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Reactivity to heteromodel stimulation and the modulation of excitation.

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REACTIVITY TO HETEROMODAL STIMULATION AND THE MODULATION OF EXCITATION

A Thesis Presented

by

Robert B. Alexander

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ABSTRACT

Reactivity to Heteromodal Stimulation and the Modulation of Reactivity

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A review of the psychological literature found a number of studies which reported that reactivity to a test stimulus can be facilitated or inhibited by simultaneous stimulation, depending upon the intensity of stimulation. Physiological studies have shown that cortical excitability is influenced by the reticular activating system. These findings may relate to the findings of two studies that directly led to this one. Both of these studies measured autonomic reactivity to simultaneous light and noise stimulation of 0.5 second duration and of moderate to high intensities. The findings of both studies were that reactivity to both sensory modes were additive for moderate intensities, but that reactivity to the most intense stimulus combination was reduced relative to stimulus combinations of slightly less intensity. The present study attempted to replicate this finding using 0.08 second duration noise and 0.001 second duration light stimulation in order to control for eyeblinks and to

determine whether the inhibitory effect was a quick-acting lower brain reflex. Forty-eight subjects were presented with simultaneous noise and light, each of four intensities spaced at ten decibels intervals. Sixty-four light and noise combinations were presented, using a repeated measures design of four blocks of sixteen random noise and light combinations in a Latin Square Design. Results were that stimulation of the two sensory modes produced additive effects upon the skin conductance response. No inhibitory heteromodal effects were found. The conclusion was that the inhibitory effects observed in previous studies are not due to a quick reflex. Rather, the effect called protective inhibition seems, by the process of elimination, to be a slower and presumably more complex process, perhaps best described as attentional shifts. (62 references).

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CHAPTER I

INTRODUCTION

A curious discrepancy has been observed in studies concerning the effects of heteromodal stimulation. Several studies have found that stimulation in one sensory mode increased sensitivity to simultaneous stimulation in another sensory mode. Studies by Urbantschitsch (1888) and Child and Wendt (1938) found that mild visual stimulation increased awareness of near threshold ticking noises. Ide (1919) reported that temperature sensation (hot or cold) added to the subjective sensation of weight. Hartman (1934) found that strong illumination facilitated the discrimination of pitch and intensity differences. Newhall (1923) found that simultaneous clicking noises increased awareness of near threshold visual stimuli. Hartman (1933) reported that simultaneous auditory, olfactory, touch and even painful stimuli all facilitated the discrimination of visual patterns. Kravkov (1933, 1934) reported that simultaneous auditory and olfactory stimulation, and illumination of the other eye, all facilitated the perception of light figures on a dark background.

Other studies have found that simultaneous stimulation reduced reactivity to a test stimulus. Heymans (1904) reported that electrical stimulation to the hand decreased auditory sensitivity. Jacobson (1911) found that simultaneous sound reduced subjective estimates of weight, and that strong pressure reduced subjective noise

intensity. Gescheider and Niblette (1967) reported that brief tactile stimulation raised the threshold for simultaneous auditory clicks, and that auditory stimulation raised the threshold for tactile stimulation. Malzack, Weisz, and Sprague (1963) reported that loud music and white noise reduced reactivity to the pain of a cold pressor. Lavine, Buchsbaum, and Poncy (1976) found that music reduced the discomfort of electrical shocks.

Some studies have found both increases and reductions in reactivity, depending upon stimulus strength, or the time relationship between the heteromodal stimulation. Urbantschitsch (1888) reported that a loud noise often momentarily darkened the visual field, then lightened it. He also reported that soft low tones increased sensitivity to contact by a hair, but loud high tones tended to reduce touch sensitivity. Thorne (1934) found that the visual threshold was either raised or lowered by a simultaneous buzzer noise. He suggested that a background stimulus has a facilitory effect upon a test stimulus, but when the background stimulus is strong enough to compete for attention there is an inhibitory effect upon perception of the test stimulus.

Gilbert (1941) in a comprehensive review of early studies concluded that "Under conditions of momentary heteromodal stimulation (a) a sufficiently intense stimulus will momentarily reduce sensitivity in another modality, and increase it after an optimum interval

(about ½ second); (b) a less intense heteromodal stimulus will momentarily increase sensitivity" (p. 391). He attributed this effect to his hydraulic "drainage theory" in which an intense momentary stimulus at first drains off energy in the nervous system, which reduces sensitivity to other stimuli. Metabolic processes compensate for this drain by increasing nervous energy. This reaction briefly overcompensates so that excess energy is irradiated and sensitivity is increased. Continued stimulation prolongs the irradiated excitability until adaptation sets in. Gilbert's concept that intense stimulation drains excitability implies that there is a passive limit to the degree of excitability.

This biphasic inhibitory-facilitative effect upon sensitivity has also been reported by Sokolov (1963), but he attributes the effect to an active centrally mediated inhibitory process. He reported that intense noise or pain stimulation causes an immediate defense reflex followed by an orienting reflex. Defensive reactions raise sensory thresholds in general while orienting reactions lower sensory thresholds.

Physiological studies have shown that changes in sensory stimulation are transmitted to the reticular activating system (French, Van Ameronger, and Magoun, 1952), which reflexively excites the entire cortex and increases autonomic activity as part of the orienting reflex (French, 1958; Magoun, 1953; Moruzzi and Magoun,

1949). An experiment by Furster (1958) suggests that reticular activation may improve attentiveness. He electrically stimulated the reticular systems of monkeys and found that they made fewer errors when discriminating brief visual stimuli. These studies suggest that reticular activity mediates cortical sensitivity.

