



Baseline response patterns of hand temperature in normal and migrainous subjects
by Thomas Charles Trusk

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Psychology

Montana State University

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Abstract:

The baseline response patterns of hand temperature were observed in nonclinical and clinical (migraine headache) males and females, with five subjects per group. Hand temperature was monitored from each subject's dominant hand for 50 minutes each day for three consecutive days. Hand temperature level, variability, and per cent time temperature increased were used to define the baseline response pattern. Migraine headache subjects presented similar baseline response patterns of hand temperature as normal subjects of the same sex. Two significantly different response patterns based on sex were observed, which could explain some of the individual differences noted in training thermal self-regulation.

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Date

August 4, 1978

BASELINE RESPONSE PATTERNS OF HAND TEMPERATURE
IN NORMAL AND MIGRAINOUS SUBJECTS

by

THOMAS CHARLES TRUSK

A thesis submitted in partial fulfillment
of the requirements for the degree

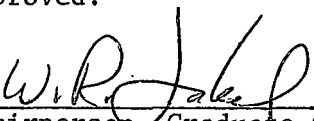
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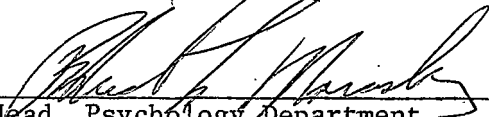
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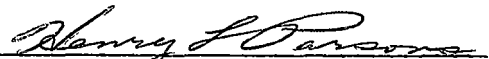
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Abstract

The baseline response patterns of hand temperature were observed in nonclinical and clinical (migraine headache) males and females, with five subjects per group. Hand temperature was monitored from each subject's dominant hand for 50 minutes each day for three consecutive days. Hand temperature level, variability, and per cent time temperature increased were used to define the baseline response pattern. Migraine headache subjects presented similar baseline response patterns of hand temperature as normal subjects of the same sex. Two significantly different response patterns based on sex were observed, which could explain some of the individual differences noted in training thermal self-regulation.

INTRODUCTION

Although it is generally accepted that humans can learn to control skin temperature, particularly in the hands (Keefe, 1975; Lynch, Hama, Kohn, & Miller, 1976; Ohno, Tanaka, Takeya, & Ikema, 1977; Roberts, Kewman, & MacDonald, 1973; Roberts, Schuler, Bacon, Zimmerman, & Patterson, 1975; Surwit, Shapiro, & Feld, 1976; and Taub & Emurian, 1976), individual differences in learning ability, rate of learning, and magnitude of control achieved are continually noted. Attempts have been made to relate these differences to motivation, personality variables, states of consciousness, and skeletal muscle intervention (Ohno, et al., 1977; Roberts, et al., 1975; and Surwit, et al., 1976) with variable results (Miller, 1978).

These differences may best be studied by investigating the individual nature of the response being trained. Skin temperature activity is measured and fed back to the trainee as an indirect measure of the activity of the vasomotor responses, viz., vasodilatation and vasoconstriction, which are the true target responses in thermal self-regulation (Taub, 1977). Since skin temperature is the parameter measured and provided as feedback, it is changes in this response between control (baseline) and training sessions that are used to provide evidence of learning. If the reinforced, or fed-back response shows increased amplitude over the level shown in a free-operant period, then the minimal criteria of learning are met (Katkin & Murray, 1968). Skin temperature is a stochastic and highly variable function across and within individuals (Bazett, 1949), and the free-operant or normal

resting behavior of this response remains poorly defined (Silberstein, Bahr, & Kattan, 1975). More basic information about the baseline response patterns of skin temperature is essential to establish confidence in the subsequent analysis of training effects. In general regard to problems of this sort, Kamiya (1977) writes:

Since biofeedback involves learning, research in the field. . . will need to include careful assessment of pre-training baseline activity. These should assess not only short and long-term averages, but variability as well. (p. xviii)

Kamiya maintains that recording these dimensions of a subject's response pattern will increase the understanding of training effects. This could also provide insight into the individual differences noted in learning ability, rate of learning, and magnitude of control achieved.

Skin temperature is the end product of fine thermoregulatory mechanisms and, as a repeatedly measured response, is dynamic and highly unstable (Frens, 1974). While stability is highly desirable to provide evidence of experimental manipulation, it is not entirely necessary. Through the use of single-subject experimental design with repeated measurement and multiple baselines, an experimenter can find evidence of learning by deviating the activity of a response from its defined resting response pattern (Hersen & Barlow, 1976; and Barlow, Blanchard, Hayes, & Epstein, 1977). If the experimenter is to reliably prove desired deviations from this resting pattern, it is necessary to

be able to operantly define the baseline response pattern for the subject. Measurable qualities of skin temperature that may be used to define this baseline pattern are the absolute level, degree of variation, and direction of predominate drift, or trend. In addition, it must be remembered that skin temperature activity represents the activity of homeostatic mechanisms. As such, it will be subject to the process of adaption as the individual moves into new environmental situations. There is, consequently, a certain length of time that must be allowed for the skin temperature to equilibrate to the experimental chamber (Iampietro, 1971). Houdas & Guieu (1974) state that the primary adaptation mechanisms of skin temperature are the vasomotor responses, and only in a state of skin temperature equilibrium will these responses remain in a relatively stable state. This is especially important in attempting to train control of skin temperature through biofeedback procedures, since, as previously stated, the vasomotor responses are the target responses in thermal self-regulation.

