness: A B C D E

Q. Can you see the bird fly up and land on a branch of a tree?
11. control: A no B-unsure C-yes
12. vividness: A B C D E

Q. Can you see a bottle on a picnic table?
13. control: A-no B-unsure C-yes
14. vividness: A B C D E

Q. Can you see the same bottle on the picnic table, filled with a colored liquid?
15. control: A no B-unsure C-yes
16. vividness: A B C D E

Q. Can you see the same bottle with a different colored liquid?
17. control: A-no B-unsure C-yes
18. vividness: A B C D E

Q. Can you see a girl with red hair eating a green apple?
19. control: A-no B-unsure C-yes
20. vividness: A B C D E

Q. Can you see a tobacco pipe?
21. control: A-no B-unsure C-yes
22. vividness: A B C D E

Q. Can you visualize the number "123" written on a blackboard?
23. control: A-no B-unsure C-yes
24. vividness: A B C D E

Q. Can you visualize a circle with the letter B inside?
25. control: A-no B-unsure C-yes
26. vividness: A B C D E

Q. Can you see a dog dancing?
27. control: A-no B-unsure C-yes
28. vividness: A B C D E

Q. Can you see a bird reading?
29. control: A-no B-unsure C-yes
30. vividness: A B C D E

Q. Can you see a woman lifting an automobile over her head?
31. control: A-no B-unsure C-yes
32. vividness: A B C D E

VIVIDNESS SCALE:

A--absolutely no image
B--indistinct, vague, ambiguous, dim, hazy, doubtful
C--limited, moderately clear or vivid and perceptible
D--reasonably unobscure, vivid and clear
E--really happening; distinct, perfectly clear and vivid (photographic)

II. ATTEMPT THE FOLLOWING ITEMS WITH YOUR EYES CLOSED. TRY TO "HEAR THE SOUND" PROPOSED IN EACH ITEM.

Q. Can you hear the voice of a woman talking to someone?
33. control: A-no B-unsure C-yes
34. vividness: A B C D E

Q. Can you hear a woman's voice in the distance yelling something out loud?
35. control: A-no B-unsure C-yes
36. vividness: A B C D E

Q. Can you hear a masculine voice humming a tune?
37. control: A-no B-unsure C-yes
38. vividness: A B C D E

Q. Can you hear the sound of a train whistle?
39. control: A-no B-unsure C-yes
40. vividness: A B C D E

Q. Can you hear the sound of a police siren?
41. control: A-no B-unsure C-yes
42. vividness: A B C D E

Q. Can you hear a record being played loudly?
43. control: A-no B-unsure C-yes
44. vividness: A B C D E

Q. Can you hear someone lower the volume on the record player?
45. control: A-no B-unsure C-yes
46. vividness: A B C D E

Q. Can you hear a trumpet being played?
47. control: A-no B-unsure C-yes
48. vividness: A B C D E

Q. Can you hear a bathtub filling with water?
49. control: A-no B-unsure C-yes
50. vividness: A B C D E

Q. Can you hear a child crying?
51. control: A-no B-unsure C-yes
52. vividness: A B C D E

Q. Can you hear someone with heavy leather boots walking across a wooden floor?
53. control: A-no B-unsure C-yes
54. vividness: A B C D E

Q. Can you hear two people whistling while a third person sings?
55. control: A-no B-unsure C-yes
56. vividness: A B C D E

Q. Can you hear water splashing?
57. control: A-no B-unsure C-yes
58. vividness: A B C D E

VIVIDNESS SCALE:

A--absolutely no image
B--indistinct, vague, ambiguous, dim, hazy, doubtful
C--limited, moderately clear or vivid and perceptible
D--reasonably unobscure, vivid and clear
E--really happening; distinct, perfectly clear and vivid (photographic)

III. AGAIN WITH YOUR EYES CLOSED, ATTEMPT TO "SMELL THE FOLLOWING ODOURS AND FRAGRANCES."

Q. Can you smell the odor of a gasoline station?
59. control: A-no B-unsure C-yes
60. vividness: A B C D E

Q. Can you smell a raw onion?
61. control: A-no B-unsure C-yes
62. vividness: A B C D E

Q. Can you smell a rose?
63. control: A-no B-unsure C-yes
64. vividness: A B C D E

Q. Can you smell an odor that you really like?
65. control: A-no B-unsure C-yes
66. vividness: A B C D E

Q. Can you smell the odor of a freshly mown lawn?
67. control: A-no B-unsure C-yes
68. vividness: A B C D E

Q. Can you smell a hamburger?
69. control: A-no B-unsure C-yes
70. vividness: A B C D E

Q. Can you smell the odor of a new pair of shoes?
71. control: A-no B-unsure C-yes
72. vividness: A B C D E

Q. Can you smell the scent of a new bar of soap?
73. control: A-no B-unsure C-yes
74. vividness: A B C D E

Q. Can you smell incense burning?
75. control: A-no B-unsure C-yes
76. vividness: A B C D E

Q. Can you smell the odor of sausages frying?
77. control: A-no B-unsure C-yes
78. vividness: A B C D E

Q. Can you smell the strong odor of ammonia?
79. control: A-no B-unsure C-yes
80. vividness: A B C D E

VIVIDNESS SCALE:

A--absolutely no image
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C--limited, moderately clear or vivid and perceptible
D--reasonably unobscure, vivid and clear
E--really happening; distinct, perfectly clear and vivid (photographic)

IV. WITH EYES CLOSED, ATTEMPT TO EXPERIENCE THE PROPOSED "TASTES."

Q. Can you taste fresh raw lemon juice?
81. control: A-no B-unsure C-yes
82. vividness: A B C D E

Q. Can you taste salt?
83. control: A-no B-unsure C-yes
84. vividness: A B C D E

Q. Can you taste something sweet?
85. control: A-no B-unsure C-yes
86. vividness: A B C D E

Q. Can you taste a chocolate bar?
87. control: A-no B-unsure C-yes
88. vividness: A B C D E

Q. Can you taste jelly?
89. control: A-no B-unsure C-yes
90. vividness: A B C D E

Q. Can you taste an apple?
91. control: A-no B-unsure C-yes
92. vividness: A B C D E

Q. Can you taste soup?
93. control: A-no B-unsure C-yes
94. vividness: A B C D E

Q. Can you taste fried chicken?
95. control: A-no B-unsure C-yes
96. vividness: A B C D E

Q. Can you taste salad dressing?
97. control: A-no B-unsure C-yes
98. vividness: A B C D E

Q. Can you taste a piece of pizza?
99. control: A-no B-unsure C-yes
100. vividness: A B C D E

Q. Can you taste Coca-Cola?
101. control: A-no B-unsure C-yes
102. vividness: A B C D E

Q. Can you taste a pear?
103. control: A-no B-unsure C-yes
104. vividness: A B C D E

Q. Can you taste fried eggs?
105. control: A-no B-unsure C-yes
106. vividness: A B C D E

VIVIDNESS SCALE:

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V. NEXT, SEE IF YOU CAN "FEEL" THE FOLLOWING PROPOSED EXPERIENCES. ONCE AGAIN, ATTEMPT TO HAVE THESE EXPERIENCES WITH YOUR EYES CLOSED.

Q. Can you feel a toothbrush rubbing against your gums and teeth?
107. control: A-no B-unsure C-yes
108. vividness: A B C D E

Q. Can you feel long cool grass against the bottom of your bare feet?
109. control: A-no B-unsure C-yes
110. vividness: A B C D E

Q. Can you now feel a rough scouring-pad rubbing over your fingertips?
111. control: A-no B-unsure C-yes
112. vividness: A B C D E

Q. Can you feel a feather tickling your nose?
113. control: A-no B-unsure C-yes
114. vividness: A B C D E

Q. Can you feel a hand on your shoulder?
115. control: A-no B-unsure C-yes
116. vividness: A B C D E

Q. Can you feel fingers scratching your scalp?
117. control: A-no B-unsure C-yes
118. vividness: A B C D E

Q. Can you feel a warm cup pressed against your lips?
119. control: A-no B-unsure C-yes
120. vividness: A B C D E

Q. Can you feel your hand on a doorknob?
121. control: A-no B-unsure C-yes
122. vividness: A B C D E

Q. Can you feel fur-lined gloves on your hands?
123. control: A-no B-unsure C-yes
124. vividness: A B C D E

Q. Can you feel warm soup in your mouth?
125. control: A-no B-unsure C-yes
126. vividness: A B C D E

VIVIDNESS SCALE:

A--absolutely no image
B--indistinct, vague, ambiguous, dim, hazy, doubtful
C--limited, moderately clear or vivid and perceptible
D--reasonably unobscure, vivid and clear
E--really happening; distinct, perfectly clear and vivid (photographic)

VI. WITH EYES CLOSED, TRY TO IMAGE (EXPERIENCE) THE FOLLOWING "**PHYSICAL SENSATIONS.**"

Q. Can you imagine yourself being extremely hungry?
127. control: A-no B-unsure C-yes
128. vividness: A B C D E

Q. Can you imagine (feel yourself) becoming sick to your stomach?
129. control: A-no B-unsure C-yes
130. vividness: A B C D E

Q. Can you feel your mouth becoming dry?
131. control: A-no B-unsure C-yes
132. vividness: A B C D E

Q. Can you feel your mouth now becoming moist?
133. control: A-no B-unsure C-yes
134. vividness: A B C D E

Q. Can you feel a headache?
135. control: A-no B-unsure C-yes
136. vividness: A B C D E

Q. Can you feel your body surge with energy?
137. control: A-no B-unsure C-yes
138. vividness: A B C D E

Q. Can you feel a tickle in your arm?
139. control: A-no B-unsure C-yes
140. vividness: A B C D E

Q. Can you feel a numbness in your foot?
141. control: A-no B-unsure C-yes
142. vividness: A B C D E

Q. Can you feel this numbness move up to your hand?
143. control: A-no B-unsure C-yes
144. vividness: A B C D E

Q. Can you feel an itch on your left cheek?
145. control: A-no B-unsure C-yes
146. vividness: A B C D E

VIVIDNESS SCALE:

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B--indistinct, vague, ambiguous, dim, hazy, doubtful
C--limited, moderately clear or vivid and perceptible
D--reasonably unobscure, vivid and clear
E--really happening; distinct, perfectly clear and vivid (photographic)

