LIMB TREMOR RESPONSES TO ANTAGONISTIC AND INFORMATIONAL COMMUNICATION

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ABSTRACT

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By

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This study was an investigation of limb tremor (LT) responses of male and female subjects (Ss) to a complex stimulus situation. The stimulus situation involved televised presentations of an actor speaking to and looking directly at individual Ss. A set of five antagonistic scenes were presented to two groups of 10 Ss (males and females) and five informational scenes were presented to two other groups of 10 Ss each. Tremors were measured with an accelerometer in an object the approximate size of a human infant. The mean change in LT magnitude over a trial (a 30 second scene and the 30 second rest period following each scene) was significantly larger for the groups receiving the antagonistic communication. Males had a larger overall mean level of tremor, although there were no significant sex differences in the pattern of response. LT magnitude increased in a linear fashion as a function of the five trials for all groups. The mean level of tremor during periods of attention to the actor

was significantly lower than the mean level during the rest periods. This difference and a significant positive correlation between period difference scores and performance on an attention demanding task were sited as support for a somatic inhibition model of attention. Because the mean magnitude of tremor recorded in this study (.006gs) was three times the magnitude necessary for human perception of body oscillation (.002gs) in this frequency range (5-15Hz), this study concluded that LT is a prime candidate for a role in the physical contact relationship between an infant and its mother or mother substitute.

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Robert W. Grossman

A THESIS

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DEDICATION

To S. Howard Bartley and his contribution to the knowledge and understanding of man's physical relationships with his environment.

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INTRODUCTION

Limb tremor (LT), a normal oscilatory movement of the body limbs can be recorded from any site on the body surface provided one has a sufficiently sensitive measuring instrument (Denier, 1957; Rohracker, 1958; Williams, 1963). Frequency of LT varies between 5 and 15 Hz (mean = 10 Hz) and is relatively constant over the body surface (Haider & Lindsley, 1964; Halliday & Redfearn, 1956; Lippold, 1971; Marshall & Walsh, 1956; Sugano, 1960). On the other hand, LT amplitude varies according to the location of the recording site on the limb and to the state of limb muscle tension (Williams, 1963). When the individual is at rest, is sleeping or is deeply relaxed, with his limb fully supported, LT amplitude is relatively low (Brumlik, 1962; Friedlander, 1956; Haider & Lindsley, 1964; Van Buskirk, 1962).

From Brumlik's (1962) report of LT amplitude and frequency ranges one can compute the range of maximum accelerations during the oscillation cycle for tremor. The maximum accelerations varied between .0004 gs and .01 gs under these rest conditions (acceleration due to gravity = 1g). Brumlik also recorded LT while his subject (S) lifted his arm even with his shoulder and then made a maximum voluntary contraction of all the limb muscles. Under this condition maximum LT accelerations ranged from .02 gs and .2 gs. In studies where weights were added to _Ss_' unsupported limbs, LT amplitude increased with the amount of weight added (Marshall, 1959; Whitney, 1958). Both Brumlik (1962) and Marshall (1959) reported that LT amplitude varied with the position of the measuring instrument on the limb.

Relation of tremor to emotionality and bodily tension.--The amplitude of tremor has been found to vary with other stimulus variables as well as with a variety of subject variables. For example, Kellogg (1932) and Luria (1932) found that LT amplitude increases were associated with "emotionality." Kellogg (1932) tested _Ss_ before and after they sliced a live mouse in half. As measured by a Whipple Steadiness testor, higher tremor amplitudes occurred after the cutting episode. Luria (1932) conducted detailed examinations of individual records in various stimulus situations. In one study he was able to test murderers within several days of their crimes. Subjects were asked to give free association responses to a list of stimulus words. The words on the list that were related to the scene of _S_'s crime elicited increased tremor amplitude and other forms of "motor disturbance" during the periods immediately prior to and immediately after _S_'s response to these words.

Other researchers have found similar amplitude increases associated with "bodily tension" as have been associated with emotionality. Young (1933) found that amplitude increased when he instructed _S_ to "make an effort" to reduce LT amplitude. Sollenberger (1937) found that larger tremor amplitudes were associated with more difficult arithmetic problems. Reymert and Speer (1938) obtained similar results. Morgan and Ojemorn (1942) found amplitude to increase after the administration of "mild mental tests."

Relation of tremor to stress.--More recent studies have found tremor amplitude differences between anxiety patients and normal _S_s during stressful stimulus situations. Malmo (1949), using heat as "nonspecific stress," found that patients had more "significant disturbances" in tremor than normals did during the periods immediately following stress. To create nonspecific stress periods Williams (1964) provided _S_s auditory feedback while they read out loud. Neurotics and schizophrenics showed significantly larger tremor amplitudes during the stress period when compared to normals. During the rest periods before and after stress, neurotic _S_s did not differ significantly in tremor amplitude from normal _S_s although schizophrenics showed much larger tremors.

Relation of tremor to sex differences.--Williams (1964) reported a significant difference in mean amplitude of tremor, suggesting that this difference was due to the larger size of the "contributing muscles" of male _S_s. Grossman, Fitzgerald and Porges (1971) found sex differences in the pattern of muscle response in a reaction time study. They suggested that this pattern difference was related to the response demands of the experimental task. Moreover, they advanced the hypothesis that the sex differences in response pattern would diminish as the demands for rapid motor response decreased.

Relation of tremor to fatigue.--Bousfield (1933) obtained increased LT amplitude as a function of physical exercise. Lippold (1967) reported that integrated electrical activity gradually increases over time, although the tension maintained by the muscle remains constant. He suggested that tension is maintained by the recruitment of more muscle units. As the number of muscle fibers increases, firing of the involved motor units reaches synchronization (Buchtal & Madison, 1950). In accord with increased synchronization one would expect to find an increase in tremor amplitude as a function of fatigue, rather than as a function of stimulus characteristics.

Relation of tremor to attention.--Webb & Obrist (1970) have recently hypothesized a somatic inhibitory mechanism which functions to reduce irrelevant and interfering activity during attention demanding tasks. In a reaction time experiment they found _S_s to inhibit eye movement and EMG while simultaneously recording good reaction times. If general inhibition of irrelevant muscle activity does occur during attention demanding tasks, then one would expect a decrease in tremor amplitude while S's are attending.

Porges (1970) investigating heart rate activity during a reaction time task, hypothesized a two component model of attention; a phasic reflexive component dependent on a specific stimulus change and a tonic, performance related, component. Since the cardiovascular system and the somatic system are so biologically interlinked, it is possible that tremor amplitude will reflect both of these attentional responses.