Previous consideration of the baseline activity of skin temperature is limited to one published study. Taub & Emurian (1976), in an appendix to their study, discuss the behavior of baseline skin temperature of nonclinical subjects as observed in their laboratory. They find resting skin temperature in 74°F ambient conditions to fall between 85 and 95°F, with most subjects "stabilized" at 90°F.¹ Stability is defined as less than .25°F temperature variation for a period of at least four minutes. Subjects who presented hand temperatures far from these norms during

self-regulation made it difficult to distinguish between true self-regulation and stochastic drifts toward normal levels. A large proportion of their subjects displayed a predominately increasing baseline temperature, which Taub & Emurian attribute to "some unrecognized aspect of the experimental situation" (p. 163) which was not controlled.

[Brown (1977) has suggested that most subjects would tend to relax into the experimental situation, decrease tone in the sympathetic-vasoconstrictive vasomotor system, and cause a concomitant rise in skin temperature.] Taub & Emurian also report that the stabilization (or adaption) period varied across subjects and session days, which made it impractical to define a standard stabilization epoch. They finally note that consecutive days and time of training, smoking behavior, and elapsed time between the last meal and training had no significant effect on learning ability.

Morasky & Trusk (1978) studied thermal biofeedback training in nine nonclinical subjects (four males and five females). Resting hand temperature was measured for thirty minutes a day for five days in a baseline phase. Ex post facto analysis of the baseline data shows basic agreement with the conclusions of Taub & Emurian (1976). It was noted, however, that high hand temperatures were strongly correlated to low intrasession temperature variability ($r = -.98$; $p = .001$) This suggests a "ceiling effect" of skin temperature in that the temperature is stabilizing at the upper limits of thermoregulatory control. That the thermoregulatory mechanism involved is vasomotor is suggested by

the results of McDonagh & McGinnis (1973), who found that subjects with high baseline hand temperatures were only able to produce small temperature increases as compared to subjects with low baseline hand temperatures.

Migraine patients typically present low hand temperatures (Sargent, Walters, & Green, 1973). Jankel (Note 1) finds the finger temperatures of his migraine patients to be usually below 86°F. The skin variability of his subjects has not been recorded intrasession, but is found to be quite high across treatment days. The etiology of migraine headache, which has yet to be confidently defined (Mumenthaler, 1977), suggests a maladaptive response of the vasomotor system to environmental stimuli. The results of Sargent, et al. (1973) show that migrainous individuals can reverse the symptoms of a migraine attack by self-regulating hand temperature. Migraine headache is a chronic disorder with possible hereditary components. That is, some individuals are highly predisposed to migraine headache attacks, whether by familial trait, physiological dysfunction, or maladaptive learning (psychosomatic). This predisposition to migraine attack may be observable in the baseline response patterns of hand temperature in such individuals. If so, it may be possible to define the specific response or system of responses that predispose an individual to migraine headache attack.

The purpose of the present study is to observe and describe the baseline response patterns of hand temperature in groups of subjects commonly used in biofeedback studies of thermal self-regulation. The

sample will include clinical (migraine headache) and nonclinical subjects of both sexes. A pertinent question to consider is whether the presence of a pathological condition, i.e., migraine headache, which is known to be affected by thermal self-regulation, can pre-determine a type of baseline response pattern of hand temperature. This study will also attempt to observe the process of temperature adaptation in order to define a reasonable period of time in which this process can occur. Typically in thermal biofeedback studies, a period of ten to twenty minutes is allowed for adaptation. Brown (1977) has suggested that this period may be insufficient, and several studies have stated that depending upon the degree of ambient temperature change, a subject could require up to two hours to adapt (Helson & Quantius, 1934; Houdas & Guieu, 1975; and Iampietro, 1975).

Method

Subjects

20 subjects (10 males and 10 females) were recruited from psychology courses at Montana State University and by campus advertisement. A Medical History Questionnaire consisting of 28 checklist items of psychophysiologic disorders was completed by each prospective subject. (See Appendix.) Nonclinical subjects (5 males and 5 females) were chosen on the basis of no reported disorder related to skin temperature abnormality. Prospective subjects who reported a present problem with migraine headache, who could properly describe the symptoms and signs

of a migraine attack, and who were under a physician's care where chosen as clinical subjects. Five males and five females were chosen on the basis of those criteria. Subject ages ranged from 18 to 48 years, with the average age being 27.2 years.

Apparatus

Hand temperature was measured with an Autogen 2000b Temperature Feedback Unit. Average hand temperature and per cent time the temperature increased in one minute epochs was integrated and digitally displayed on an Autogen 5600 Data Acquisition Center. Outdoor and room temperatures were monitored on an Autogen 1000 Temperature Feedback Unit.