VII. WITH EYES CLOSED, TRY TO "EXPERIENCE THE FOLLOWING MOVEMENTS," AS IF YOU WERE ACTUALLY DOING THEM.

Q. Can you feel yourself running down some stairs?
147. control: A-no B-unsure C-yes
148. vividness: A B C D E

Q. Can you feel yourself jumping up and down?
149. control: A-no B-unsure C-yes
150. vividness: A B C D E

Q. Can you feel yourself throwing a heavy rock?
151. control: A-no B-unsure C-yes
152. vividness: A B C D E

Q. Can you feel yourself drawing a triangle?
153. control: A-no B-unsure C-yes
154. vividness: A B C D E

Q. Can you feel yourself writing your name?
155. control: A-no B-unsure C-yes
156. vividness: A B C D E

Q. Can you feel yourself kicking a football?
157. control: A-no B-unsure C-yes
158. vividness: A B C D E

Q. Can you feel yourself swinging a baseball bat?
159. control: A-no B-unsure C-yes
160. vividness: A B C D E

Q. Can you feel yourself tying a knot with some rope?
161. control: A-no B-unsure C-yes
162. vividness: A B C D E

Q. Can you feel yourself swinging on a park swing?
163. control: A-no B-unsure C-yes
164. vividness: A B C D E

Q. Can you feel yourself shuffling a deck of playing cards?
165. control: A-no B-unsure C-yes
166. vividness: A B C D E

Q. Can you feel yourself bending down to pick up a dime?
 167. control: A-no B-unsure C-yes
 168. vividness: A B C D E

Q. Can you feel yourself standing up from a seated position?
 169. control: A-no B-unsure C-yes
 170. vividness: A B C D E

Q. Can you feel yourself singing a song?
 171. control: A-no B-unsure C-yes
 172. vividness: A B C D E

APPENDIX II

Extended results: Sample characteristics

TABLE 1: Age (in years) by Groups (4)

Group	n	Mean	S. D.	Range
1	20	30.20	8.85	20 - 55
2	20	27.45	6.92	19 - 39
3	22	31.14	9.32	20 - 47
4	21	29.24	7.52	21 - 52
Total	83	29.54	8.20	19 - 55

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	3	154.0520	51.3507	.7576	.5212
Within	79	5354.5504	67.7791		
Total	82	5508.6024			

TABLE 2: Age (in years) by Groups (8)

Group	n	Mean	S. D.	Range
1-HI	10	31.00	12.04	20 - 55
2-HI	10	26.60	6.88	19 - 39
3-HI	11	31.27	8.68	21 - 46
4-HI	11	29.18	9.57	21 - 52
1-LO	10	29.40	4.35	23 - 36
2-LO	10	28.20	7.23	19 - 38
3-LO	11	31.00	10.34	20 - 47
4-LO	10	29.30	4.90	23 - 39
Total	83	29.54	8.20	19 - 55

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	7	181.7842	25.9692	.3656	.9194
Within	75	5326.8182	71.0242		
Total	82	5508.6024			

TABLE 3: Years of Education by Groups (4)

Group	n	Mean	S. D.	Range
1	20	15.75	2.95	11 - 21
2	20	14.25	2.38	10 - 21
3	22	14.77	2.86	11 - 21
4	21	15.14	2.46	12 - 21
Total	83	14.98	2.68	10 - 21

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	3	24.0167	8.0056	1.1175	.3471
Within	79	565.9351	7.1637		
Total	82	589.9518			

TABLE 4: Years of Education by Groups (8)

Group	n	Mean	S. D.	Range
1-HI	10	15.70	3.43	11 - 21
2-HI	10	13.30	1.64	10 - 15
3-HI	11	14.55	2.58	11 - 20
4-HI	11	15.00	2.28	13 - 19
1-LO	10	15.80	2.57	12 - 21
2-LO	10	15.20	2.70	13 - 21
3-LO	11	15.00	3.22	11 - 21
4-LO	10	15.30	2.75	12 - 21
Total	83	14.98	2.68	10 - 21

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	7	43.7245	6.2464	.8577	.5439
Within	75	546.2273	7.2830		
Total	82	589.9518			

TABLE 5: Total Controllability Scores by Groups (4)

Group	n	Mean	S. D.	Range
1	20	229.10	26.75	156 - 258
2	20	231.00	22.39	183 - 258
3	22	228.32	31.38	155 - 258
4	21	230.43	25.81	162 - 258
Total	83	229.69	26.41	155 - 258

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	3	94.1398	31.3799	.0434	.9879
Within	79	57117.7156	723.0091		
Total	82	57211.8554			

TABLE 6: Total Controllability Scores by Groups (8)

Group	n	Mean	S. D.	Range
1-HI	10	248.50	9.14	235 - 258
2-HI	10	249.60	8.09	236 - 258
3-HI	11	251.18	6.87	236 - 258
4-HI	11	249.18	6.13	239 - 258
1-LO	10	209.70	24.30	156 - 229
2-LO	10	212.40	14.96	183 - 234
3-LO	11	205.45	29.51	155 - 234
4-LO	10	209.80	23.15	162 - 235
Total	83	229.69	26.41	155 - 258

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	7	34164.8554	4880.6936	15.8828	.0000
Within	75	23047.0000	307.2933		
Total	82	57211.8554			

SCHEFFE PROCEDURE: (*) pairs different at .05 level

group	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5	*	*	*	*				
6	*	*	*	*				
7	*	*	*	*				
8	*	*	*	*				

TABLE 7: Total Vividness Scores by Groups (4)

Group	n	Mean	S. D.	Range
1	20	308.70	66.64	174 - 417
2	20	311.85	65.34	204 - 430
3	22	297.27	68.61	171 - 402
4	21	302.81	56.60	198 - 387
Total	83	304.94	63.54	171 - 430

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	3	2626.3471	875.4490	.2106	.8888
Within	79	328396.3517	4156.9158		
Total	82	331022.6988			

TABLE 8: Total Vividness Scores by Groups (8)

Group	n	Mean	S. D.	Range
1-HI	10	363.10	33.40	320 - 417
2-HI	10	368.90	29.70	329 - 430
3-HI	11	352.00	27.63	319 - 402
4-HI	11	350.18	19.26	323 - 387
1-LO	10	254.30	41.01	174 - 301
2-LO	10	258.80	29.96	204 - 291
3-LO	11	242.55	50.32	171 - 313
4-LO	10	250.70	30.78	198 - 287
Total	83	304.94	63.54	171 - 430

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	7	244638.7352	34948.3907	30.3428	.0000
Within	75	86383.9636	1151.7862		
Total	82	331022.6988			

SCHEFFE PROCEDURE: (*) pairs different at .05 level

mean	group	7	8	5	6	4	3	1	2
242.55	7								
250.70	8								
254.30	5								
254.80	6								
350.18	4	*	*	*	*				
352.00	3	*	*	*	*				
363.10	1	*	*	*	*				
368.90	2	*	*	*	*				

TABLE 9: Total SMI Scores by GROUPS (4)

Group	n	Mean	S. D.	Range
1	20	527.80	108.01	273 - 674
2	20	542.85	85.32	419 - 688
3	22	525.14	98.43	342 - 660
4	21	533.33	79.99	380 - 635
Total	83	532.12	92.07	273 - 688

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	3	3779.7876	1259.9292	.1440	.9333
Within	79	691375.0076	8751.5824		
Total	82	695154.7952			

TABLE 10: Total SMI Scores by GROUPS (8)

Group	n	Mean	S. D.	Range
1-HI	10	611.60	39.05	561 - 674
2-HI	10	618.50	34.33	579 - 688
3-HI	11	603.18	30.87	571 - 660
4-HI	11	599.55	22.04	572 - 635
1-LO	10	444.00	86.58	273 - 529
2-LO	10	467.20	38.39	419 - 523
3-LO	11	447.09	77.40	342 - 546
4-LO	10	460.50	49.25	380 - 522
Total	83	532.12	92.07	273 - 688

Source	D. F.	S. S.	M. S.	F	prob.
Between groups	7	493962.5225	70566.0746	26.3055	.0000
Within	75	201192.2727	2682.5636		
Total	82	695154.7952			

SCHEFFE PROCEDURE: (*) pairs different at .05 level

mean	group	5	7	8	6	4	3	1	2
444.00	5								
447.09	7								
460.50	8								
467.20	6								
599.55	4	*	*	*	*				
603.18	3	*	*	*	*				
611.60	2	*	*	*	*				
618.50	1	*	*	*	*				

TABLE 11: GENDER by GROUPS (4)

Gender	Group 1	2	3	4	row
female	12	13	13	14	52
%	23.1	25.0	25.0	26.9	62.7
%	60.0	65.0	59.1	66.7	
male	8	7	9	7	31
%	25.0	25.0	28.1	21.9	37.3
%	40.0	35.0	40.9	33.3	
column total%	20 24.1	20 24.1	22 26 5	21 25.3	83 100.0

chi-square	D.F.	significance
0.37111	3	0.9461

TABLE 12: GENDER by GROUPS (8)

Gender	Group 1	2	3	4	5	6	7	8	row
female	7	7	8	8	5	6	5	6	52
%	13.5	13.5	15.4	15.4	9.6	11.5	9.6	11.5	62.7
%	70.0	70.0	72.7	72.7	50.0	60.0	45.5	60.0	
male	3	3	3	3	5	4	6	4	31
%	9.7	9.7	9.7	9.7	16.1	16.1	16.1	12.9	37.3
%	30.0	30.0	27.3	27.3	50.0	40.0	54.5	40.0	
column total%	10 12.0	10 12.0	11 13.3	11 13.3	10 12.0	10 12.0	11 13.3	10 12.0	83 100.0

chi-square	D.F.	significance
3.55039	7	0.8299

APPENDIX III

Daily Pre-training Instructions.

Biofeedback group

Your task in this study is to raise the temperature in your dominant hand with the use of biofeedback. The information provided by the thermal feedback may be used to help you develop a method for increasing your hand temperature. While raising your finger temperature, breathe normally and relax your arms, legs and body as much as possible.

Guided imagery group

Your task in this study is to raise the temperature in your dominant hand with the use of a guided imagery audiotape. The thermal suggestions may be used to help you develop a method for increasing your hand temperature. While raising your finger temperature, breathe normally and relax your arms, legs and body as much as possible.

Combined group

Your task in this study is to raise the temperature in your dominant hand with the use of a guided imagery audiotape and thermal biofeedback. The hand temperature feedback and the thermal suggestions may be used to help you develop a method for increasing your hand temperature. While raising your finger temperature, breathe normally and relax your arms, legs and body as much as possible.

Control group

Your task in this study is simply to relax yourself as much as possible with the use of some audiotaped material. This material is designed to maintain your attention indirectly. While listening to the audiotape, please relax your arms, legs and body as much as possible.

Audiotaped Instructions: Control Group

This audiotape consists of four 5-minute segments of definitions. Although some of these definitions may not have much meaning for you, they are designed to hold and focus your attention. While listening to this audiotape, try to maintain your regular rate of breathing and try to relax your arms and legs and your body, as much as possible. [13]

Before we begin, create in your mind's eye some sort of vase or jar ... with a lid or a cover. It could be a vase or a jar from your memory, or your imagination. Whatever shape or color that you chose is fine. When you can see your jar or vase clearly in your mind's eye, put your everyday thoughts and concerns into it for safe keeping and place the lid or cover over it. You can retrieve these concerns and thoughts whenever you wish. [37]

Take a few seconds now, and allow yourself to relax more fully. Check to see that your legs are relaxed, ... your arms are relaxed, your head and shoulders relaxed, ... if necessary shift in your chair to make yourself as comfortable as possible. When ready allow yourself to passively focus on the following passages.