Implications of Limb Tremor for Human Behavior

Since tremor is measurable from anywhere on the body surface (Rohracker, 1958) it is an integral aspect of all physical contact with the human body. The importance of physical contact in early mother-infant interaction has been emphasized by several investigators. Kulka, Fry and Goldstein (1960) hypothesized that infants have a *need* for kinesthetic stimulation. They based this hypothesis on the results of clinical case studies of children who were deprived of contact as well as on a review of relevant research literature. Gordon and Foss (1966) and Ourth and Brown (1961) systematically studied the relationship between kinesthetic-tactile stimulation and the infant's crying behavior.

Handling was found to significantly reduce the amount of crying. Korner & Grobstein (1966) reported that handling alone is not as effective in fostering visual scanning as is placing the infant on one's shoulder. Schaffer and Emerson (1964) found individual differences among both infants and mothers with respect to their desire for either cuddling or handling. Though they report that all infants seemed to enjoy being swung through the air and touched during haptically stimulating games, some infants actively resisted any cuddling which was physically restraining. Other infants actively sought cuddling contact. Moreover, handling and non-handling mothers differed in this desire for close physical contact with their infants.

Fitzgerald and McKinney (1970) discuss this research in the context of an infant's general need for sensory stimulation. They point out that when an infant is handled it is nearly always a case of multiple sensory modality involvement. Nevertheless, strong evidence for the importance of tactile and tactile-kinesthetic stimulation may be found in Harlow's (1959) research. Harlow studied the behavior of young rhesus monkeys and demonstrated that monkeys show an early preference for a terry-towel-covered wire surrogate mother as opposed to the wire-only surrogate. This preference held up even when monkeys were fed at the wire-only surrogate. In another situation, monkeys were given a choice between a rocking and a stable terry-towel-covered "mother." They consistently preferred the rocking "mother." Kessen and Mandler (1961) discuss the pacifying effects of rocking in terms of the importance of kinesthetic stimulation as an inhibitor of distress behavior. They suggested that an investigation of the relationship between this rhythmic activity and the infants' visceral rhythms might lead to an increased understanding of the effects of this stimulation.

If LT amplitude is large enough to be perceived by an infant, it might play an important role in mother-infant contact situations. If it is large enough, LT could give the infant a cue to the caretaker's level of stress, bodily tension, emotionality, anxiety, and perhaps even a cue to his sex.

The amplitude of tremor has been reported to vary with both stimulus and subject variables that may be important ingredients of the caretaker-infant relationship. Nevertheless, the results of LT studies are difficult to apply to caretaker-infant relationships for at least three reasons. First, in these studies, LT amplitudes were measured with transducer systems which fail to provide a reasonable approximation of the tremor magnitude which would impinge on an infant being held. For example, it is very unreasonable to generalize from the magnitude of LT recorded from the second joint on the middle finger by a 2.5 gram accelerometer to a situation where the infant weighs five or more pounds and is cradled in the arms. In this study a transducer shaped and weighted to be slightly smaller than 90% of newborn infants will be used so that the results will more readily apply to the infant-adult relationship. Since LT amplitude is larger for larger weights, the tremors impinging on infants should be larger than those recorded by this transducer.

Second, results of previous LT studies were reported in terms which cannot be compared to perceptual thresholds for this type of stimulation. The perceptual thresholds for vibratory stimulation are reported in terms of maximum acceleration while most of the tremor differences are reported in terms of number of "significant disturbances" in the tremor record. By using an accelerometer to measure tremor and by scoring the output peak-by-peak, the results of this study will be reported in terms of maximum acceleration.

Third, the stimulus situations used to create stress in these studies are not at all likely to be encountered by a parent or caretaker holding an infant. One just does not have his voice recorded, delayed slightly, and fed back to him in any situation in which he would be holding a baby. It would seem, however, that a person holding a baby might encounter a socially stressful situation. For example, it would be more relevant to investigate LT responses to antagonistic and neutral communication from another person. At the same time, it is very difficult to maintain stimulus consistency from S to S. As a compromise between these two considerations a video tape of an actor speaking in these two modes will be presented to Ss on a TV monitor. He will speak antagonistically in one series of vignettes to create the socially stressful situation. He will speak neutrally in another series of vignettes to create the neutral or less stressful condition. Each condition will be presented to one group of male S's and one group of female S's. To more effectively relate the findings of this study to the interaction situation, S's will be asked to compare the degree of threat they experience in this situation to a similar but real situation.

Specific Purposes of the Present Study

This experiment was designed, therefore, to examine the following questions concerning LT: What is the general range of the magnitude of tremors which would be impinging on an infant being held by S in this experimental situation? Are there sex differences in LT amplitude? If so, how large are they and can they be ascribed solely to the influence of differences in physical size? Does tremor increase over time and, if so, what is the magnitude of that increase? Does inhibition of LT amplitude occur when S is attending to the stimulus? If so, what is the magnitude of that inhibition? Is this inhibition in any way related to performance on an attention demanding task? Are there differences between the socially stressful and socially neutral stimulus conditions in either the pattern or magnitude of LT response? What is the relationship between this experimental situation and a real life situation in terms of S's judgment of his level of experience of threat?

METHOD

Subjects

Subjects were volunteers from introductory psychology classes at Michigan State University. Twenty males and twenty females received course credit for their participation. There were four experimental groups with 10 Ss per group. One group of 10 males and one group of 10 females received stimuli judged to be antagonistic (i.e., stressful); while the other two groups received stimuli judged to be neutral (i.e., not stressful).

Apparatus

The stimulus situations were constructed to confront S with two different types of social interaction using Bales categories (1950) as the models. In one situation S was confronted with antagonistic hostile communication (Bales category 12). In the other situation S received emotionally neutral informational communication (Bales category 6). To maintain stimulus consistency from one S to the next, the social settings were recorded and presented via video tapes. If differences in response to the televised situations could be shown, it would be reasonable to infer that differences in the real situation will be larger.

To examine further the relationship between stimulus situations and S's response to "real life" situations, a questionnaire was administered. Subjects were asked to rate their degree of involvement with the actor, the degree to which they were threatened by the actor, and the degree to which they were tense because of the expermimental situation as a whole. Subjects were asked to make judgments concerning the degree of threat in comparison with a similar but real social situation. The questionnaire also asked for information concerning Ss weight and height (See Appendix A).

The vignettes were recorded on Scotch brand one-inch video tapes and were presented to S on an RCA 23 inch television monitor. The tapes were played on an Ampex AR5100 video tape recorder. Hostile vignettes averaged 31.8 words per vignette, while neutral vignettes averaged 52.8 words per vignette (The full monologue is in Appendix B). The loudness range of the hostile vignette was judged to be somewhat larger than the range of the neutral vignettes.

The accelerometer was a Kistler Model 305T Servo Accelerometer. It had its own pre-amplifier (Kistler Model 515T). The output from the pre-amplifier was recorded on a Beckman type RS dynograph. AC-DC couplers were used to permit recording of a wide band of acceleration (from .001 gs to .4 gs). A 1 sec. time constant was employed in order to enhance the accuracy of measurement of full tremor cycles.