Procedure

Each subject was placed in a semi-recumbent position in a reclining chair placed along the long dimension of a 2.3 x 1.4 m. carpeted chamber. Three thermistors (sensitive to .01°F) were placed on the center of the digital pad of the thumb, second, and fourth fingers of the dominant hand, and held in place with porous paper tape. Each subject supinated both hands on the arms of the chair, and was asked to keep arm and hand movements to an absolute minimum. The purpose and function of the thermistors was briefly explained and the subjects were finally asked to remain relaxed yet awake throughout the fifty minute session. It was explained that if the subject experienced difficulty remaining awake, he/she could briefly converse with the experimenter in an adjoining room through an intercom which remained open throughout each session.

Baseline hand temperature was measured as the average of the three thermistors and was recorded from each subject for fifty minutes per day for three consecutive days, at approximately the same time each day. Average hand temperature and per cent time the temperature increased was recorded every sixty seconds. Room temperature was recorded at the beginning, middle and end of each session through a thermistor placed in close proximity to the subjects hand. Outdoor temperature during each session was recorded prior to the subjects arrival, and each subject reported the relative amount of time he/she had spent outdoors prior to each session. The experimenter periodically checked each subject for compliance to instructions, and informed the subject of time remaining in the session at 25 and 40 minutes into each session.

Results

Average hand temperature and per cent time temperature increased were plotted over time for each subject. The per cent time data was highly variable in one minute epochs, hence this data was recalculated into five minute epochs where a meaningful pattern emerged. The per cent time temperature increased data showed a cyclic nature for all subjects of varying frequency and amplitude, but with a definite peak-to-peak period of 10-20 minutes. This cyclic activity was also present in continuously decreasing or increasing hand temperatures. The only exception to this cyclic activity was during the first few minutes of a session, when the process of adaptation was most likely

occurring. During this time the per cent time data largely remained constant above 75%. Figures 1-4 show the most representative subject from each group, i.e., these subject's data best described their group means in average hand temperature, temperature variability, and per cent time temperature increased.

A two-way analysis of variance was performed on the dependent variables of mean absolute hand temperature, temperature variability, and total per cent time temperature increased to test for effects of migrainous condition and sex. Males were found to have significantly higher hand temperatures, $F(1,16) = 11.56$, $p < .01$; significantly lower temperature variability, $F(1,16) = 6.57$, $p < .05$; and to have spent significantly more per cent time increasing temperature, $F(1,16) = 10.49$, $p < .01$. The presence of a migrainous condition had no significant effect on any of these variables. The diversity of hand temperature baseline activity both across sessions and individuals is evident in Table 1, which is a summary of the average measures obtained for all subjects of each group.

Hand temperature adaptation and stabilization was analyzed using the stabilization criteria of Taub & Emurian (1976). A FORTRAN computer program searched each subject's data for instances where temperature variability fell below $.25^{\circ}\text{F}$ for at least four consecutive minutes. An average stabilization temperature level was computed for each instance of stabilization, and the time period for each stabilization was reported as session-minute to session-minute. Table 2 is a summary of

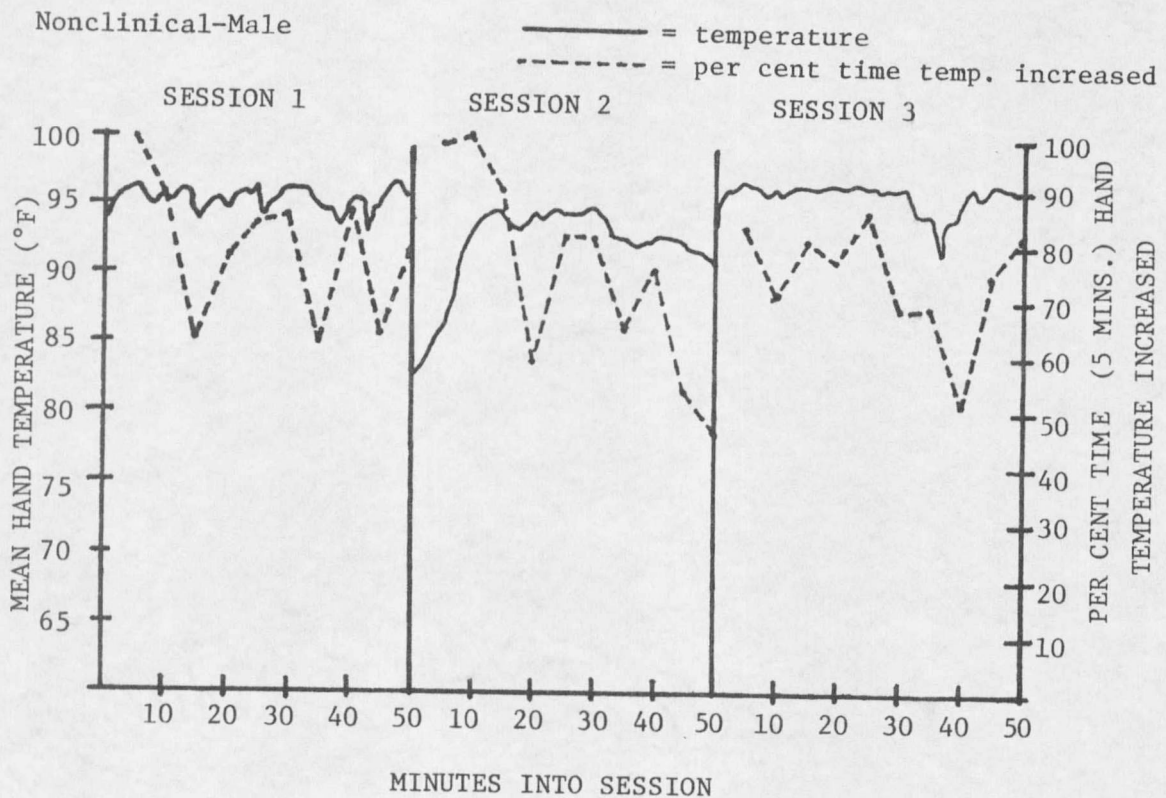


Figure 1. Hand temperature (°F - one minute averages) and Per cent time temperature increased (five minute averages) over time for most representative Nonclinical-Male.