(TRIAL 1)

1. Physical quantities which have both magnitude and direction and which add like displacements are called vector quantities. (p. 16)
2. The coefficient of kinetic friction between two surfaces is the ratio of the force required to overcome friction to the normal force pressing the surfaces together when one surface is sliding over the other at constant speed. (p. 30)

3. The coefficient of static friction between two surfaces is the ratio of the force required to overcome friction to the normal force pressing the surfaces together when the surfaces are at rest relative to one another. (p. 31)
4. The torque exerted by a force about a fixed point is the product of the lever arm and the force, where the lever arm is the distance from the point to the line along which the force acts. (p. 38)
5. If the vector sum of the torques acting on a rigid body is zero, the rotational velocity of the body is constant. (p. 42)
6. One newton is that force which produces an acceleration of one meter per second per second in a mass of one kilogram. (p. 69)
7. The acceleration of a body is directly proportional to the resultant force acting upon it and is inversely proportional to the mass of the body. (p. 69)

For the next minute or so, simply relax and make yourself comfortable. Another five minutes of training will follow shortly. Please remain seated quietly and wait for the beginning of the next passage.

The second set of definitions will begin shortly. [196] Take a few seconds now, and allow yourself to relax again fully. Check to see that your legs are relaxed, ... your arms are relaxed, your head and shoulders relaxed, ... if necessary adjust your seating to make yourself as comfortable as possible. When ready allow yourself to focus passively on the following passage. (RESET EQUIPMENT)

(TRIAL 2)

8. When a force acts upon a body to produce a displacement, the work done by the force is defined as the product of the displacement and the component of the force in the direction of the displacement. (p. 80)
9. The product of the force and the time during which the force acts is called the impulse. The impulse is equal to the change in the momentum. (p. 95).
10. The law of conservation of momentum states that the total momentum of any system of bodies is unchanged by any actions which occur among the different members of the system. (p. 97)

11. The resultant momentum of a system remains constant when no external forces act on the system; if external forces act, the center of mass has an acceleration proportional to the resultant external force and inversely proportional to the mass of the system. (p. 98)
12. A transverse wave is one in which the vibrations take place at right angles to the direction in which the wave travels. (p. 194)
13. A wave motion in which the individual particles vibrate back and forth along the direction in which the wave travels is called a compressional or a longitudinal wave. (p. 194)
14. Huygen's principle may be summarized as follows: every point on the wave front by any wave motion may be regarded as a secondary source of "Huygens" wavelets which spread out with the velocity of the primary wave. To find the wave front at any time (delta t) later, we find the forward surface which is tangent to all these secondary wave fronts. This surface gives the new positon of the primary wave front. (p. 199)

For the next minute or so, simply relax and make yourself comfortable. Another five minutes of training will follow shortly. Please remain seated quietly and wait for the beginning of the next passage. (RESET EQUIPMENT)

The third passage will begin shortly, take a few seconds now and allow yourself to relax again, fully. Check to see that your legs are relaxed, your arms are relaxed, your head and shoulders relaxed. If necessary adjust your seating to make yourself as comfortable as possible. When ready allow yourself to passively focus on the following passage.

(TRIAL 3)

15. The product of the pressure and the volume is given by two-thirds of the number of molecules multiplied by the average kinetic energy of the translation of the molecules. (p. 260)
16. The index of refraction of a medium is the ratio of the sine of the angle of incidence measured in vacuum to the sine of the angle of refraction measured in the medium. (p. 339).

17. When light in a medium is reflected at the surface of a second medium which has a greater index of refraction, there is a half-wavelength phase shift; there is no phase shift when the second medium has a lower index of refraction. (p. 382)
18. Coulomb's law indicates that the force between two charges $Q1$ and $Q2$ is directly proportional to the product of the charges and inversely proportional to the square of the distance r between the charges ($F= k[Q1Q2/r^2]$). (p. 426)
19. The potential difference between two points is the work per unit positive charge required to move a small test charge from one point to the other. Potential difference, as well as potential is commonly measured in volts (or joules per coulomb). The potential difference between two points is one volt if it requires one joule of external work to move each coulomb of charge from one point to the other. (p. 441)
20. An electron volt is the kinetic energy gained by a particle bearing one atomic unit of charge in falling through a potential difference of one volt. (p. 444)
21. The capacitance C is defined as the ratio of the charge to the potential difference: $C=Q/V$. (p. 451)

For the next minute or so, seemly relax and make yourself comfortable, the final 5 minutes of training will follow shortly.

[432] (RESET EQUIPMENT)

Take a few seconds now and allow yourself to relax again fully. Check to see that your legs are relaxed, your arms relaxed, your head and shoulders relaxed and if necessary adjust your seating to make yourself as comfortable as possible. When ready allow yourself to focus fully on the following passage. [443]

(TRIAL 4)

22. The ratio of the capacitance of a capacitor with a given material filling the space between conductors to the capacitance of the same capacitor when the space is evacuated is the dielectric constant K of the material. (Some authors prefer the term specific inductive capacity and others use the name relative permittivity.) p453
23. Resistance is commonly expressed in ohms. One ohm is that resistance in which a potential difference of one volt produces a current of one ampere. (p466)

24. When a charge of one coulomb receives one joule of energy upon passing through a source, the source is said to have an electomotive force of one volt. (A 12-volt battery delivers 12 joules of energy to each coulomb which passes through it.) (p. 476)
25. Lenz's law indicates that the direction of an induced emf is always such that any current it produces opposes, through it magnetic effects, the change inducing the emf. (p524)
26. The coefficient of mutual inductance between two circuits is the ratio of the emf induced in the second circuit to the rate of change of current with time in the first circuit. When an EMF of 1 volt is induced in a secondary coil by a current change of 1 amp/sec in the primary, the coefficient of mutual inductance is said to be 1 henry. (p. 536)

(from Smith, A. W., & Cooper, J. N. [1964]. Elements of physics 7th ed.]. New York: McGraw-Hill.)

You have just completed your training session for today ... Find the vase or jar that you have created in your mind's eye and remove the cover or lid, to recover your everyday thoughts and concerns. Take a minute now to open your eyes if they are closed, and then wiggle your hands, your arms ... your feet ... and your legs ... scrunch up your shoulders and then turn your head from side to side. [536] Thank-you for your participation.

Audiotaped Instructions:

Guided Imagery & Combined Groups

This audiotape consists of four 5-minute scripts or passages which should help you to raise the temperature in your hands. While listening to this audiotape, try to maintain your regular rate of breathing and try to relax your arms and legs and your body, as much as possible. [13]

Before we begin, create in your mind's eye some sort of vase or jar ... with a lid or a cover. It could be a vase or a jar from your memory, or your imagination. Whatever shape or color that you chose is fine. When you can see your jar or vase clearly in your mind's-eye, put your everyday thoughts and concerns into it for safe keeping and place the lid or cover over it. You can retrieve these concerns and thoughts whenever you wish. [37]

Take a few seconds now, and allow yourself to relax more fully. Check to see that your legs are relaxed, ... your arms are relaxed, your head and shoulders relaxed, ... if necessary shift in your chair to make yourself as comfortable as possible. When ready allow yourself to focus fully on the following passages. [56]

(TRIAL 1) Picture yourself beside a warm cozy fire. It could be a fire in your fireplace at home, or a camp fire somewhere from your memory. Allow yourself some time now to become part of this scene. (Pause) The fire is before you and you are warming your hands. The warmth from the fire caresses and warms your hands and fingertips. Your eyes are closed and you can hear the hissing of the logs and the crackling of the wood as it burns, and radiates heat towards your hands. A radiant heat which is makes your hands feel warmer and warmer. The soft roar of the fire can be heard as it burns effortlessly, radiating more heat into your hands ... warming your hands. Your arms are relaxed as your hands and fingers become warmer and warmer. The pleasant hissing of the logs reminds you of the warm sensations in your hands. The gentle crackling of the fire reminds you of the warmth in your hands. The soft roar of the fire reminds you of the warmth in your fingers ... and your hands. [115] Again, picture yourself beside this fire, completely relaxed, with hands held at a comfortable distance from the warm glow of the fire. Take a few seconds now to enjoy this warmth and the relaxed sensations within your body ... Allow your mind's eye to travel to your hands and visualize the blood vessels in your hands as they relax and expand as your hands and fingers become warmer and warmer. The soft hissing of the fire reminds you of the warmth in your hands and fingers. The soft roar of the fire, ... the gentle crackling sounds of the fire ... remind you of the warmth in your hands and fingers ... When you are ready, focus once again, on your hands, picture your hands ... warm and relaxed with the warm glow of the fire focused on the backs or palms of your hands. Take a few moments and allow yourself to fully experience these warm pleasant sensations. As your hands become warmer and warmer, you will almost surprise yourself by noticing how deeply relaxed you are at this moment. Feel the warmth of the fire on your hands, and feel your hands becoming exquisitely relaxed and warm. The gentle crackling sounds of the fire ... the soft hissing of the logs help you to focus on the warmth in your hands and fingers. [178]

For the next minute or so, simply relax and make yourself comfortable. [185] Another five minutes of training will follow shortly. Any questions that you have will be answered following the completion of this training session. Please remain seated quietly and wait for the beginning of the next passage. (RESET EQUIPMENT)

The second passage will begin shortly. [196] Take a few seconds now, and allow yourself to relax again fully. Check to see that your legs are relaxed, ... your arms are relaxed, your head and shoulders relaxed, ... if necessary adjust your seating to make yourself as comfortable as possible. When ready allow yourself to focus fully on the following passage.

(TRIAL 2) Picture yourself having a hot shower [211] ... or perhaps a very warm jacuzzi. Perhaps you have just finished a vigourous workout ... or some sort of activity requiring physical exhertion, ... and now you simply wish to relax ... to relax and allow the tired, dull aches from your muscles to ease away from your body ... You can hear the sounds of the warm water splashing against your body, ... warming the skin of your arms and legs ... warming and relaxing your hands and your fingers ... you can feel the warmth flowing and oozing into your hands and fingers ... as you experience yourself becoming more and more relaxed [240] ... visualize the blood vessels in your hands and fingers relaxing, and expanding, as your hands becomer warmer and warmer ... your blood vessels relaxing and expanding as you feel your hands becoming warmer and warmer ... the soft splashing sounds remind you of the increased warmth and relaxation in your hands and fingers ... the warm water against your hands, your arms and your body create further sensations of warmth and relaxation ... as you relax more and more, and deeper and deeper ... take a little time now ... to more fully enjoy these sensations of warmth and relaxation in your body, your legs, your arms, and particularly your hands ... [277] You feel unhurried, relaxed and tranquil ... See yourself enjoying all the sensuous aspects of having your hot shower or jacuzzi. The warm splashing sounds remind you of the warmth in your hands ... The trickling hot water helps to warm and relax your hands and arms ... Allow yourself to relax more fully and to enjoy the exquisite warm in your hands and fingers. [299]

For the next minute or so, simply relax and make yourself comfortable. [303] Another five minutes of training will follow shortly. Please remain seated quietly and wait for the beginning of the next passage. (RESET EQUIPMENT)

The third passage will begin shortly, take a few seconds now and allow yourself to relax again, fully. Check to see that your legs are relaxed, your arms are relaxed, your head and shoulders relaxed. If necessary adjust your seating to make yourself as comfortable as possinble. When ready allow yourself to focus fully on the following passage.