The size and shape of the accelerometer affects the amplitude of tremor in three ways: by its weight, by its shape, and by its resonance frequency. The weight and shape of the transducer selected for use in this study was appropriate for measuring the general range of tremor as it applies to the physical contact relationship between an adult and an infant.

A real infant could not be used as part of the measurement transducer for evaluating the impingement characteristics of tremor because an infant has LT of his own--he breathes and, whether asleep or awake, he moves. Since movement appears as artifact on the dynagraphy, the impingement characteristics of tremor would be confounded with a live infant. A metal container was used so that the resonance frequency of the transducer would not interact with the low frequency of LT. The container was the general shape and approximate size of an infant to enable S to hold it in a similiar position and with the same type of muscle effort required to hold a real infant.

The metal cylinder was a single 18-inch section of Sears 10-inch diameter galvanized steel stove pipe. Extra weight was added by bolting lead weights in the cylinder so that the transducer weighted 5 3/4 pounds. The cylinder was modified to provide S a more realistic holding posture by cutting it in half for one-third of its length. The accelerometer was mounted on the inside surface of the cylinder (see Figure 1). The accelerometer was located in the approximate position of the infant's left vestibular organ. The size proportions of the cylinder were based on those reported by Breckenridge and Murphy (1958, p. 139) and applied to the dimensions reported by Smart and Smart (1967, p. 98-101) to be smaller than 90% of newborns. By using these dimensions, all tremors measured were smaller than those impinging on 90% of newborn infants. That is, if this small transducer was sensitive enough to record changes in tremor amplitudes, one could be certain such changes were greater than those impinging on 90% of newborn infants.

Procedure

The subject was seated in the experimental room facing the TV monitor. Room temperature was maintained at approximately 72°F. After handing S the cylinder, the experimentor (E) demonstrated the proper holding posture. The cylinder was held by placing the uncut end housing the accelerometer, in the crook of S's left elbow so that his left arm fully supported the back of the cylinder. To minimize movement artifacts attributable to the right hand, This is to certify that the

thesis entitled

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presented by

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has been accepted towards fulfillment
of the requirements for

Ph. D. degree in PSYCHOLOGY

Hiram E. Fitzgerald
Major professor

Date 11/12/71

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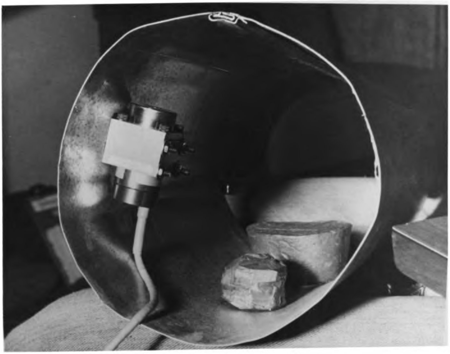
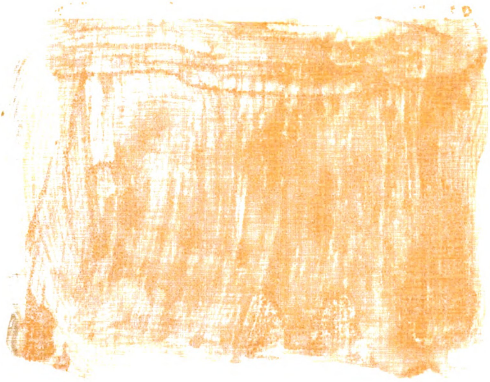


Figure 1. Picture of the accelerometer mounted in the modified stove pipe.



it was placed on top of S's left hand. Subject was then given the remaining instructions (see Appendix C), and asked to stand until instructed to relax. The lights were dimmed to reduce irrelevant stimulation, and E left the room. The equipment was calibrated and then S was instructed to sit and relax for fifteen minutes. After the relaxation period, S was instructed to stand and hold the cylinder as he had been shown and to watch the television monitor. After fifty-seven seconds the video tape was presented. Each tape had 5 thirty second attention periods (actor on screen) with a thirty second rest period (screen blank) between each scene. After the tape finished, S remained standing for five minutes, after which a final sample was taken. Then E returned to the experimental room, took the cylinder from S and brought him to the equipment room to fill out the questionnaire.

The subject's forearm was measured for both length and circumference. Forearm length was determined by measuring from the medial humeral epicondyle to the styloid process of the radius as suggested by Lippold (1967). Forearm circumference was measured around a point one-third of the distance from the epicondyle to the styloid process.

Quantification of the Data

Each subject's record was broken down into five vignettes. Each vignette was divided into 2 thirty second periods--attention and rest (Figure 2). Thirty peaks were scored beginning with the first, fourteenth, and twenty-seventh second of each period. Since there is an average of ten peaks per second, a sample of approximately one-third of each period was scored. There were five vignettes for each S, two periods per vignette, and three samples of thirty peaks for each period, so that there were nine hundred data points for each S. Since computer capacity is limited, the mean of each 30 peak sample was computed for the analysis of variance. In addition to these measures, samples before and after the fifteen minute relaxation period and at the end of a final five minute rest period were taken and used in a separate analysis to evaluate change in base level over the experiment.

A peak was defined as at least a one millimeter reversal in the direction of pen deflection. A peak was scored as the total number of millimeters of pen deflection from the reversal point near the bottom of the chart paper (the trough) to the first reversal point near the top of the chart paper (the peak) (Figure 3). The pre-study showed that this method yields thirty scorable peaks between 2.8 and 3.2 seconds. This corresponds to the 5-15 Hz frequency of LT reported in other studies.

The recording equipment was calibrated so that one millimeter of deflection occurred for each .001 g change in acceleration. This method of scoring allows one to get

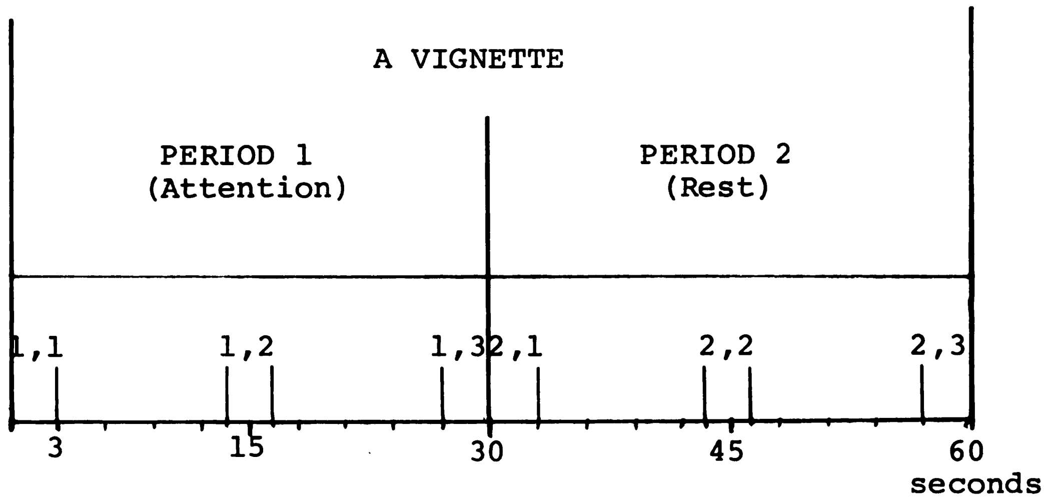


Figure 2. The location of the samples in the attention and rest periods as a function of time.