Nonclinical-Female

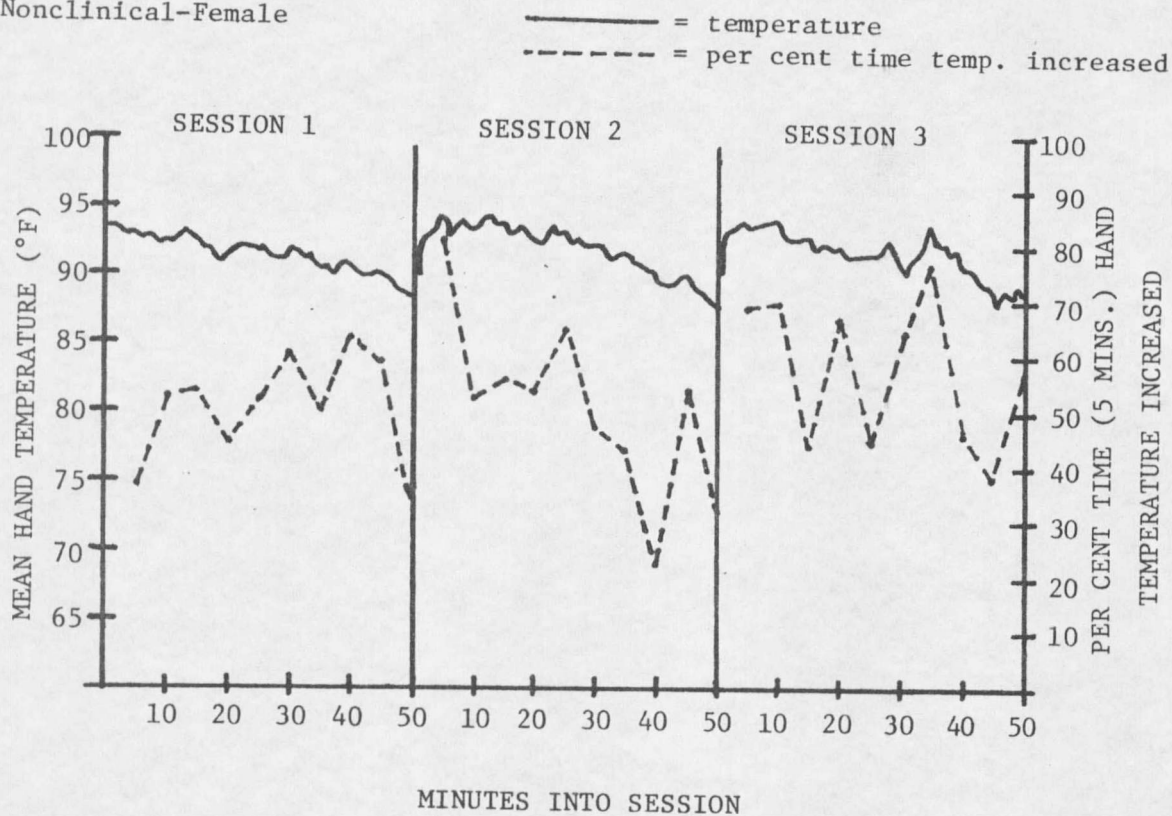


Figure 2. Hand temperature (°F - one minute averages) and Per cent time temperature increased (five minute averages) over time for most representative Nonclinical-Female.