(TRIAL 3) Again, picture yourself beside a warm cozy fire. It could be a fire in your fireplace at home, ... or a camp fire somewhere from your memory ... Allow yourself some time now ... to make yourself part of this scene. (Pause) The fire is before you and you are warming your hands. The warmth from the fire caresses and warms your hands and fingertips. Your eyes are closed and you can hear the hissing of the logs and the crackling of the wood as it burns, and radiates heat towards your hands. A radiant heat which is makes your hands feel warmer and warmer. ...The soft roar of the fire can be heard as it burns effortlessly, radiating more heat into your hands ... warming your hands. [357] Your arms are relaxed as your hands and fingers become warmer and warmer. The pleasant hissing of the logs reminds you of the warm sensations in your hands ... your fingers ... The gentle crackling of the fire reminds you of the warmth in your hands ... your fingers. The soft roar of the fire reminds you of the warmth in your hands, your fingers ... Again, picture yourself beside this fire, completely relaxed, with hands held at a comfortable distance from the warm glow of the fire. Take a few seconds now to enjoy this warmth and the relaxed sensations within your body ... Allow your mind's eye to travel to your hands and visualize the blood vessels in your hands as they relax and expand as your hands and fingers become warmer and warmer. The soft hissing of the fire reminds you of the warmth in your hands and fingers. The soft roar of the fire, ... the gentle crackling sounds of the fire ... remind you of the warmth in your hands and fingers ... [396] When you are ready, focus once again, on your hands, picture your hands ... warm and relaxed with the warm glow of the fire focused on the backs or palms of your hands. Take a few moments and allow yourself to fully experience these warm pleasant sensations. As your hands become warmer and warmer, you will almost surprise yourself by noticing how deeply relaxed you are at this very moment. Feel the warmth of the fire on your hands, and feel your hands becoming exquisitely relaxed and warm. The gentle crackling sounds of the fire ... the soft hissing of the logs help you to focus on the warmth in your hands and fingers. [421] (RESET EQUIPMENT)

For the next minute or so, seemly relax and make yourself comfortable, the final five minutes of training will follow shortly. [432]

Take a few seconds now and allow yourself to relax again fully. Check to see that your legs are relaxed, your arms relaxed, your head and shoulders relaxed and if necessary adjust your seating to make yourself as comfortable as possible. When ready allow yourself to focus fully on the following passage. [443]

(TRIAL 4) Picture yourself again having a very hot show [445] ... or perhaps a very warm jacuzzi. Perhaps you have just finished a vigourous workout ... or some sort of activity requiring physical exhertion, ... and now you simply wish to relax ... to relax and allow the tired, dull aches from your muscles to ease away from your body ... You can hear the sounds of the warm water splashing against your body, ... warming the skin of your arms and legs ... warming and relaxing your hands and your fingers ... you can feel the warmth flowing and oozing into your hands and fingers ... as you experience yourself becoming more and more relaxed [468] ... visualize the blood vessels in your hands and fingers relaxing, and expanding, as your hands becomer warmer and warmer ... your blood vessels relaxing and expanding as you feel your hands becoming warmer and warmer ... the soft splashing sounds remind you of the increased warmth and relaxation in your hands and fingers ... the warm water against your hands, your arms and your body create further sensations of warmth and relaxation ... as you relax more and more, and deeper and deeper ... take a little time now .... to more fully enjoy these sensations of warmth and relaxation in your body, your legs, your arms, and particularly your hands ... [495] You feel unhurried, relaxed and tranquil ... See yourself enjoying all the sensuous aspects of having your hot shower or Jacuzzi. The warm splashing sounds remind you of the warmth in your hands ... The trickling hot water helps to warm and relax your hands and arms ... Allow yourself to relax more fully and to enjoy the exquisite warm in your hands and fingers. [511]

You have just completed your training session for today ... [517] Find the vase or jar that you have created in your mind's eye and remove the cover or lid, to recover your everyday thoughts and concerns. Take a minute now to open your eyes if they are closed, and then wiggle your hands, your arms ... your feet ... and your legs ... scrunch up your shoulders and then turn your head from side to side. [536] Thank-you for your participation.

APPENDIX IV

POST-TRAINING SESSION QUESTIONNAIRE: BIOFEEDBACK

NAME: ______ GROUP: ______ Session: ______

TRIAL 1

1. What kinds of strategies did you use to raise your finger temperature?

a) Describe most frequently used method (strategy 1a):

______

______

b) Describe next most frequently used method (S1b):

______

______

c) Any other methods (S1c):

______

______

d) How long did you use each method?

TRIAL 1

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? VH (very helpful), H (helpful), SH (sort of helpful), NH (not helpful), RNH (really not helpful)

TRIAL 2

2. What kinds of strategies did you use to raise your finger temperature?

a) Describe most frequently used method (strategy 2a):

______

______

b) Describe next most frequently used method (S2b):

____

____

c) Any other methods (S2c):

____

____

d) How long did you use each method?

TRIAL 2

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? VH (very helpful), H (helpful), SH (sort of helpful), NH (not helpful), RNH (really not helpful)

TRIAL 3

3. What kinds of strategies did you use to raise your finger temperature?

a) Describe most frequently used method (strategy 3a):

____

____

b) Describe next most frequently used method (S3b):

____

____

c) Any other methods (S3c):

____

____

d) How long did you use each method?

TRIAL 3

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? **VH** (very helpful), **H** (helpful), **SH** (sort of helpful), **NH** (not helpful), **RNH** (really not helpful)

TRIAL 4

4. What kinds of strategies did you use to raise your finger temperature?

a) Describe most frequently used method (strategy 4a):

____

____

b) Describe next most frequently used method (S4b):

____

____

c) Any other methods (S4c):

____

____

d) How long did you use each method?

TRIAL 4

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? **VH** (very helpful), **H** (helpful), **SH** (sort of helpful), **NH** (not helpful), **RNH** (really not helpful)

5. a) Did you use the visual or auditory biofeedback information on the screen? (please check)

visual only ___ both visual & auditory ___

auditory only ___ none ___

b) How long did you focus on the biofeedback?

	VISUAL (minutes)			AUDITORY (minutes)	
TRIALS	1	_____	TRIALS	1	_____
	2	_____		2	_____
	3	_____		3	_____
	4	_____		4	_____

c) Did you find the biofeedback information helpful in learning to develop some control over your finger temperature?

visual feedback:

very helpful ___ ___ ___ ___ ___ not helpful at all

auditory feedback:

very helpful ___ ___ ___ ___ ___ not helpful at all

6. Any additional comments:

____

____

____

POST-TRAINING SESSION QUESTIONNAIRE: G. IMAGERY

NAME: ____________________ GROUP: ____ Session: ____

TRIAL 1

1. What kinds of strategies did you use to raise your finger temperature?

   a) Describe most frequently used method (strategy 1a):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   b) Describe next most frequently used method (S1b):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   c) Any other methods (S1c):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   d) How long did you use each method?

   TRIAL 1

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? VH (very helpful), H (helpful), SH (sort of helpful), NH (not helpful), RNH (really not helpful)

TRIAL 2

2. What kinds of strategies did you use to raise your finger temperature?

   a) Describe most frequently used method (strategy 2a):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   b) Describe next most frequently used method (S2b):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   c) Any other methods (S2c):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   d) How long did you use each method?

TRIAL 2

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? VH (very helpful), H (helpful), SH (sort of helpful), NH (not helpful), RNH (really not helpful)

TRIAL 3

3. What kinds of strategies did you use to raise your finger temperature?

a) Describe most frequently used method (strategy 3a):

____

____

(Please check, if YES)

Did you see ___, hear ___, feel ___ the above?

b) Describe next most frequently used method (S3b):

____

____

(Please check, if YES)

Did you see ___, hear ___, feel ___ the above?

c) Any other methods (S3c):

____

____

(Please check, if YES)

Did you see ___, hear ___, feel ___ the above?

d) How long did you use each method?

TRIAL 3

		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? VH (very helpful), H (helpful), SH (sort of helpful), NH (not helpful), RNH (really not helpful)

TRIAL 4

4. What kinds of strategies did you use to raise your finger temperature?

   a) Describe most frequently used method (strategy 4a):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   b) Describe next most frequently used method (S4b):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   c) Any other methods (S4c):

   ____

   ____

   (Please check, if YES)

   Did you see ___, hear ___, feel ___ the above?

   d) How long did you use each method?

TRIAL 4		minutes	utility*
strategies:	1a -----:	____	____
	1b -----:	____	____
	1c -----:	____	____

*UTILITY: How helpful was the strategy in helping you warm our hand/finger? VH (very helpful), H (helpful), SH (sort of helpful), NH (not helpful), RNH (really not helpful)

The following items deal with aspects of the audiotape that you have been listening to. Try to answer all questions and make your best guess when you are not absolutely certain about the exact response.

5. a) Did you generate visual images? yes: ____ no: ____

b) Were these images related directly to material scripted on the audiotape? yes: ____ no: ____

c) Were you able to create these images quite easily?

with ease ___ ___ ___ ___ ___ with difficulty

d) Were visual images relatively constant or transient and changing?

constant ____ ____ ____ ____ ____ transient

e) How long did you focus on these visual images? (Please check.)

VISUAL IMAGES minutes:

TRIALS:	I	0__ 1__ 2__ 3__ 4__ 5__
	II	0__ 1__ 2__ 3__ 4__ 5__
	III	0__ 1__ 2__ 3__ 4__ 5__
	IV	0__ 1__ 2__ 3__ 4__ 5__

f) Did you find visual images helpful towards developing some self-control over your finger temperature?

very helpful ___ ___ ___ ___ ___ not helpful at all

6. a) Did you focus on bodily sensations, such as (please check):

Warmth ___ (Located where? ______________________)

Relaxation ___ (Where? ______________________)

Other sensations ______________________

____

b) Were these bodily sensations directly related to material on the audiotape? yes: ___ no: ___

c) Was it easy to produce the above bodily sensations?

warmth:	easy	___ ___ ___ ___ ___	difficult
relaxation:	easy	___ ___ ___ ___ ___	difficult
other:	easy	___ ___ ___ ___ ___	difficult

d) Were bodily sensations relatively constant or transient?

constant ____ ____ ____ ____ ____ transient

e) How long did you engage in creating each of the above bodily sensations?