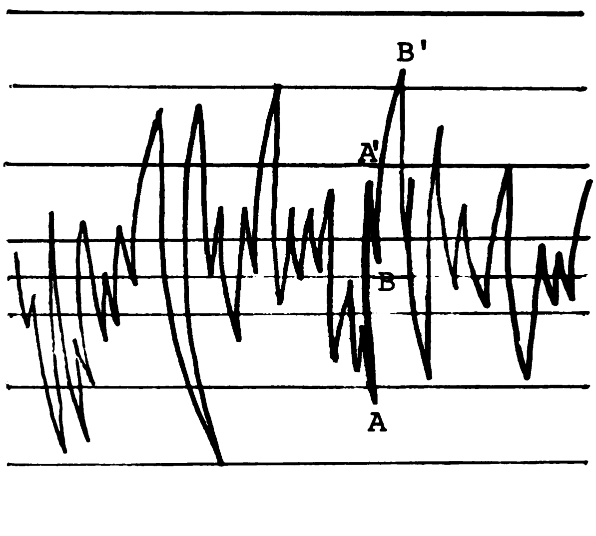


Figure 3. A sample of the dynograph record of tremor highlighting two scorable peaks: peak (A, A') = 26 mm; peak (B, B') = 25 mm.

an approximation of the maximum acceleration during the cycle by dividing the number of .001 gs by two. Thus:

$$\text{maximum acceleration} = \frac{\text{millimeters of deflection (.001 gs)}}{2}$$

This approximation can then be related to the threshold for human perception of whole body vibration. This threshold is reported to be about .002 gs for vibrations in the frequency range of tremor (Cope, 1963; Guignard, 1965; Soliman, 1968).

Because individual subject base level differences could mask the effects of the stimulus conditions, a measure of change during each trial was computed. This measure was derived by subtracting the mean of sample 11 from the mean of sample 23 for each subject during each trial (Figure 2). These difference scores were analyzed separately in a change during trials analysis of variance.

Scores were derived for each subject for degree of threat, involvement and tenseness from his responses to the questionnaire. The degree of threat score was derived from question nine by summing S's responses to each of the five vignettes. Each vignette was judged on a seven point scale from much more threatening (1) to much less threatening (7) than the same situation would be with a real person speaking to him. A total score of thirty-five would be the least threatening experience score possible. Each subject's score was divided by thirty-five and transformed using the arcsine transformation suggested by Winer (1962) for proportions. These scores along with the degree-of-involvement-score and the degree-of-tenseness-score are presented in Table 5 (see Appendix D). Memory scores were derived by giving S one point for each vignette he remembered and a second point if the vignette were in the correct position.

RESULTS

Overall Means

The mean level of maximum acceleration in this study was .006 gs. This is three times as large as the known minimum threshold for human perception of vibration at frequencies similar to LT.

Males had a higher mean level of maximum acceleration (.0060 gs) than females (.0048 gs) [$F(1,36) = 5.98$ $p < .05$ (Table 1)]. This represents a difference of more than .001 gs. There were no significant mean differences or interaction effects involving sex as a variable. This simple difference in mean amplitude of tremor is similar

Table 1. Analysis of variance summary table for overall mean tremor magnitude.

Source	df	MS	F
Sex (A)	1	1702.6545	5.98*
Condition (B)	1	7.0912	0.02
AB	1	26.4167	0.09
Error	36	284.8933	
Trials (C)	4	495.1142	25.39***
AC	4	2.4143	0.12
BC	4	20.3029	1.04
ABC	4	30.4488	1.56
Error	144	19.4972	

Table 1--continued.

Source	df	MS	F
Period (D)	1	438.7497	29.12***
AD	1	0.1603	0.01
BD	1	4.7445	0.31
ABD	1	0.0141	0.00
Error	36	15.0685	
Sample (E)	2	117.8465	11.5136***
AE	2	2.8860	0.2820
BE	2	9.5932	0.9373
ABE	2	3.1530	0.3081
Error	72	10.2354	
DE	2	58.5887	6.23**
ADE	2	21.4033	2.27
BDE	2	6.6725	0.71
ABDE	2	21.5694	2.29
Error	72	9.4108	
CD	4	21.1012	1.8652
ACD	4	4.9239	0.4352
BCD	4	6.5277	0.5770
ABCD	4	5.1260	0.4531
Error	144	11.3132	
CE	8	11.6744	1.23
ACE	8	8.7659	0.93
BCE	8	9.1219	0.96
Error	288	9.4561	
CDE	8	7.9976	0.79
ACDE	8	11.1650	1.11
BCDE	8	2.9317	0.29
ABCDE	8	5.3480	0.53
Error	288	10.0262	
Total	1,199		

*p < .05

**p < .01

***p < .0005

to that reported by Williams (1967). He attributed this sex difference solely to the larger physical size of males.

To examine the relationship between physical size and LT a series of Pearson product moment correlation coefficients was computed between various physical measurements of S's and their mean tremor level. These correlations are presented in Table 2. Forearm length was the sole variable to be significantly correlated with mean tremor level. Moreover, the effect holds only for male Ss (.52 $p < .05$). Although the correlation between

Table 2. Matrix of Pearson product moment correlation coefficients for the relationship between physical size and mean tremor magnitude.

	Mean	Height	Weight	Arm Length	Arm Circumference
Male					
Mean	1.00				
Height	.42	1.00			
Weight	.21	.58**	1.00		
Arm length	.52*	.77***	.61**	1.00	
Arm circumference	-.03	.20	.39	.35	1.00
Female					
Mean	1.00				
Height	.09	1.00			
Weight	.09	.28	1.00		
Arm length	.34	.54**	.58**	1.00	
Arm circumference	.04	.00	.81***	.27	1.00

*$p < .05$

**$p < .01$

***$p < .0005$

forearm length and mean tremor level for females was in the same direction ($r = .39$), it was not significant. It is important to point out that the correlations between arm circumference and mean tremor level were very near zero (-.03 for males and .04 for females).

As indicated in Figure 4, one can see that there was almost a linear increase in the mean level of tremor across trials. The mean from the first trial was .0045 gs and the mean for the fifth trial was .0063 gs indicating a change of almost .002 gs over the five trials. These over trial differences were significant at the .0005 level [$F(4,144) = 25.39$ (Table 1)].