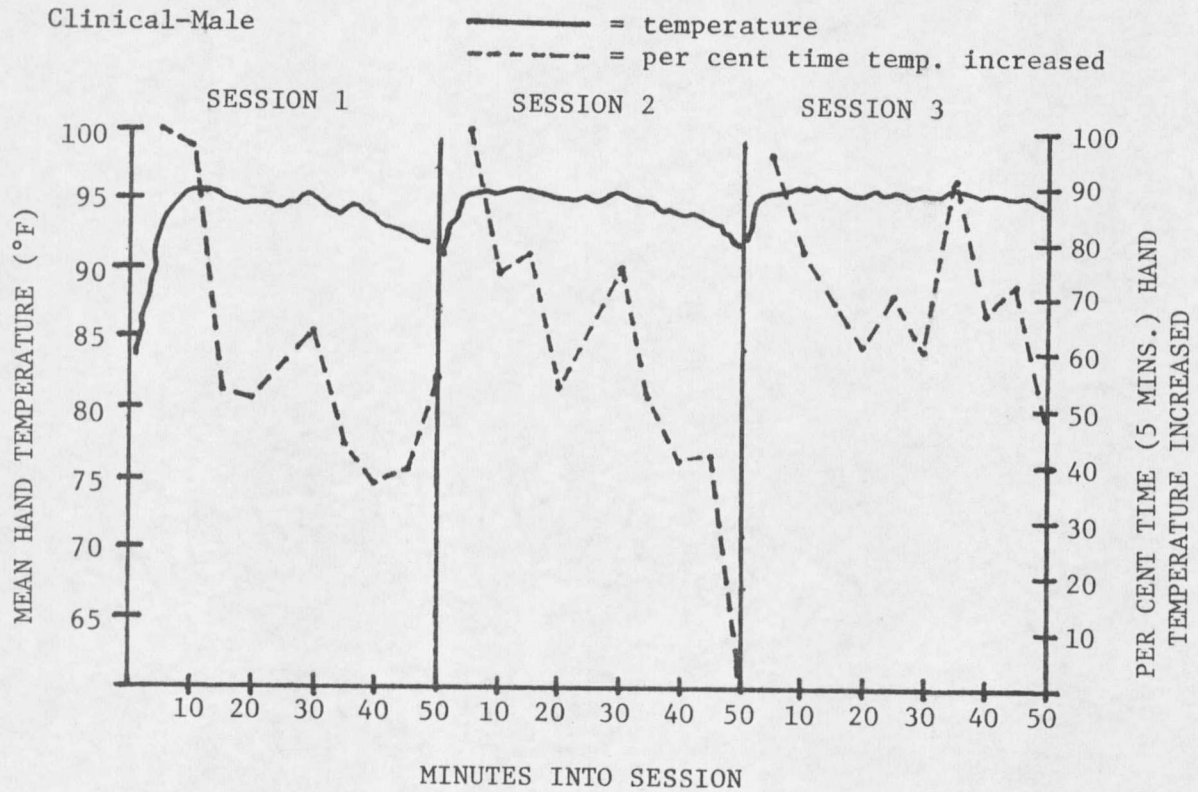


Figure 3. Hand temperature (°F - one minute averages) and Per cent time temperature increased (five minute averages) over time for most representative Clinical-Male.

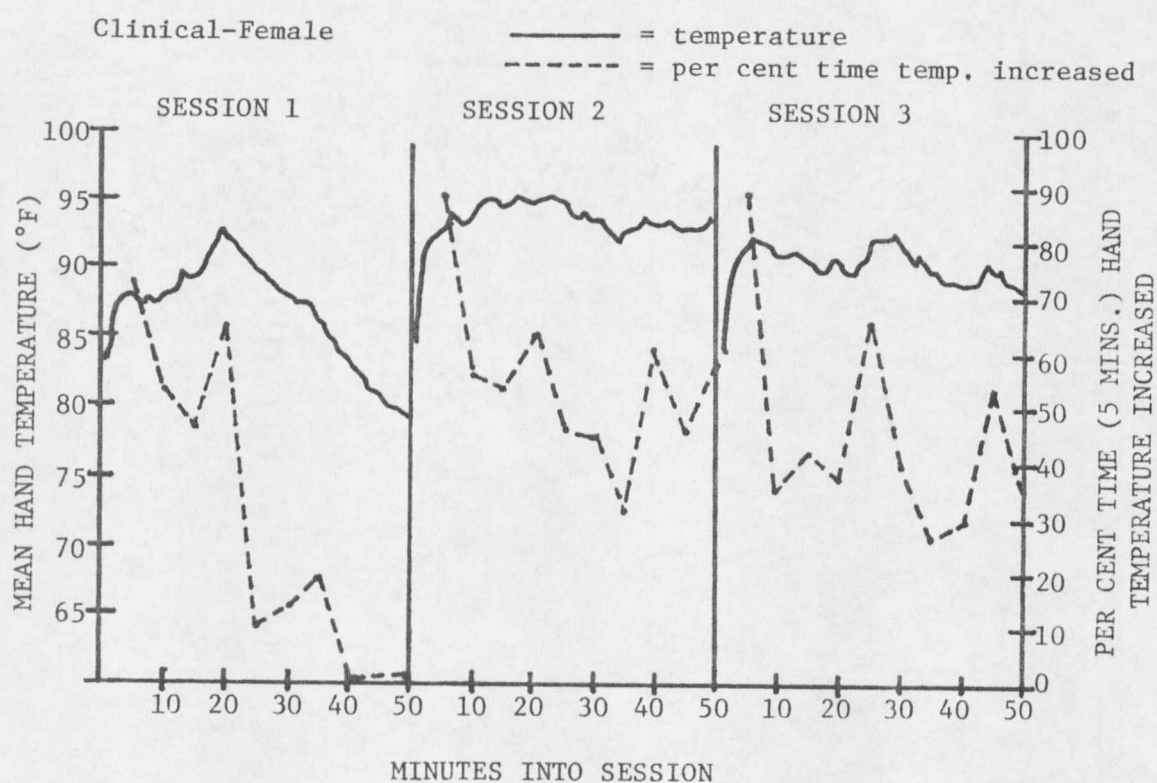


Figure 4. Hand temperature (°F - one minute averages) and Per cent time temperature increased (five minute averages) over time for most representative Clinical-Female.