WARMTH minutes:

TRIALS: I 0__ 1__ 2__ 3__ 4__ 5__

II 0__ 1__ 2__ 3__ 4__ 5__

III 0__ 1__ 2__ 3__ 4__ 5__

IV 0__ 1__ 2__ 3__ 4__ 5__

RELAXATION minutes:

TRIALS: I 0__ 1__ 2__ 3__ 4__ 5__

II 0__ 1__ 2__ 3__ 4__ 5__

III 0__ 1__ 2__ 3__ 4__ 5__

IV 0__ 1__ 2__ 3__ 4__ 5__

f) Did you find that the creation of bodily sensations was helpful in learning to develop some self-control over your finger temperature?

very helpful ___ ___ ___ ___ ___ not helpful at all

7. a) Did you generate any auditory images of sounds?
yes: ___ no: ___

b) Were these sounds related directly to material on the audiotape? yes: ___ no: ___

Describe these sounds or noises: ____________________

____

____

c) Were you able to create these sounds quite easily?

with ease ___ ___ ___ ___ ___ with difficulty

d) Were these sound images relatively constant or transient?

constant ___ ___ ___ ___ ___ transient

e) How long did you focus on these sound images?

SOUNDS minutes:

TRIALS:	I	0__ 1__ 2__ 3__ 4__ 5__
	II	0__ 1__ 2__ 3__ 4__ 5__
	III	0__ 1__ 2__ 3__ 4__ 5__
	IV	0__ 1__ 2__ 3__ 4__ 5__

f) Did you find sound images helpful in learning to develop some control over your finger temperature?

very helpful ___ ___ ___ ___ ___ not helpful at all

8. Any additional comments regarding today's session:

____

____

POST-TRAINING SESSION QUESTIONNAIRE: COMBINED

NAME: ____________________ GROUP: _____ Session: _____

(Items 1 to 7 were identical for the combined and guided imagery groups.)

8. a) Did you use the visual or auditory biofeedback information on the screen? (please check)

visual only ___ both visual & auditory ___

auditory only ___ none ___

b) How long did you focus on the biofeedback?

VISUAL (minutes)			AUDITORY (minutes)		
TRIALS	1	_____	TRIALS	1	_____
	2	_____		2	_____
	3	_____		3	_____
	4	_____		4	_____

c) Did you find the biofeedback information helpful in learning to develop some control over your finger temperature?

visual feedback:

very helpful ___ ___ ___ ___ ___ not helpful at all

auditory feedback:

very helpful ___ ___ ___ ___ ___ not helpful at all

9. Any additional comments regarding today's session:

____

____

POST-TRAINING SESSION QUESTIONNAIRE: RELAXATION

NAME: ____________________ GROUP: ___ Session: _

1. a) Did the audiotape help you to relax?

   very helpful ___ ___ ___ ___ ___ not helpful at all

   b) Any comments regarding the audiotape?

   ____

   ____

2. a) Were there other things that you did to relax?

   yes: ___ no: ___

   b) Describe: ________________________________

   ____

   ____

3. Did you feel subjectively relaxed during today's training?

   Trial **I:**

   very relaxed ___ ___ ___ ___ ___ not relaxed at all

   Trial **II:**

   very relaxed ___ ___ ___ ___ ___ not relaxed at all

   Trial **III:**

   very relaxed ___ ___ ___ ___ ___ not relaxed at all

   Trial **IV:**

   very relaxed ___ ___ ___ ___ ___ not relaxed at all

4. Were you aware of any other body sensations?

   ____

   ____

APPENDIX V

TABLE 5: Groups by Imagery Level by Baseline (interval 2)

Between subject factors

A Groups 1= biofeedback 2= guided imagery
3= combined 4= control

B - Imagery level 1=high 2=low

Within subject factors
C - Baseline sessions: 1 - 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	9.706	0.290	0.833
B	1	7.805	0.233	0.631
AB	3	4.705	0.140	0.935
S-within	75	33.502		
C	4	1.244	0.295	0.881
AB	12	3.090	0.733	0.719
BC	4	4.368	1.036	0.389
ABC	12	5.102	1.210	0.275
BS-within	300	4.216		

SOURCE: A - Groups

1	2	3	4
30.196	30.364	29.648	30.014

SOURCE: B - Imagery level

1	2
29.906	30.188

SOURCE: AB

Groups:	1	2	3	4
Imagery: 1	29.940	30.545	29.428	29.771
2	30.452	30.182	29.869	30.280

SOURCE: C

Baselines session:	1	2	3	4	5
	30.088	29.938	30.198	29.891	30.111

SOURCE: AC

Baselines

Groups / session:	1	2	3	4	5
1	30.369	30.160	30.399	30.412	29.638
2	30.346	30.043	30.208	30.396	30.825
3	29.365	29.527	29.698	29.408	30.244
4	30.331	30.056	30.520	29.419	29.741

SOURCE: BC

Baselines

Imagery / session:	1	2	3	4	5
1	30.247	29.631	30.241	29.673	29.736
2	29.925	30.252	30.153	30.113	30.494

SOURCE: ABC

Group: biofeedback

Baselines

Imagery / session:	1	2	3	4	5
1	29.894	29.631	30.241	29.673	29.736
2	29.925	30.252	30.153	30.113	30.494

Group: guided imagery

Baselines

Imagery / session:	1	2	3	4	5
1	29.894	30.096	30.995	30.068	28.646
2	30.844	30.225	29.803	30.756	30.630

Group: combined

Baselines

Imagery / session:	1	2	3	4	5
1	29.822	28.696	28.969	29.523	30.131
2	28.906	30.358	30.427	29.293	30.356

Group: control

Baselines

Imagery / session:	1	2	3	4	5
1	30.540	29.606	30.586	29.222	29.000
2	30.102	30.660	30.448	29.636	30.556

Table 6

Groups by Gender by Baselines
(interval 2)

Between subject factors

A - Groups 1= biofeedback 2= guided imagery
3= combined 4= control

B - Gender 1= female 2= male

Within subject factors

C - Baseline sessions: 1 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	12.544	0.465	0.708
B	1	483.181	17.902	0.001
AB	3	9.746	0.361	0.781
S-within	75	26.991		
C	4	0.668	0.154	0.951
AB	12	2.452	0.567	0.868
BC	4	1.712	0.396	0.812
ABC	12	3.236	0.748	0.704
BS-within	300	4.327		

SOURCE: A - Groups

1	2	3	4
30.196	30.364	29.648	30.014

SOURCE: B - Gender

1	2
29.222	31.426

SOURCE: AB

	Groups: 1	2	3	4
Gender: 1	29.457	29.707	28.809	28.952
2	31.303	31.583	30.861	32.136

SOURCE: C

Baselines

session:	1	2	3	4	5
	30.088	29.938	30.198	29.891	30.111

SOURCE: AC

Baselines

session:	1	2	3	4	5
1	30.369	30.160	30.399	30.412	29.638
2	30.346	30.043	30.208	30.396	30.825
3	29.365	29.527	29.698	29.408	30.244
4	30.331	30.056	30.520	29.419	29.741

SOURCE: BC

Baselines

	session:	1	2	3	4	5
Gender:	1	29.450	29.078	29.391	28.938	29.250
	2	31.158	31.379	31.552	31.488	31.554

SOURCE: ABC

Group: biofeedback

Baselines

	session:	1	2	3	4	5
Gender:	1	29.512	30.024	29.742	29.553	28.459
	2	31.655	30.371	31.385	31.700	31.406

Group: guided imagery

Baselines

	session:	1	2	3	4	5
Gender:	1	29.892	29.016	29.617	29.670	30.340
	2	31.190	31.950	31.306	31.743	31.727

Group: combined

Baselines

	session:	1	2	3	4	5
Gender:	1	28.968	28.509	28.508	28.618	29.440
	2	29.939	30.998	31.417	30.549	31.404

Group: control

Baselines

session:		1	2	3	4	5
Gender:	1	29.435	28.858	29.700	28.029	28.741
	2	32.124	32.451	32.161	32.200	31.741

Table 7

Females: Groups by Imagery Levels by Baselines

Between subject factors

A - Groups 1= biofeedback 2= guided imagery
3= combined 4= control

B - Imagery level 1=high 2=low

Within subject factors

C - baseline sessions: 1 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	8.988	0.220	0.882
B	1	0.369	0.009	0.925
AB	3	7.453	0.182	0.908
S-within	44	40.872		
C	4	1.570	0.274	0.895
AB	12	3.620	0.631	0.814
BC	4	5.959	1.039	0.388
ABC	12	6.010	1.048	0.407
BS-within	176	5.734		

SOURCE: A - Groups

1	2	3	4
29.457	29.707	28.809	28.952

SOURCE: B - Imagery level

1	2
29.181	29.276

SOURCE: AB

	Groups:	1	2	3	4
Imagery:	1	29.443	30.035	28.437	28.958
	2	29.491	29.324	29.403	28.945

SOURCE: C

Baselines session:	1	2	3	4	5
	29.450	29.078	29.391	28.938	29.250

SOURCE: AC

	Baselines session:	1	2	3	4	5
Group:	1	29.512	30.020	29.742	29.553	28.459
	2	29.892	29.016	29.617	29.670	30.340
	3	28.968	28.509	28.508	28.618	29.440
	4	29.435	28.858	29.700	28.029	28.741

SOURCE: BC

	Baselines session:	1	2	3	4	5
Imagery:	1	29.691	28.741	29.652	28.858	28.966
	2	29.122	29.539	29.035	29.048	29.639

SOURCE: ABC

Group: biofeedback

	Baselines session:	1	2	3	4	5
Imagery:	1	29.571	29.577	30.969	29.597	27.450
	2	29.428	30.640	28.024	29.492	29.872

Group: guided imagery

	Baselines session:	1	2	3	4	5
Imagery:	1	30.324	29.757	29.903	29.296	30.897
	2	29.387	28.152	29.283	30.107	29.690

Group: combined

Baselines session:		1	2	3	4	5
Imagery:	1	28.931	27.536	27.770	28.620	29.329
	2	29.026	30.066	29.690	28.614	29.618

Group: control

Baselines session:		1	2	3	4	5
Imagery:	1	30.000	28.325	30.162	28.065	28.239
	2	28.682	29.568	29.083	27.980	29.410

Table 8

Males: Groups by Imagery Levels by Baselines (interval 2)