The mean LT amplitude during the period of attention to the actor on the screen was lower (.0050 gs) than the mean during the rest period (.0057 gs) [$F(1,36) = 29.12$, $p < .0005$ (Table 1)]. There was a significant effect due to samples [$F(3,72) = 11.51$, $p < .0005$ (Table 1)] and a significant interaction between periods and samples [$F(2,72) = 6.23$, $p < .003$ (Table 1)]. From the graph of the means of this interaction shown in Figure 5, it is clear that the means of the first four samples were lower than those of the last two samples. One way of looking at these results is that the inhibition during the attention period does not attain its full release until sometime after the first 3 seconds of the rest period. By the last

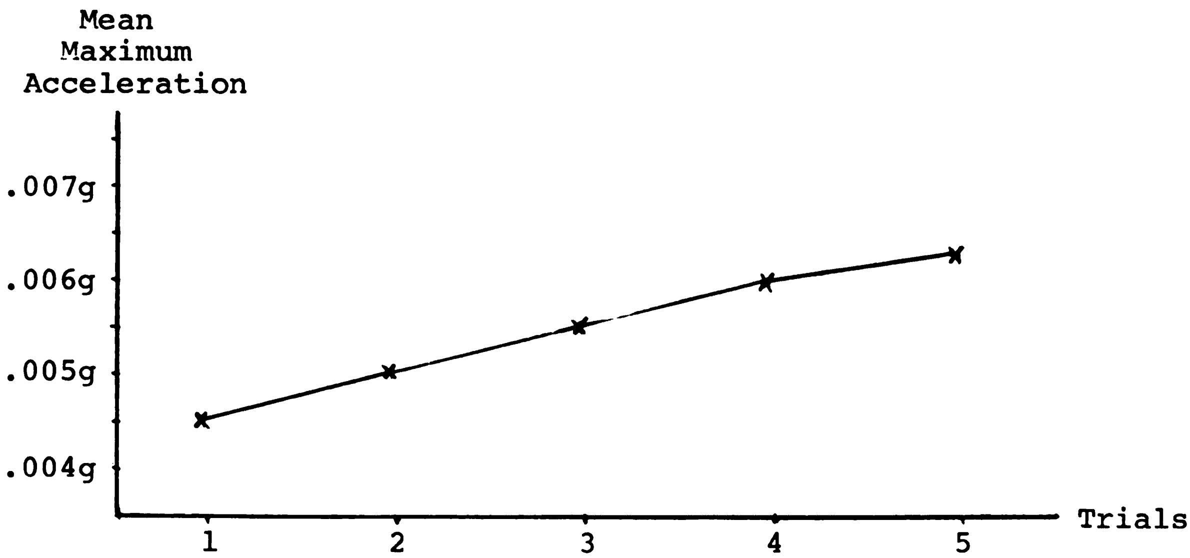


Figure 4. Mean limb tremor magnitude as a function of the five trials.

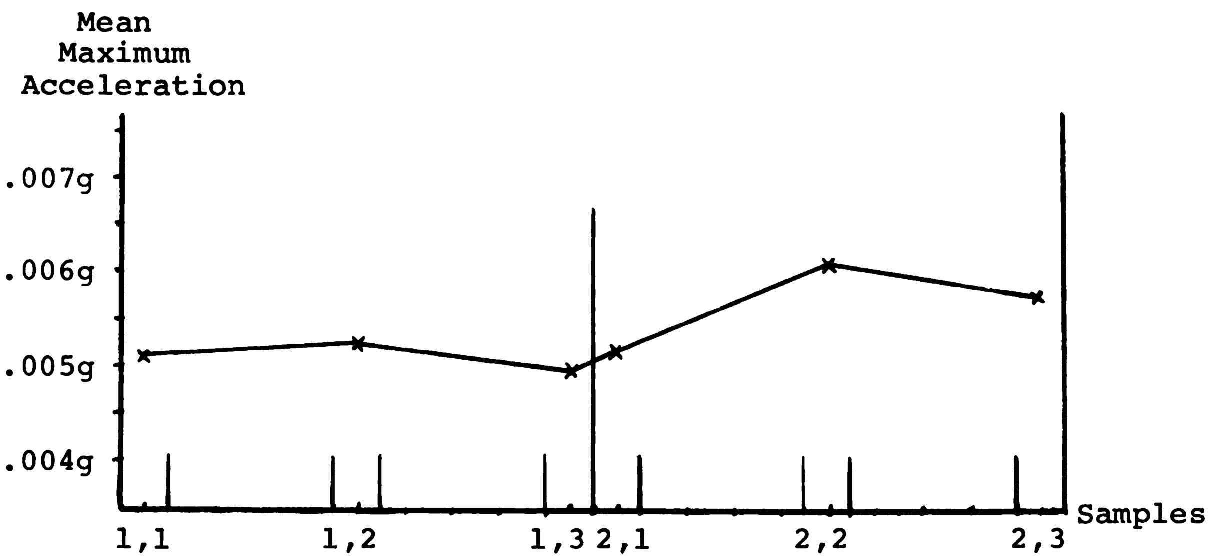


Figure 5. Mean limb tremor magnitude as a function of periods and samples.

3 seconds of this period it may be fully released and moving in a downward trend.

To examine further the relationship between inhibition and attention a Pearson product moment correlation was computed between mean period difference scores and mean scores on an attention demanding task. Each S was tested for memory of the content of the vignettes presented to him. The mean inhibition scores were computed by subtracting the mean of the attention period from the mean of the rest period. The correlation coefficient between mean attentional score and mean memory score was .42 [$p < .01$ (see Table 5, Appendix D)]. This significant positive correlation between inhibition of tremor amplitude and performance on an attention demanding task is strong support for the attentional character of the limb tremor response.

Because the relationship between tremor inhibition performance on an attention demanding task seemed to be similar to Porges's (1970) tonic component of attention, further examination for a phasic component of attention seemed justified. To examine for this component an indicator of phasic response was derived by subtracting the mean of the sample just after vignette onset from the mean of the sample just before trial onset. The correlation between this mean phasic response and performance was not significant (.25, $p > .05$). Since it is difficult to tell the direction of this phasic change from sample (2,3) in one trial to sample (1,1) of the next trial, the mean peak-by-peak graph of the last 10 peaks of the sample (2,3) before vignette outset and the full 30 peaks of the sample (1,1) after vignette onset is presented in Figure 6. One can see that there is a general decrease in mean tremor level during the first thirty peaks after vignette onset.