Table 1

Mean Hand Temperature $\pm$ Variability ($^{\circ}\text{F}$) and (Per Cent Time Temperature Increased) per Session
for all Subjects

NONCLINICAL				CLINICAL			
SESSION	1	2	3	1	2	3	
<u>MALES</u>	Subject: 1	95.54±.42 (72.16)	95.73±.20 (82.38)	85.77±1.9 (67.42)	95.25±1.2 (58.20)	93.59±.89 (50.49)	94.55±.68 (63.71)
	2	88.44±3.5 (54.63)	90.34±2.2 (57.48)	94.55±.73 (58.11)	95.98±.43 (81.59)	95.23±.63 (79.05)	93.74±.94 (72.97)
	3	88.91±5.1 (66.48)	93.05±1.8 (56.33)	94.62±.87 (65.66)	93.74±2.1 (59.41)	94.66±.91 (54.82)	95.44±.57 (71.42)
	4	95.39±.26 (69.41)	96.51±.29 (70.44)	96.99±.31 (76.30)	95.08±.79 (73.41)	94.87±1.0 (70.71)	93.37±2.4 (70.15)
	5	95.19±.85 (78.94)	91.93±3.0 (74.62)	95.77±.81 (73.55)	95.18±.37 (61.27)	94.61±.74 (56.74)	94.29±.68 (53.59)
<u>FEMALES</u>	1	95.09±.73 (59.69)	86.98±4.2 (8.87)	92.84±2.2 (46.34)	81.14±6.0 (7.92)	82.31±5.9 (15.08)	93.75±1.3 (48.23)
	2	91.21±1.4 (50.16)	91.71±1.9 (50.08)	91.55±1.6 (56.80)	90.50±2.6 (42.17)	83.24±6.3 (20.29)	87.60±3.1 (32.91)
	3	92.45±2.1 (60.91)	77.77±2.9 (42.80)	86.62±2.5 (54.33)	86.62±3.8 (27.56)	93.63±1.2 (53.48)	90.27±1.6 (45.65)
	4	93.67±1.1 (59.49)	84.28±2.0 (47.91)	79.01±1.2 (53.96)	79.39±1.4 (45.39)	73.16±.35 (90.55)	74.01±.44 (98.84)
	5	91.21±2.7 (43.46)	94.37±.65 (67.27)	94.93±.67 (71.69)	94.23±1.4 (52.01)	94.48±.87 (56.18)	90.74±3.9 (33.83)

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Note. Numbers in parentheses indicate per cent of 50 minute session that temperature increased.

Table 2
 Mean Stabilization Temperature (°F)
 and (Mean Earliest Stabilization Minute)
 for each Subject across Sessions

		<u>NONCLINICAL</u>	<u>CLINICAL</u>
<u>MALES</u>	Subject: 1	92.63 (9)	94.64 (15)
	2	91.66 (30)	95.48 (8)
	3	93.46 (12)	95.07 (7)
	4	96.32 (5)	94.89 (13)
	5	94.86 (19)	94.75 (3)
	$\bar{X}$	93.79 (15)	94.96 (9)
<u>FEMALES</u>	1	92.93 (7)	93.83 (3)
	2	91.35 (25)	-0- ^a
	3	86.85 (19)	91.14 (12)
	4	85.22 (16)	75.49 (4)
	5	94.45 (4)	92.28 (4)
	$\bar{X}$	90.16 (14)	86.91 (7)

^aNo stabilization occurred for this subject.

each subject's mean stabilized hand temperature and mean earliest minute of stabilization across three sessions. Earliest minute of stabilization, representing the adaptation period, ranged from minute 1 to minute 44, with an overall mean adaptation period of 12 minutes. One female-migraine subject showed no evidence of stabilization in three baseline sessions, and another female-migraine subject did not stabilize in her first two sessions. Number of stabilizations per session ranged from 0 to 6, with a mean of 2.3 stabilizations per session. Hand temperature stabilized for an average 8.4 minutes per stabilization. Tables 3 and 4 are compilations of the mean stabilized temperatures per session for all subjects, demonstrating that hand temperature did not necessarily stabilize at the same level during any given session. Change in ambient temperature (room temperature - outdoor temperature) and amount of time spent outdoors prior to each session did not correlate with adaptation period, when defined as the earliest minute of stabilization. Mean room temperature throughout the study was 72.5°F, and mean outdoor temperature was 56°F.

High hand temperatures were found to correlate significantly with low temperature variability, $r = -.58$, $p = .004$.