Between subject factors

A - Groups 1= biofeedback 2= guided imagery 3= combined 4= control

B - Imagery level 1=high 2=low

Within subject factors

C - Baseline sessions: 1 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	6.615	0.903	0.455
B	1	4.730	0.645	0.430
AB	3	9.223	1.259	0.312
S-within	23	7.329		
C	4	0.408	0.220	0.927
AB	12	1.217	0.656	0.789
BC	4	0.444	0.239	0.915
ABC	12	1.853	0.998	0.457
BS-within	92	1.855		

SOURCE: A - Groups

1	2	3	4
31.303	31.583	30.861	32.136

SOURCE: B - Imagery level

1	2
31.716	31.243

SOURCE: AB

	Groups: 1	2	3	4
Imagery: 1	31.123	31.735	32.071	31.938
2	31.412	31.469	30.257	32.284

SOURCE: C

Baselines session:	1	2	3	4	5
	31.158	31.379	31.552	31.488	31.554

SOURCE: AC

Baselines session:	1	2	3	4	5
Group: 1	31.655	30.371	31.385	31.700	31.406
2	31.190	31.950	31.306	31.743	31.727
3	29.939	20.998	31.417	30.549	31.404
4	32.124	32.451	32.161	32.200	31.741

SOURCE: BC

Bselines session:	1	2	3	4	5
Imagery: 1	31.637	31.855	31.715	31.712	31.663
2	30.855	31.079	31.448	31.347	31.485

SOURCE: ABC

Group: biofeedback

Baselines session:	1	2	3	4	5
Imagery: 1	30.647	31.307	31.057	31.167	31.437
2	32.260	29.810	31.582	32.020	31.388

Group: guided imagery

Baselines session:		1	2	3	4	5
Imagery:	1	31.727	31.667	31.920	31.443	31.917
	2	30.787	32.162	30.845	31.967	31.585

Group: combined

Baselines session:		1	2	3	4	5
Imagery:	1	32.197	31.790	32.167	31.930	32.270
	2	28.810	30.602	31.042	29.858	30.972

Group: control

Baselines session:		1	2	3	4	5
Imagery:	1	31.980	32.657	31.717	32.307	31.030
	2	32.232	32.297	32.495	32.120	32.275

APPENDIX VI

MEANS AND STANDARD DEVIATIONS

Groups by Imagery Level by Trials by Sessions
(Interval 2: Temperature means)

Between subject factors
A - groups: 1= biofeedback 2= guided imagery
3= combined 4= control
B - imagery level: 1= high 2= low

Within subject factors
C - trials: 1 2 3 4
D - sessions: 1 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	38.176	0.280	0.840
B	1	51.765	0.379	0.540
AB	3	29.549	0.217	0.885
S-within	75	136.413		
C	3	36.020	30.128	0.001**
AC	9	2.876	2.405	0.013*
BC	3	0.216	0.180	0.910
ABC	9	0.719	0.601	0.795
CS-within	225	1.196		
D	4	14.721	1.114	0.350
AD	12	10.299	0.779	0.672
BD	4	15.529	1.175	0.322
ABD	12	25.828	1.954	0.028*
DS-within	300	13.140		
CD	12	0.917	2.378	0.005**
ACD	36	0.270	0.699	0.909
BCD	12	0.162	0.420	0.956
ABCD	36	0.342	0.886	0.663
CDS-within	900	0.386		

SOURCE: A

Group	1	2	3	4
	29.753	29.828	29.158	29.656
SD:	2.283	2.364	2.819	2.711

SOURCE: B

B =	high	low
	29.412	29.770
SD:	2.053	2.995

SOURCE: AB

	B =	high	SD	low	SD
A = GRP	1	29.416	1.493	30.089	2.919
	2	30.035	1.666	29.620	2.988
	3	28.955	2.756	29.361	3.000
	4	29.299	2.134	30.050	3.308

SOURCE: C

trials:	1	2	3	4
	29.874	29.756	29.526	29.199
SD:	2.555	2.531	2.573	2.607

SCHEFFE PROCEDURE:

(*) denotes pairs significantly different at .05 level

mean	trial	trials 1	2	3	4
29.831	1			*	*
29.816	2			*	*
29.589	3				*
29.269	4				

SOURCE: AC

	trials:	1	2	3	4
A = grp	1	29.796	29.887	29.788	29.539
	SD:	2.293	2.320	2.281	2.337
	2	30.175	30.016	29.723	29.395
	SD:	2.250	2.307	2.472	2.520
	3	29.330	29.323	29.162	28.818
	SD:	3.042	2.865	2.805	2.768
	4	30.230	29.836	29.472	29.088
	SD:	2.587	2.679	2.806	2.876

SOURCE: BC

	trials:	1	2	3	4
B = high	1	29.711	29.593	29.344	29.001
	SD:	2.110	2.057	2.107	2.215
low	2	30.041	29.924	29.713	29.402
	SD:	2.961	2:956	2.992	2.970

SOURCE: ABC

GRP: 1

		trials: 1	2	3	4
B = high	1	29.392	29.581	29.457	29.235
	SD:	1.548	1.554	1.509	1.600
low	2	30.200	30.194	30.119	29.842
	SD:	2.888	2.956	2.910	2.960

GRP: 2

		trials: 1	2	3	4
B = high	1	30.415	30.154	29.942	29.631
	SD:	1.333	1.506	1.856	2.078
low	2	29.936	29.879	29.505	29.160
	SD:	2.964	2.988	3.058	2.995

GRP: 3

		trials: 1	2	3	4
B = high	1	29.050	29.159	28.987	28.624
	SD:	3.146	2.857	2.706	2.712
low	2	29.609	29.488	29.337	29.012
	SD:	3.060	3.003	3.022	2.942

GRP: 4

		trials: 1	2	3	4
B = high	1	30.020	29.527	29.055	28.593
	SD:	1.847	2.108	2.264	2.403
low	2	30.461	30.177	29.931	29.632
	SD:	3.311	3.281	3.370	3.366

SOURCE D

sessions:	1	2	3	4	5
	29.338	29.652	29.907	29.549	29.499
SD:	3.054	3.106	2.795	3.121	3.016

SOURCE AD

	sessions:	1	2	3	4	5
A=grp	1	29.530	29.826	30.164	29.957	29.286
	SD:	2.616	2.954	2.683	2.769	2.254
	2	29.535	29.763	30.010	29.728	30.102
	SD:	2.874	3.258	2.658	3.038	2.534
	3	28.426	29.271	29.387	29.089	29.617
	SD:	3.677	3.386	3.396	3.516	2.938
	4	29.921	29.781	30.107	29.471	29.003
	SD:	2.889	2.986	2.441	3.237	3.376

SOURCE BD

	sessions:	1	2	3	4	5
B=high	1	29.420	29.509	29.765	29.392	28.975
	SD:	2.667	2.642	2.482	2.799	2.960
low	2	29.253	29.799	30.052	29.709	30.035
	SD:	3.437	3.546	3.107	3.448	3.015

SOURCE: ABD

GRP: 1

	sessions:	1	2	3	4	5
B=high	1	28.575	29.990	30.577	29.911	28.027
	SD:	1.718	2.139	0.916	2.461	3.390
low	2	30.485	29.662	29.750	30.002	30.544
	SD:	3.078	3.603	3.740	3.182	2.708

GRP: 2

	sessions:	1	2	3	4	5
B=high	1	30.243	29.969	30.269	29.306	30.391
	SD:	2.048	2.100	2.633	3.077	1.898
low	2	28.828	29.557	29.750	30.151	29.812
	SD:	3.483	4.231	2.798	3.101	3.125

GRP: 3

	sessions:	1	2	3	4	5
B=high	1	28.866	28.673	28.552	29.190	29.493
	SD:	3.576	3.589	3.615	3.006	2.954
low	2	27.987	29.868	30.223	28.988	29.741
	SD:	3.897	3.223	3.099	4.111	3.061

GRP: 4

sessions:		1	2	3	4	5
B=high	1	29.994	29.488	29.781	29.201	28.029
	SD:	2.803	2.293	1.632	2.960	3.070
low	2	29.840	30.102	30.466	29.767	30.074
	SD:	3.132	3.638	3.163	3.655	3.525

SOURCE: CD

sessions:		1	2	3	4	5
C=trial	1	29.424	29.906	30.157	29.929	29.951
	SD:	3.173	3.124	2.874	3.081	3.056
	2	29.550	29.803	30.050	29.769	29.610
	SD:	3.096	3.116	2.881	3.149	3.017
	3	29.307	29.606	29.881	29.409	29.430
	SD:	3.141	3.164	2.798	3.260	3.112
	4	29.070	29.295	29.538	29.088	29.003
	SD:	3.089	3.230	2.826	3.264	3.249

SOURCE: ACD

GRP 1

sessions:		1	2	3	4	5
C=trial	1	29.231	29.935	30.148	30.246	29.418
	SD:	2.834	2.948	2.732	2.720	3.222
	2	29.761	29.960	30.208	30.119	29.389
	SD:	2.547	3.027	2.791	2.734	3.258
	3	29.658	29.844	30.318	29.814	29.304
	SD:	2.671	3.056	2.624	2.852	3.323
	4	29.407	29.565	29.980	29.647	29.031
	SD:	2.654	2.950	2.669	2.897	3.496

GRP 2

sessions:		1	2	3	4	5
C=trial	1	29.547	29.990	30.369	30.176	30.794
	SD:	2.854	3.196	2.714	2.956	2.306
	2	29.771	29.902	30.245	29.985	30.238
	SD:	2.959	3.134	2.683	3.016	2.405
	3	29.537	29.709	29.879	29.588	29.902
	SD:	3.012	3.332	2.677	3.247	2.751
	4	29.346	29.450	29.545	29.164	29.471
	SD:	2.968	3.501	2.747	3.207	2.895

GRP 3

sessions:	1	2	3	4	5
C=trial 1	28.484	29.388	29.502	29.301	29.973
SD:	3.803	3.551	3.622	3.562	3.348
2	28.578	29.435	29.478	29.327	29.800
SD:	3.719	3.506	3.598	3.630	3.062
3	28.505	29.186	29.465	29.031	29.621
SD:	3.752	3.405	3.319	3.580	2.962
4	28.139	29.074	29.104	28.696	29.075
SD:	3.737	3.338	3.216	3.593	3.038

GRP 4

sessions:	1	2	3	4	5
C=trial 1	30.475	30.340	30.650	30.050	29.634
SD:	2.921	2.883	2.287	3.110	3.242
2	30.214	29.942	30.311	29.691	29.023
SD:	2.952	2.944	2.389	3.267	3.325
3	29.591	29.721	29.902	29.247	28.898
SD:	3.050	3.029	2.606	3.462	3.497
4	29.403	29.120	29.565	28.895	28.456
SD:	2.845	3.313	2.749	3.441	3.672