Differences Between Stimulus Conditions

To examine differences between groups in response to the hostile and the neutral vignettes, means were computed for change in mean tremor level during a trial. The mean change over an average trial for the hostile condition was .001 gs while the mean change for the neutral group was only .0004 gs [$F(1,36) = 4.85$ $p < .04$ (Table 3)]. The graph in Figure 7 shows that the sample means straddle one another. That is, the hostile group is somewhat lower during sample (1,1) and somewhat higher during sample (2,3) than the neutral group. Perhaps this greater mean change during a trial for _Ss_ in the hostile condition represents a combination of slightly more inhibition during sample (1,1) due to attentiveness and slightly more excitation during sample (2,3) due to increased response to the vignette.

A questionnaire was administered at the end of the experimental session in order to ascertain _S_'s judgment

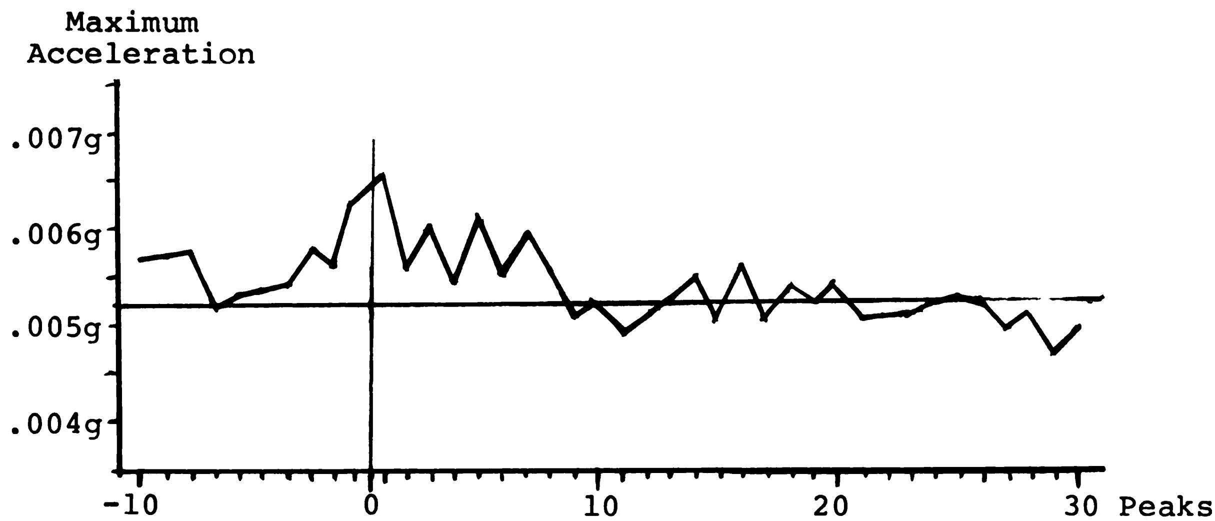


Figure 6. Mean limb tremor magnitude as a function of peak during trial onset.

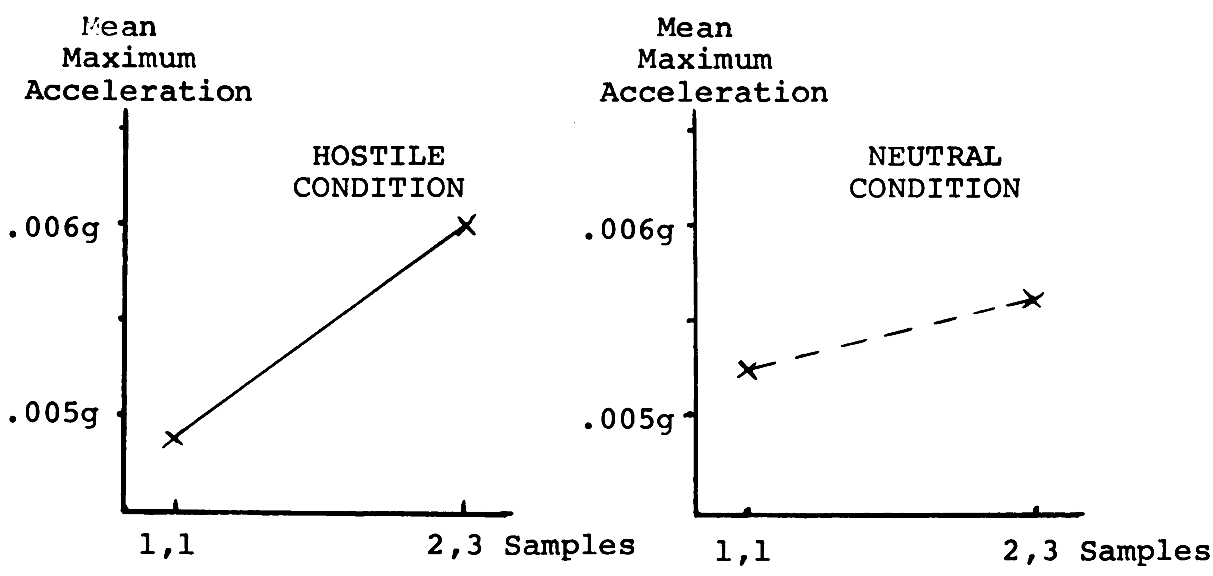


Figure 7. Mean limb tremor magnitude as a function of change during a trial.

Table 3. Analysis of variance summary table for mean change during a trial.

Source	df	MS	F
Sex (A)	1	10.9748	0.78
Condition (B)	1	68.1353	4.85*
AB	1	11.3020	0.80
Error	36	14.0448	
Trial (C)	4	28.8877	1.62
AC	4	29.5316	1.66
BC	4	6.8419	0.38
ABC	4	9.9665	0.56
Error	144	17.8244	
Total	199		

*p < .05

of his experience during the situation. The results of this questionnaire are presented in Table 5. Males in the hostile condition and females in the neutral condition had mean scores (29.3 and 30.1 respectively) showing less experienced threat than the other two groups (26.5 and 26.5 respectively) [$F(1,36) = 4.39$, $p < .05$ (Table 4)]. Even the groups which experienced the situation to be most threatening, judged the situation to be only equally as threatening as having a real person talking with them.

The important thing to note is that experienced threat differences did not correspond with stimulus tape differences. The differences in LT response to the hostile and neutral video taped vignettes does not correspond to

Table 4. Analysis of variance summary table for mean level of experienced threat

Source	df	MS	F
Sex (A)	1	0.0067	0.02
Condition (B)	1	.1032	0.37
AB	1	1.2060	4.36*
Error	36	.2763	
Total	39		

*$p < .05$

the experience of threat differences as reported in the questionnaire. This lack of correspondence between physiological response to hostility and report of experienced threat would be expected if one hypothesized that American males in this age group were reluctant to admit being threatened or upset.

DISCUSSION

By using an accelerometer to measure tremor and by scoring the output peak by peak, this study examined limb tremor activity in a complex stimulus situation. Not only has the general pattern of tremor response been examined but the magnitude of the response pattern has also been reported. Because of this detailed examination the findings of this study have implications for several different areas of scientific investigations.