Discussion

The results indicate that a migrainous condition has no observable effect on the baseline response pattern of hand temperature. It should be noted here that none of the migrainous subjects tested reported

Table 3

Mean Stabilized Hand Temperature (°F) Per Session
for all Male Subjects

SESSION	<u>NONCLINICAL</u>			<u>CLINICAL</u>		
	1	2	3	1	2	3
Subject: 1	95.38	95.76	87.59	95.27	94.06	94.52
	95.52		85.48	95.52	93.32	
	95.27			95.42	94.50	
	95.92				94.09	
2	90.03	90.70	95.19	96.36	95.85	94.40
		90.15	93.89	96.44		
			94.52	96.24		
				96.01		
3	91.87	94.03	95.28	95.43	95.48	95.60
	92.43	94.44	94.38	94.53	94.97	
		92.75		94.38	94.01	
		93.29				
4		93.44				
		92.53				
	94.83	96.53	96.87	95.37	94.82	94.40
	95.31	96.58	97.42	95.20	95.28	93.87
5	95.37	96.64	96.90		95.58	
	95.29					
	95.79					
5	95.87	94.24	96.31	95.22	95.35	94.95
		92.33	96.21		94.99	94.78
		92.43	94.09		93.51	94.55
			96.21			93.36

Table 4

Mean Stabilized Hand Temperature (°F) Per Session
for all Female Subjects

SESSION	NONCLINICAL			CLINICAL		
	1	2	3	1	2	3
Subject: 1	94.80	91.03	95.48	-0- ^a	-0-	95.19
	96.15	88.26	92.79			94.73
	94.51					93.46
	94.58					91.92
2	89.71	93.44	91.89	-0-	-0-	-0-
		91.93	91.42			
3	93.42	80.73	87.36	87.53	95.27	91.01
	93.98		85.44		93.38	92.40
	92.85				92.83	
4	93.48	82.69	77.29	77.49	73.13	73.23
	94.43		79.28	79.50		74.26
	94.88		79.71	81.36		
			78.53	80.00		
5	94.01	95.02	95.32	95.74	95.32	94.42
	92.90	94.45	94.50	95.56	95.70	
			95.21	94.76	94.36	
			95.62	92.12	94.51	
				94.11		

^a-0- indicates no stabilization occurred for that session.

having a migraine attack within the 72 hours preceding their first baseline session, and no migraine attacks were reported during the three days of baseline measurement for any of the clinical subjects. The results suggest two possible conclusions. First, migraine headache attacks are a transient phenomena as far as hand temperature is concerned. The predisposition to migraine attack may be found in the activity of a more central mechanism. Second, the predisposition to migraine attack may affect hand temperature in a manner abstruse to the methods of analysis used in this study.

Sex Effects

The sex variable was of secondary importance in this study as is evident from the small sample size. Yet the results indicate a sex effect that has strong implications in training thermal self-regulation. The results indicate that there is a significant difference between males and females in baseline response patterns of hand temperature. In a resting situation, males as a group respond with higher hand temperatures of low variability, and spend more time increasing hand temperature. In this study, the average male increased hand temperature 67% of the time, or 34 out of 50 minutes, compared to the average female who increased hand temperatures 45% of the time, or 23 out of 50 minutes. Although no empirical explanation can be offered as to why males tend to have higher hand temperatures and spend more time increasing temperature over females, a few speculative reasons seem possible. Physiologically, males tend to be more muscular than females

and as such, would tend to produce more muscular thermal energy. For reasons of thermal balance and homeostasis, this excess heat is liberated into the environment through the skin. Psychologically, males might tend to relax more than females in the experimental situation, leading to the concomitant rise in skin temperature as previously mentioned, (Brown, 1977).

How might this difference affect learning ability, rate of learning, and magnitude of control achieved in thermal biofeedback training? Recall that high hand temperatures significantly correlated with low temperature variability in this study and in the ex post facto analysis of baseline data in Morasky & Trusk (1978). This drop in temperature variability as the skin temperature rises suggests a "ceiling effect" in that skin temperature is reaching the upper limit of vasomotor thermoregulatory control, or maximum vasodilatation. Males were found to have significantly lower temperature variability, implying that males in a resting situation are approaching a state of maximum vasodilatation. When providing such individuals with feedback to train temperature increase control, the probability of the subject producing a correct response, i.e., an increase in vasodilation, would be low. Feedback is only provided during correct responses, hence with fewer presentations of feedback, acquisition of temperature control would appear difficult, and probably require more training sessions. The results of McDonagh & McGinnis (1973) suggest further that such individuals who do gain control would appear to have achieved less

magnitude of thermal self-regulation control. Thus males as a group, because of their characteristic baseline response pattern of hand temperature, may seem to learn to self-regulate temperature increases with some degree of difficulty. Some of the females in this study also responded in a few sessions with high hand temperatures coupled with low temperature variability. To train individuals who present such a baseline response pattern, it may be necessary to control the level of resting skin temperature by lowering the ambient temperature of the training chamber. Clearly, further study with a much larger sample size is needed to verify this sex difference and "ceiling effect" of hand temperature and the implications they present for understanding the individual differences of learning skin temperature self-regulation.

Hand Temperature Adaptation and Stabilization

Period of hand temperature adaptation and level of hand temperature stabilization results were somewhat equivocal, although this was expected due to the individual and random nature of skin temperature activity. Adaptation period was defined as the amount of time necessary for hand temperature to reach its first level of stabilization. The results show that 12 minutes would be sufficient for a majority of the individuals tested to equilibrate. However, some subjects did not stabilize for 30 minutes, and two female-migraine subjects did not stabilize in 5 out of 6 fifty minutes baseline sessions. Of the 60 baseline sessions in this study, 16 sessions (27%) required over 20

minutes to stabilize. 90% of the sessions evidenced stability in 30 minutes, thus this is the recommended minimum period of adaptation, (Houdas & Guieu, 1974).