SOURCE BCD

B=high (1)

sessions:	1	2	3	4	5
C=trial 1	29.465	29.762	30.098	29.753	29.475
SD:	2.941	2.611	2.520	2.821	3.103
2	29.667	29.671	29.913	29.619	29.094
SD:	2.695	2.657	2.616	2.881	2.987
3	29.412	29.496	29.714	29.210	28.888
SD:	2.731	2.730	2.516	2.971	3.045
4	29.137	29.106	29.334	28.987	28.442
SD:	2.741	2.923	2.555	2.917	3.283

B=low (2)

sessions:	1	2	3	4	5
C=trial 1	29.382	30.053	30.218	30.110	30.439
SD:	3.431	3.602	3.228	3.353	2.966
2	29.430	29.938	30.190	29.922	30.139
SD:	3.489	3.554	3.156	3.430	2.992
3	29.199	29.718	30.052	29.613	29.985
SD:	3.543	3.585	3.082	3.557	3.118
4	29.002	29.488	29.747	29.192	29.579
SD:	3.442	3.543	3.097	3.618	3.151

SOURCE ABCD

GRP = 1

B=high (1)

sessions:	1	2	3	4	5
C=trial 1	28.088	29.991	30.619	30.153	28.109
SD	2.205	2.147	0.776	2.496	3.168
2	28.888	30.111	30.667	30.082	28.157
SD	1.514	2.406	0.939	2.460	3.332
3	28.688	30.099	30.679	29.810	28.008
SD	1.793	2.347	0.990	2.532	3.573
4	28.638	29.759	30.344	29.600	27.836
SD	1.888	2.509	1.194	2.522	3.899

B=low (2)

sessions:	1	2	3	4	5
C=trial 1	30.375	29.880	29.678	30.340	30.728
SD	3.032	3.705	3.830	3.060	2.841
2	30.634	29.809	29.750	30.156	30.621
SD	3.116	3.675	3.885	3.118	2.818
3	30.629	29.589	29.958	29.819	30.600
SD	3.122	3.750	3.642	3.280	2.609
4	30.302	29.371	29.616	29.694	30.227
SD	3.125	3.463	3.649	3.369	2.725

GRP = 2

B=high (1)

sessions:	1	2	3	4	5
C=trial 1	30.085	30.359	30.694	29.770	31.169
SD	2.416	1.701	2.431	3.002	1.273
2	30.333	30.069	30.366	29.456	30.547
SD	2.357	1.803	2.699	3.060	1.555
3	30.322	29.863	30.200	29.116	30.207
SD	2.092	2.295	2.757	3.396	2.165
4	30.231	29.585	29.815	28.881	29.642
SD	1.607	2.822	2.822	3.185	2.708

SOURCE: ABCD (continued)

B=low (2)

sessions:	1	2	3	4	5
C=trial 1	29.010	29.622	30.044	30.582	30.420
SD	3.275	4.285	3.068	3.011	3.048
2	29.089	29.736	30.124	30.515	29.930
SD	3.474	4.175	2.806	3.036	3.095
3	28.753	29.555	29.559	30.060	29.598
SD	3.661	4.257	2.701	3.198	3.330
4	28.461	29.316	29.275	29.448	29.300
SD	3.778	4.228	2.793	3.375	3.208

GRP = 3
B = high (1)

sessions:	1	2	3	4	5
C=trial 1	28.882	28.575	28.735	29.332	29.727
SD	3.745	3.826	4.007	3.204	3.871
2	29.119	28.832	28.670	29.562	29.610
SD	3.566	3.748	4.002	3.230	3.311
3	28.927	28.593	28.681	29.138	29.595
SD	3.691	3.654	3.461	3.097	2.862
4	28.535	28.695	28.121	28.727	29.040
SD	3.877	3.527	3.227	3.146	2.858

B=low (2)

sessions:	1	2	3	4	5
C=trial 1	28.085	30.202	30.269	29.270	30.218
SD	4.000	3.223	3.195	4.046	2.901
2	28.036	30.038	30.286	29.092	29.989
SD	3.960	3.311	3.120	4.138	2.941
3	28.083	29.779	30.249	28.925	29.647
SD	3.943	3.196	3.131	4.159	3.199
4	27.743	29.453	30.086	28.665	29.111
SD	3.734	3.263	3.029	4.149	3.348

GRP=4
B=high (1)

sessions:	1	2	3	4	5
C=trial 1	30.735	30.199	30.445	29.794	28.925
SD	2.715	2.093	1.146	2.880	2.976
2	30.317	29.747	30.060	29.403	28.108
SD	2.857	2.374	1.483	3.071	3.017
3	29.727	29.519	29.428	28.821	27.780
SD	2.901	2.474	1.951	3.146	3.112
4	29.197	28.488	29.190	28.786	27.304
SD	2.899	2.913	2.237	3.102	3.479

B=low (2)

sessions:	1	2	3	4	5
C=trial 1	30.189	30.494	30.876	30.331	30.413
SD	3.255	3.681	3.170	3.481	3.497
2	30.101	30.157	30.588	30.008	30.030
SD	3.205	3.592	3.174	3.609	3.507
3	29.442	29.943	30.424	29.716	30.128
SD	3.357	3.673	3.206	3.894	3.634
4	29.629	29.816	29.977	29.014	29.724
SD	2.923	3.733	3.297	3.949	3.621

TABLE: 9b

Groups by Imagery Level by Trials by Sessions
(Interval 1: Temperature means)

Between subject factors
A - groups: 1= biofeedback 2= guided imagery
3= combined 4= control
B - imagery level: 1= high 2= low

Within subject factors
C - trials: 1 2 3 4
D - sessions: 1 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	48.745	0.359	0.783
B	1	52.412	0.386	0.536
AB	3	32.353	0.238	0.870
S-within	75	135.867		
C	3	28.255	23.118	0.001**
AC	9	2.948	2.412	0.012*
BC	3	0.0	0.036	0.999
ABC	9	1.222	1.000	0.441
CS-within	225	1.222		
D	4	15.529	1.182	0.319
AD	12	10.029	0.763	0.688
BD	4	14.074	1.071	0.371
ABD	12	25.074	1.908	0.033*
DS-within	300	13.140		
CD	12	1.240	3.198	0.001**
ACD	36	0.252	0.649	0.946
BCD	12	0.108	0.278	0.993
ABCD	36	0.252	0.649	0.946
CDS-within	900	0.388		

SOURCE: A

Group	1	2	3	4
	29.707	29.918	29.143	29.777

SOURCE: B

B =	high	low
	29.449	29.808

SOURCE: AB

A = GRP	B =	high	low
	1	29.360	30.054
	2	30.150	29.687
	3	28.911	29.376
	4	29.431	30.158

SOURCE: C

trials:	1	2	3	4
	29.831	29.816	29.589	29.269

SCHEFFE PROCEDURE:

(*) denotes pairs significantly different at .05 level

mean	trial	trials 1	2	3	4
29.831	1			*	*
29.816	2			*	*
29.589	3				*
29.269	4				

SOURCE: AC

	trials:	1	2	3	4
A = grp	1	29.691	29.859	29.753	29.523
	2	30.190	30.119	29.834	29.530
	3	29.205	29.338	29.177	28.853
	4	30.280	29.987	29.630	29.213

SOURCE: BC

	trials:	1	2	3	4
B = high	1	29.651	29.668	29.416	29.061
low	2	30.016	29.968	29.766	29.481

SOURCE: ABC

GRP: 1

	trials:	1	2	3	4
B = high	1	29.272	29.570	29.401	29.197
low	2	30.111	30.149	30.106	29.849

GRP: 2

trials:		1	2	3	4
B = high	1	30.437	30.290	30.064	29.811
low	2	29.943	29.949	29.605	29.250

GRP: 3

trials:		1	2	3	4
B = high	1	28.846	29.156	29.000	28.640
low	2	29.564	29.521	29.353	29.065

GRP: 4

trials:		1	2	3	4
B = high	1	30.087	29.704	29.256	28.679
low	2	30.492	30.298	30.041	29.801

SOURCE D

sessions:	1	2	3	4	5
	29.337	29.691	29.937	29.600	29.565

SOURCE AD

sessions:		1	2	3	4	5
A=grp	1	29.451	29.786	30.103	29.895	29.299
	2	29.604	29.824	30.109	29.840	30.216
	3	28.368	29.264	29.381	29.078	29.624
	4	29.991	29.922	30.199	29.638	29.137

SOURCE BD

sessions:		1	2	3	4	5
B=high	1	29.405	29.557	29.792	29.433	29.059
low	2	29.268	29.829	30.086	29.772	30.084

SOURCE: ABD

GRP: 1

sessions:		1	2	3	4	5
B=high	1	28.476	29.912	30.505	29.861	28.044
low	2	30.426	29.659	29.700	29.929	30.554

GRP: 2

sessions:		1	2	3	4	5
B=high	1	30.317	30.076	30.378	29.430	30.550
low	2	28.891	29.571	29.839	30.250	29.882

GRP: 3

sessions:		1	2	3	4	5
B=high	1	28.755	28.647	28.546	29.138	29.467
low	2	27.981	29.881	30.216	29.019	29.782

GRP: 4

sessions:		1	2	3	4	5
B=high	1	30.070	29.671	29.857	29.340	28.219
low	2	29.903	30.199	30.575	29.966	30.146

SOURCE: CD

sessions:		1	2	3	4	5
C=trial	1	29.320	29.858	30.099	29.922	29.958
	2	29.571	29.843	30.112	29.825	29.729
	3	29.304	29.690	29.951	29.492	29.507
	4	29.155	29.374	29.587	29.162	29.067

SOURCE: ACD

GRP 1

sessions:		1	2	3	4	5
C=trial	1	29.129	29.772	30.048	30.133	29.373
	2	29.736	29.934	30.163	30.048	29.414
	3	29.523	29.820	30.259	29.811	29.352
	4	29.415	29.615	29.940	29.589	29.056

GRP 2

sessions:		1	2	3	4	5
C=trial	1	29.467	30.001	30.352	30.280	30.849
	2	29.775	29.964	30.355	30.080	30.420
	3	29.657	29.822	30.011	29.677	30.003
	4	29.516	29.507	29.715	29.321	29.591

GRP 3

sessions:		1	2	3	4	5
C=trial	1	28.322	29.276	29.385	29.161	29.880
	2	28.528	29.433	29.514	29.345	29.872
	3	28.418	29.220	29.507	29.111	29.627
	4	28.204	29.128	29.117	29.696	29.118

GRP 4

sessions:	1	2	3	4	5
C=trial 1	30.405	30.414	30.654	30.177	29.748
2	30.310	30.070	30.459	29.873	29.221
3	29.689	29.931	30.065	29.410	29.054
4	29.558	29.274	29.620	29.092	28.523

SOURCE BCD

B = high (1)

sessions:	1	2	3	4	5
C=trial 1	29.330	29.697	30.005	29.747	29.476
2	29.683	29.740	29.997	29.664	29.256
3	29.381	29.611	29.800	29.326	28.960
4	29.226	29.179	29.366	28.994	28.544