The significant sex differences found in this study support the findings of Williams (1964). Males in both studies showed significantly larger mean tremor amplitude. Williams hypothesized that the larger size of the contributing muscles of the males would impart more energy to the limb. If the energy characteristics of the contributing muscles were responsible for the larger tremor one would expect the circumference of the forearm to be most related to mean tremor level. However, mean tremor level and forearm circumference were not significantly related in the present study. An alternative hypothesis is that the limb acts as a lever such that the longer the limb the greater the amplification of energy. This hypothesis receives support in male _S_s in that forearm length and mean tremor level were significantly correlated. Nevertheless, the significant correlations for male Ss account for only 25% of the variance in mean tremor level. Since there was no significant relationship between forearm length and mean tremor level for female Ss, there is a real possibility that physical size is only one of several variables contributing to the obtained differences in mean tremor level.

Though this study shows that males have a somewhat larger tremor than females, there is no indication that the pattern of response is any different for the sexes. The lack of pattern differences is in clear contrast to those reported by Grossman et al. (1971) in a reaction time study. Grossman et al. suggested that sex differences in muscle response pattern might decrease as the task demands for rapid, almost reflexive, motor response decreased. The results of the present study support the contention in that sex differences in the pattern of muscular response were not evident.

The increase in tremor level over time is consistant with Lippold's (1967) findings with electromyographic recordings of muscle activity. Lippold offered a two fold explanation for this increase over time: First, individual muscle units require a larger potential to maintain a constant state of tension; and second, more muscle units must be activated as each single unit is able to do less work. The increase in tremor over trials found in this study would tend to support Lippold's second explaination since larger tremors should occur as more and more units fire synchronously. It is, of course, not possible in the present study to assess the extent to which viewing the vignettes influenced tremor over time.

The significant difference between the attention and rest periods provides additional support for a somatic inhibition model of attention (Obrist _et al._, 1970). This is especially strong support because the periods difference is significantly related to performance on the attention demanding task of memory. Because there are significant interaction effects between periods and samples, it is important to exercise caution in taking an over-simplified view of this inhibitory process. There was consistent variation in mean tremor level over relatively short periods of time. The lower and nonsignificant correlation between the phasic component and performance on the attention demanding task makes this caution even more emphatic. The findings of this study also support the more complex two-component model of attention suggested by Porges (1970), as well as the theories of somatic responsivity advanced by Jacobson (1927) and Freeman (1948).

It is important to note the clear distinction between the stimulus variables and the response variables employed in the present study. The hostile vignettes were judged by _E_ to be negative evaluations of _S_ by the actor.

The neutral vignettes were judged to be informational acts to S. Moreover, there were quantitative differences between the vignettes with the hostile vignettes having fewer words per vignette and a somewhat higher maximum noise level than the neutral vignettes. The significant effect due to the conditions factor in the "change during a trial" analysis must be viewed as response associated with these judged and quantitative differences. These LT response differences do not correspond with significant differences in experience threat level reported by S's. These differences between report of experienced threat and existence of physiological response would be readily explained if one accepted the hypothesis that American males in this age group are reluctant to admit being upset or threatened.

It is also important to note that the significant effect due to the tape differences is the mean change in tremor level over a trial and not simply a difference in overall mean level. This mean change difference may represent a combination of response differences. Perhaps it can be best understood as a function of both slightly more attention to the hostile vignettes as well as a slightly greater physiological response to the hostile content of the vignettes.

Implications for the Tactile-Kinesthetic Contact Between an Infant and his Caretaker

The magnitude of tremor found in this study makes LT a prime candidate for a role in the physical contact relationship between an infant and his parents or primary caretaker. But there is a very real question to explore: Is an infant capable of perceiving and responding differentially to differences in LT magnitude of the order obtained in the present study? Considering the potential importance of physical contact and handling during early human development the above question appears worthy of intensive investigation. The results of the present study clearly suggest that body tremor may play an important role in such contact experiences.

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APPENDICES

APPENDIX A

QUESTIONNAIRE

1. Sex 1 2

2. Condition 1 2

3. Weight

4. Height

5. Arm length

6. Arm circumference

7. Were you able to become involved with the person on the screen?

    Yes _____ No _____

    Comment:

8. You have been shown five scenes. Try to recall as many of them as possible and write one or two sentence descriptions of each.

    Scene 1:

    Scene 2:

    Scene 3:

    Scene 4:

    Scene 5:

9. Did you experience any of the scenes as threatening?

    Yes _____ No _____

    If so, which ones?

    Scene 1, 2, 3, 4, 5

How threatening compared to having a real person in the room?

1) much more threatening than a real person
2) more threatening than a real person
3) somewhat more threatening than a real person
4) equally as threatening as a real person
5) somewhat less threatening than a real person
6) less threatening than a real person
7) much less threatening than a real person

Scene 1	1	:	2	:	3	:	4	:	5	:	6	:	7
2	1	:	2	:	3	:	4	:	5	:	6	:	7
3	1	:	2	:	3	:	4	:	5	:	6	:	7
4	1	:	2	:	3	:	4	:	5	:	6	:	7
5	1	:	2	:	3	:	4	:	5	:	6	:	7

10. Did you feel yourself to be nervous or tense in this situation?

Yes _____ No _____

If so, how nervous were you compared to being in a conversation with a stranger?

1) much more nervous
2) more nervous
3) somewhat more nervous
4) equally nervous
5) somewhat less nervous
6) less nervous
7) much less nervous

11. What, in your opinion, was the purpose of this experiment?

APPENDIX B

TEXT OF HOSTILE VIGNETTES

1

Well, I've listened
And I don't like your ideas one damn bit.
I think I would like to come right across this table
and punch you right in the mouth.

2

You are so God damn stupid.
You may fool those clowns around you
but you don't fool me.

3

(Laugh) I know you're trying to use me.
(Laugh) It shows. It shows all over you.

4

Ah...you son-of-a-bitch
Somebody ought to just kick your face right in.
Honest to God
I'd just like to....
Oh, oh get away from me
Get away from me before I clobber the shit right out of you.
Get out of here
Get out

5

You know, I don't very often say this to someone
right across the table, you know.
But ah, I'm afraid I just don't like you very much.
I don't know what it is, but you upset me.
Nothing personal about it, but I just don't like being
around you.

TEXT OF INFORMATIONAL VIGNETTES

1

Any student who's learning a musical instrument will become disinterested or bored if all of his teaching and practice sessions are devoted solely to music theory. I believe it is necessary to intersperse ah contemporary techniques and styles in order to maintain the students' level of interest.

2

One way to maintain a high level of student interest is to teach the student what he is most interested in learning. Most students have an idol whom they would like to pattern their music after. Even before music theory the new student could be introduced to basic chord patterns and techniques consistent with the style of music he wishes to learn.