On the average, hand temperature stabilized 2 to 3 times per session for an average 8 to 9 minutes per stabilization. The data in Tables 3 and 4 indicate that hand temperature will stabilize at different levels both within and across sessions for each subject. Many of these stabilization levels, especially for the males (Table 3), are within .25°F of each other in the same session. It should be pointed out that these levels are separated by 1 to 10 minutes of highly variable hand temperature activity. Skin temperature responds to a multitude of stimuli (Silberstein, et al., 1975), including affective states (Helson & Quantius, 1934; Mittelman & Wolff, 1939; and Crawford, Friesen, & Tomlinson-Keasy, 1977). As such, skin temperature will continually adjust its level of activity in response to these inputs. Hence, one cannot record a truly "stable" hand temperature unless all of the stimuli affecting hand temperature are controlled. Since such a degree of control is improbable, how are self-regulated temperature deviations differentiated from random fluctuations? Possibly the best method is to include baseline temperature variability in the determination of a stability point of hand temperature. The mean level of baseline hand temperature, plus or minus the temperature variability, measured in a pre-training stability phase, is considered the normal range of hand temperature. Deviations of hand temperature

outside this range during training are treated as evidence of self-regulation. This method of hand temperature training analysis is used by Taub & Emurian (1976), and provides possibly the best evidence of hand temperature self-regulation. The results of this study, however, indicate that the experimenter should allow at least 20 minutes of stabilized hand temperature activity to occur during the pre-training phase (after adaptation has occurred), to obtain a confident range of normal skin temperature activity.

Cyclic Activity of Hand Temperature

The most unexpected finding in this study was the cyclic activity of the percent time temperature increased data. It was expected that the percent time data would reflect the direction or trend of skin temperature activity, and that stable baseline temperature would show approximately 50% of the time increasing temperature. Although it can be said that this was generally true for periods greater than 20 minutes, the extreme variability of this response measured in one minute periods was unforeseen. Vasomotor oscillations of skin temperature have been studied in relation to circadian rhythms (Gautherie, 1973), but little information is offered to explain the nature of this behavior. The cyclic activity of temperature increase, as plotted in five minute means (Figs. 1-4), is only present once the process of adaptation has occurred. This suggests a possible method of determining hand temperature stability. In addition, this cyclic activity may be used as an indication of self-regulation of hand temperature.

Preliminary results of a hand temperature training study (Ryles, Note 2), indicate that per cent time temperature increased, when measured in 3 to 5 minute periods, deviates from a cyclic pattern with greater consistency as thermal control performance increases. This measure obviously deserves further investigation.

Concluding Remarks

The results of this study indicate that the presence of a pathology, i.e., migraine headache, which is known to be affected by thermal self-regulation, does not seem to change the resting pattern of hand temperature from that seen in normal individuals of the same sex. However, two types of hand temperature baseline response patterns based on sex were observed. Basically they describe a resting hand temperature of a somewhat stable yet highly variable nature in a moderate range of hand temperature (85 to 90°F); and a resting hand temperature of high level (95°F) and low variability. These baseline response patterns suggest different levels of a resting state of vasomotor thermoregulation, which could have strong implications in understanding the individual differences seen in learning to self-regulate skin temperature.

Footnotes

1. All temperature data in this study will be reported in degrees Fahrenheit. Although the current trend is to report data in the metric system, most of the previous skin temperature control literature, and much of the temperature feedback instrumentation in current use utilizes the English System of temperature measurement.

Reference Notes

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2. Ryles, J. G. Personal Communication. May, 1978.

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Appendix A

Medical History Questionnaire

Name _____

Have you ever consulted a doctor about any of the following problems?

NO YES (check one)

- | | | |
|-----|-----|------------------------------------|
| ___ | ___ | dry skin |
| ___ | ___ | excessive sweating |
| ___ | ___ | hives |
| ___ | ___ | other "itching problems" |
| ___ | ___ | blemishes (acne, boils, etc.) |
| ___ | ___ | muscle paralysis |
| ___ | ___ | muscle weakness |
| ___ | ___ | muscle pain |
| ___ | ___ | asthma |
| ___ | ___ | hyperventilation |
| ___ | ___ | other breathing problems |
| ___ | ___ | Raynaud's disease |
| ___ | ___ | migraine headache |
| ___ | ___ | syncope (fainting) |
| ___ | ___ | hypertension (high blood pressure) |
| ___ | ___ | hypotension (low blood pressure) |
| ___ | ___ | anemia |
| ___ | ___ | ulcers |
| ___ | ___ | diarrhea |

NO YES

- ___ ___ dysmenorrhea
- ___ ___ any other sexual dysfunction
- ___ ___ problems with vision (not including prescription glasses)
- ___ ___ problems with hearing
- ___ ___ problems with taste
- ___ ___ problems with sense of smell
- ___ ___ problems with sense of touch
- ___ ___ problems with any other particular sensation (heat, cold, etc.)
- ___ ___ tinnitus (ringing in the ears)
- ___ ___ other (explain) _____

[Please put down anything you consider important]

If you answered YES to any of the above, please describe any medication, diet, or other therapy that was prescribed for you. Also indicate which disorders are currently being treated. Your responses to these questions will be kept confidential.

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Baseline response
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