B = low (2)

sessions:	1	2	3	4	5
C=trial 1	29.309	30.023	30.195	30.101	30.452
2	29.456	29.949	30.230	29.991	30.214
3	29.226	29.770	30.105	29.662	30.066
4	29.082	29.574	29.813	29.334	29.602

SOURCE ABCD

GRP = 1
B = high (1)

sessions:	1	2	3	4	5
C=trial 1	27.992	29.752	30.511	30.034	28.070
2	28.889	30.090	30.613	30.019	28.237
3	28.495	30.053	30.584	29.848	28.023
4	28.529	29.755	30.312	29.545	27.846

B = low (2)

sessions:	1	2	3	4	5
C=trial 1	30.266	29.793	29.585	30.233	30.677
2	30.584	29.779	29.714	30.077	30.592
3	30.551	29.588	29.934	29.775	30.682
4	30.302	29.476	29.569	29.633	30.267

GRP = 2
B = high (1)

sessions:	1	2	3	4	5
C=trial 1	30.002	30.386	30.666	29.905	31.225
2	30.381	30.203	30.534	29.558	30.772
3	30.442	30.041	30.293	29.198	30.345
4	30.443	29.676	30.018	29.058	29.858

B = low (2)

sessions:	1	2	3	4	5
C=trial 1	28.933	29.616	30.039	30.656	30.473
2	29.170	29.726	30.177	30.602	30.068
3	28.873	29.604	29.729	30.157	29.661
4	28.590	29.338	29.413	29.585	29.325

GRP = 3

B = high (1)

sessions:	1	2	3	4	5
C=trial 1	28.645	28.409	28.553	29.075	29.548
2	28.980	28.859	28.743	29.530	29.669
3	28.780	28.635	28.768	29.258	29.557
4	28.615	28.686	28.119	28.689	29.092

B = low (2)

sessions:	1	2	3	4	5
C=trial 1	28.000	30.143	30.218	29.246	30.212
2	28.076	30.007	30.285	29.161	30.075
3	28.055	29.805	30.245	28.964	29.697
4	27.793	29.570	30.115	28.704	29.145

GRP = 4

B = high (1)

sessions:	1	2	3	4	5
C=trial 1	30.620	30.310	30.396	30.015	29.091
2	30.473	29.884	30.202	29.570	28.392
3	29.824	29.795	29.671	29.035	27.956
4	29.363	28.695	29.160	28.741	27.436

B = low (2)

sessions:	1	2	3	4	5
C=trial 1	30.168	30.529	30.937	30.355	30.470
2	30.132	30.276	30.741	30.207	30.134
3	29.541	30.080	30.499	29.824	30.261
4	29.773	29.911	30.125	29.479	29.719

APPENDIX VII

Post hoc Scheffe Contrasts:
Examination of interaction effects

Between subject factors
A - groups: 1= biofeedback 2= guided imagery
3= combined 4= control
B - imagery level: 1= high 2= low

Within subject factors
C - trials: 1 2 3 4
D - sessions: 1 2 3 4 5

Source	D. F.	M. S.	F	prob.
A	3	38.176	0.280	0.840
B	1	51.765	0.379	0.540
AB	3	29.549	0.217	0.885
S-within	75	136.413		
C	3	36.020	30.128	0.001**
AC	9	2.876	2.405	0.013*
BC	3	0.216	0.180	0.910
ABC	9	0.719	0.601	0.795
CS-within	225	1.196		
D	4	14.721	1.114	0.350
AD	12	10.299	0.779	0.672
BD	4	15.529	1.175	0.322
ABD	12	25.828	1.954	0.028*
DS-within	300	13.140		
CD	12	0.917	2.378	0.005**
ACD	36	0.270	0.699	0.909
BCD	12	0.162	0.420	0.956
ABCD	36	0.342	0.886	0.663
CDS-within	900	0.386		

TRIALS p=.001

df=3/225 Fcrit=2.65 F'crit=7.95 error=1.196

crit dif^2= (7.95x2x1.196)/415 and crit dif = .214

T1 = 29.874
T2 = 29.756 T1,T2 >T3 >T4
T3 = 29.526
T4 = 29.199

GROUPS BY TRIALS p=.013

A: Groups: 1 (BFK), 2 (GI), 3 (COMB), 4 (CONT)

df=3/225 Fcrit=2.65 F'crit=7.95 error=1.196

crit dif^2= 7.95 (1.196/n1 +1.196/n2)

crit dif = .436 grps 1 vs 2 (n=100)
crit dif = .426 grps 1 or 2 vs 3 (n=100 and 110)
crit dif = .431 grps 1 or 2 vs 4 (n=100 and 105)
crit dif = .421 grps 3 vs 4 (n=110 and 105)

TRIAL 1

GRP 1	29.796	GRP1&2 NS (non-significant)
2	30.175	GRP2&4 NS
3	29.330	4 > 1 > 3
4	30.230	2 > 3

TRIAL 2

GRP 1	29.887	1, 2, 4 NS
2	30.016	3 < 2, 1, 4
3	29.323	
4	29.836	

TRIAL 3

GRP 1	29.788	1, 2, 4 NS
2	29.723	3 ,4 NS
3	29.162	3 < 1, 2
4	29.472	

TRIAL 4

GRP 1	29.539	3, 4 NS
2	29.395	2, 4 NS
3	28.818	1 > 4
4	29.088	3 < 1, 2

B: Comparison of trials within a single group

df=3/225 Fcrit=2.65 F'crit=7.95 error=1.196

crit dif^2= 7.95 (1.196/n*1* +1.196/n*2*)

crit dif = .436 grps 1, 2 (n=100)
crit dif = .416 grp 3 (n=110)
crit dif = .426 grp 4 (n=105)

GROUP 1

TR	1	29.796	2, 1, 3, 4 NS
	2	29.887	
	3	29.788	
	4	29.539	

GROUP 2

TR	1	30.175	1, 2 NS
	2	30.016	2, 3 NS
	3	29.723	1, 2 > 4
	4	29.395	1 > 3

GROUP 3

TR	1	29.330	1, 2, 3 NS
	2	29.323	1, 2 > 4
	3	29.162	
	4	28.818	

GROUP 4

TR	1	30.230	1, 2 NS
	2	29.836	2, 3 NS
	3	29.472	3, 4 NS
	4	29.088	1, 2 > 4
			1 > 3

TRIALS BY SESSIONS

A: Comparison of a single trial across sessions

df=4/900 Fcrit=2.385 F'crit=9.54 error=.386

crit dif^2= 9.54 (.386/$n1$ +.386/$n2$)
$n1$ & $n2$= 83

crit dif= .298

TRIAL 1

SESS	1	29.424	1 < 3, 5, 4, 2
	2	29.906	
	3	30.157	
	4	29.929	
	5	29.951	

TRIAL 2

SESS	1	29.550	3 > 1, 5
	2	29.803	3, 2 NS
	3	30.050	1, 5, 4, 2 NS
	4	29.769	
	5	29.610	

TRIAL 3

SESS	1	29.307	3 > 5, 4, 1
	2	29.606	2 > 1
	3	29.881	3, 2 NS
	4	29.409	
	5	29.430	

TRIAL 4

SESS	1	29.070	3 > 1, 4, 5
	2	29.295	3, 2 NS
	3	29.538	
	4	29.088	
	5	29.003	

B. Comparison of trials within a single session

df=3/900 Fcrit=2.615 F'crit=7.845 error=.386

crit dif^2= 7.845 (.386/n*1* +.386/n*2*)
n*1* & n*2*= 83

crit dif= .270

SESS 1

TR	1	29.424	4 < 2
	2	29.550	4 < 1
	3	29.307	2, 1, 3 NS
	4	29.070	

SESS 2

TR	1	29.906	4 < 3 < 1
	2	29.803	4 < 2
	3	29.606	2, 3 NS
	4	29.295	

SESS 3

TR	1	30.157	4 < 3 < 1
	2	30.050	3, 2 NS
	3	29.881	1, 2 NS
	4	29.538	

SESS 4

TR	1	29.929	4 < 3 < 2, 1
	2	29.769	
	3	29.409	
	4	29.088	

SESS 5

TR	1	29.951	4 < 3 < 1
	2	29.610	4 < 2 < 1
	3	29.430	2, 3 NS
	4	29.003	

GROUPS BY IMAGERY LEVEL BY SESSIONS p=.028

A. **ROWS:** df=4/300 Fcrit=2.40 F'crit=9.60 error=13.140

BFK, GI & CONT.low:
$crit\ dif^2 = (9.60x2x13.140)/40$ and crit dif = 2.511

COMB & CONT.high:
$crit\ dif^2 = (9.60x2x13.140)/44$ and crit dif = 2.395

B. **HI vs LO** same group, same session df=1/300 F'crit=3.875

BFK & GI:
$crit\ dif^2 = (3.875x2x13.140)/40$ and crit dif = 1.596

COMB:
$crit\ dif^2 = (3.875x2x13.140)/44$ and crit dif = 1.521

CONT:
$crit\ dif^2 = (40+44)(3.875x13.140)/44(40)$ and crit dif = 1.559

GRP: BFK

sessions:		1	2	3	4	5	
high	1	28.575	29.990	30.577	29.911	28.027	S3>5
low	2	30.485	29.662	29.750	30.002	30.544	NS
		lo>hi	NS	NS	NS	lo>hi	

GRP: GI

sessions:		1	2	3	4	5	
high	1	30.243	29.969	30.269	29.306	30.391	NS
low	2	28.828	29.557	29.750	30.151	29.812	NS
		NS	NS	NS	NS	NS	

GRP: COMB

sessions:		1	2	3	4	5	
high	1	28.866	28.673	28.552	29.190	29.493	NS
low	2	27.987	29.868	30.223	28.988	29.741	NS3&1
		NS	NS	lo>hi	NS	NS	

GRP: 4

sessions:		1	2	3	4	5	
high	1	29.994	29.488	29.781	29.201	28.029	NS
low	2	29.840	30.102	30.466	29.767	30.074	NS
		NS	NS	NS	NS	lo>hi	

C. All HIGHS during same session: df=3/300 F'crit=7.905 or
All LOWS during same session: df=3/300 F'crit=7.905

comparisons: BFK, GI & CONT.low
crit dif^2= (7.905x2x13.140)/40 and crit dif = 2.279

comparsion: COMB & CONT.high
crit dif^2= (7.905x2x13.140)/44 and crit dif = 2.173

comparsion: (mixed n's) COMB & BFK, GI, CONT.low
crit dif^2= (40+44)(7.905x13.140)/44(40) and crit dif = 2.227

Results: all highs

S1 ns
S2 ns
S3 ns (BFK vs COMB close)
S4 ns
S5 GI > BFK, CONT

Results: all lows

S1 BFK > COMB
S2 ns
S3 ns
S4 ns
S5 ns