3

Once the student has reached a satisfactory level of proficiency at a song he has chosen to learn, his accomplishment will provide the incentive for him to learn more. Hopefully, from this experience he will recognize the need he has for training in music theory to help him to learn new songs faster and more efficiently.

4

Although it can be argued that teaching a student to play by ear can be detrimental to the development as a musician, I feel that the benefits to be gained from maintaining a high level of interest, and maintaining a continued positive reinforcement from learning styles and techniques far outweigh the possible negative results.

5

Beginning music students often find their dreams of becoming a musician suppressed because the mechanics of music theory are forced on them. Less emphasis on these untimely rudiments and more emphasis on contemporary styles and techniques can insure a student's continued interest in music.

APPENDIX C

INSTRUCTIONS

I am going to show you some scenes on this TV. While you are watching I want you to hold this cylinder. How does it feel? It is important that you make no unnecessary movements of the cylinder.

I would like to assure you that there will be no electro-shock in this experiment. The only things involved are this cylinder and this TV. Please watch the screen at all times during the experiment. In a few minutes a person will appear on the screen. Try to view him as if he is in this room with you, speaking to you, and that he means what he says to you. It is easier to do this if you look directly at his eyes. Listen carefully to what he says. At the end of the experiment you will be tested to see how carefully you were paying attention. In a moment I will turn out the overhead lights and leave the room. After a few minutes I will ask you, over the intercom, to be seated for a fifteen minute relaxation period. During this period I would like you to rest the cylinder on your lap, close your eyes and allow yourself to relax. At the end of that period I will ask you to stand up and hold the cylinder the way you are holding it now. Several scenes will be shown to you and the screen will be blank before and after each scene. I will tell you, over the intercom, when it is okay to sit down. At that time I will come back into the room to set the cylinder on the floor for you. Are there any questions?

Once again, try to get as involved as possible with the person on the TV and make no unnecessary movements of the cylinder.

APPENDIX D

Table 5. Questionnaire results.

Subjects		HT	WT	FL	FC	MT	ME	MP D	MCD T	T	I	N
	1	72"	160	13.0"	10.0"	21.3mm	06	13.0mm	6.01mm	28	NO	5
	2	70"	130	11.5"	09.0"	13.5mm	05	-1.6mm	2.23mm	35	YES	7
	3	69"	150	12.0"	10.8"	13.8mm	10	08.7mm	4.31mm	24	YES	4
	4	68"	162	11.5"	10.3"	08.4mm	07	02.2mm	0.90mm	35	NO	7
Male	5	71"	183	13.5"	11.0"	08.0mm	10	08.6mm	4.03mm	34	NO	7
Stress	6	68"	142	11.0"	11.0"	09.4mm	08	00.4mm	-.37mm	22	YES	5
	7	74"	205	13.0"	11.8"	16.1mm	02	-4.6mm	1.00mm	30	YES	1
	8	71"	150	12.0"	09.8"	10.1mm	07	02.9mm	.45mm	26	NO	7
	9	67"	168	12.0"	10.5"	09.5mm	08	06.6mm	2.26mm	35	YES	7
	10	69"	159	11.5"	10.5"	10.0mm	07	03.2mm	4.18mm	24	YES	4
	1	74"	162	13.5"	11.0"	13.0mm	08	04.4mm	2.99mm	24	YES	7
	2	72"	187	13.0"	11.0"	10.1mm	08	03.9mm	.26mm	18	YES	2
	3	73"	215	13.0"	12.0"	18.1mm	04	08.6mm	4.40mm	31	NO	7
	4	70"	160	12.0"	10.8"	08.7mm	05	04.7mm	1.03mm	19	YES	7
Male	5	72"	185	13.5"	11.5"	12.5mm	05	06.7mm	1.37mm	30	YES	5
Neutral	6	71"	185	12.0"	10.5"	06.0mm	02	-2.1mm	-.79mm	35	NO	7
	7	69"	165	12.0"	10.5"	15.1mm	04	07.1m-	2.25mm	33	NO	6
	8	69"	142	12.0"	10.0"	12.5mm	10	04.8mm	1.35mm	30	NO	6
	9	72"	175	12.0"	11.0"	13.9mm	07	-0.5mm	.29mm	33	YES	7
	10	73"	170	12.0"	10.5"	08.7mm	02	00.2mm	-.05mm	13	NO	3
	1	66"	130	11.0"	09.5"	08.9mm	05	01.1mm	.97mm	30	NO	5
	2	69"	250	13.0"	12.0"	10.7mm	07	08.3mm	1.57mm	26	YES	3
	3	66"	135	11.0"	09.5"	09.9mm	07	00.3mm	.27mm	27	NO	7
	4	64"	120	11.0"	09.0"	10.5mm	01	-0.6mm	1.46mm	18	YES	5
Female	5	67"	117	11.0"	09.0"	11.8mm	06	04.2mm	2.14mm	22	YES	3
Stress	6	54"	135	11.0"	09.5"	09.3mm	07	-0.8mm	.44mm	22	YES	3
	7	63"	140	11.0"	10.0"	09.3mm	10	14.2mm	1.13mm	34	YES	7
	8	68"	120	12.0"	08.3"	06.5mm	08	03.1mm	1.76mm	25	NO	7
	9	70"	145	12.0"	09.0"	09.9mm	10	07.6mm	4.76mm	31	NO	7
	10	60"	115	09.0"	09.0"	06.5mm	06	03.0mm	1.05mm	29	YES	6
	1	67"	115	10.0"	09.0"	08.2mm	07	04.5mm	-.34mm	25	NO	7
	2	63"	135	11.0"	10.0"	13.9mm	03	05.2mm	4.31mm	35	YES	2
	3	64"	112	10.5"	08.5"	09.2mm	05	02.7mm	.59mm	35	YES	5
	4	68"	108	12.0"	07.5"	12.0mm	06	-0.1mm	.67mm	35	YES	7
Female	5	63"	112	10.5"	08.3"	11.5mm	04	06.3mm	.88mm	26	YES	5
Neutral	6	68"	140	11.0"	09.8"	07.4mm	06	06.6mm	.68mm	35	YES	7
	7	62"	115	11.3"	09.0"	07.3mm	05	00.6mm	-.31mm	30	YES	6
	8	64"	117	10.0"	08.3"	09.1mm	10	-0.5mm	-.51mm	35	YES	7
	9	67"	127	11.0"	08.0"	10.9mm	06	24.9mm	1.48mm	20	NO	3
	10	67"	165	11.0"	09.0"	08.3mm	07	10.3mm	1.21mm	25	YES	1

Key

HT = Height in inches
WT = Weight in pounds
FL = Forearm Length in inches
FC = Forearm Length in inches
MT = Mean Tremor in millimeters of pen deflection
ME = Memory score

MPD = Mean Period Difference score in millimeter of pen deflection
MCDT = Mean Change During a Trial
T = Total threat score
I = Involvement score
N = Nervousness score