The thesis of this study, to be expanded later, is that awareness of, or reactivity to, stimulation at the cortical level is influenced by excitation and inhibition of the reticular activating system, depending upon the intensity of stimulation. If this is true, it should be possible to observe both excitatory and inhibitory effects of brief heteromodal stimulation upon reticular activity as measured by the skin conductance response.

CHAPTER II

THEORIES CONCERNING THE MODULATION OF EXCITATION

Sigmund Freud (1936) wrote, "Protection against stimuli is an almost more important function for the living organism than reception of stimuli" (p. 53). Freud claimed that the receptive surface of the cortex has a "stimulus barrier" which limits the energy that passes from the external world to the cortex. He attributed the traumatic neurosis to a breach in this protective shield. However he, as well as most Western psychologists, has used the concept of inhibition loosely, with little attempt to define the process.

Pavlov's Theory of Protective Inhibition

The classic research by Ivan Pavlov (1927; 1941) on conditioned reflexes was largely occupied with experiments concerning irradiation of excitation throughout the brain, and the necessity for its control by protective inhibition. Pavlov said that there is a limit of cortical excitation that can be tolerated. Intense "transmarginal" (beyond the frontier) stimulation produces paradoxical effects because protective inhibition develops in the cortex, that reacts against the damaging over-excitation. Further increases in excitation are actively (on a neuronal level) countered by inhibition. Reactivity over increasing stimulus intensities, normally described

by the law of strength, can level off (the phase of equilization) or even decrease (the paradoxical phase) as protective inhibition compensates and then overcompensates for excitation. Stimulation from the senses, from emotional arousal, and from associative strength were all thought by Pavlov to contribute to cortical excitation.

Pavlov's concept of protective inhibition was supported by data selected from repeated observations on single dogs. Pavlov (1927) found that the normal response strength hierarchy (judging by the number of saliva drops secreted) reversed slope to become paradoxical during drowsiness (pp. 281-283), after development of an experimental neurosis (pp. 270-272), or following intense excitation (pp. 316-318).

Pavlov reported that the temperament of the dog being tested had an important effect on his experiments. Some dogs were usually drowsy, relatively insensitive to weak stimuli, and when excited became uncontrollably active. Other dogs were usually alert and reactive to weak stimulation, but when excited became restrained (catatonic) in their movements. Pavlov claimed that the last group, with a sensitive but "weak" cortex, became restrained as a result of protective inhibition.

In his later years Pavlov extrapolated his findings to the field of psychiatry. He attributed various mental disorders to

defects of excitation and/or inhibition. If Pavlov's observations are correct, then psychiatry and psychology might well be aided by controlled studies designed to develop methods for assessing an individual's threshold for protective inhibition.

A Comparison between Pavolov's Concept of Cortical Excitation and the Western Concept of Arousal

Pavlov's laboratory used saliva secretion as a measure of the cortical excitation produced by stimulating a conditioned reflex. He also reported excitation as observed in the form of movement, fearful postures and attentiveness. Pavlov's focus was upon the excitation and inhibition that acted upon the portion of the cortex that was controlling the salivation behavior. He considered the lower parts of the brain to be dominated by cortical control, and protective inhibition to be an effect that originated in a portion of the cortex that was overstimulated, and then spread throughout the brain. Pavlov thought that excitatory modulation involved the whole brain, but was cortically controlled.

The Western Concepts of arousal activation, and drive level all resemble Pavlov's concept of cortical excitation. Arousal is inferred from physiological measures including skin conductance, electroencephalographic activity, pulse rate, respiration rate, and muscle tension. Theorists concerned with activation or arousal claim that these

peripheral measures vary together enough to justify a unitary concept of arousal (Burch and Greiner, 1960; Duffy, 1962; Malmo, 1957, 1959). There is evidence that these measures are somewhat independent due to the demands of different tasks (Lacey, 1967; Taylor and Epstein, 1967).

It is well known that increasing intensities of a given stimulus result in increases in autonomic response (e.g., Davis, Buchwald, and Frankman, 1955; Hovland and Riesen, 1940; Uno and Grings, 1965). This increasing reactivity, following a law of strength, has usually been considered an increasing function (e.g., Hull, 1943; 1951). The findings of an inverted-U function between arousal and performance (e.g., Stennet, 1957) and the inappropriate responses said to be characteristic of schizophrenics and anxiety patients, have been attributed to a passive upper limit of reactivity and to response competition at high levels of arousal (Broen and Storms, 1966; Hebb, 1955; Mednick, 1958). Theories of a passive limit to reactivity may be contrasted to dual process theories that emphasize the interaction of excitation with inhibition.

Dual Process Theories of Arousal Modulation

H. J. Eysenck (1957) suggested that the inverted-U function between arousal and performance is related to the Pavlovian concept of protective inhibition. Gray (1964) and Eysenck (1967) have

suggested that protective inhibition originates in the upper part of the reticular system that produces synchronized impulses which inhibit the activating part of the reticular formation and thus reduce cortical activity. They cite a study by Hugelin, Bonvallet and Dell (1959) that describes such a cortico-reticular inhibitory system (also see Dell, Bonvallet and Hugelin, 1961).

Temperament plays an important part in Eysenck's theory. Eysenck (1947) at first suggested a relationship between the Pavlovian concept of nervous system strength and his own dimension of neuroticism/stability. Later (e.g., 1966) he equated nervous system strength with his temperamental dimension of extroversion/introversion. Eysenck considered the physiological substrate of this dimension of personality to be based on the individual's threshold for reticular activation. Introverts are more easily disposed to reticular activation. Introverts are also expected to reach their threshold for reticular inhibition sooner than extroverts. In support of this, Eysenck and Eysenck (1967) reported that introverts have a relative response decrement in reflex salivation to a swallow of noxious lemon juice.

Inhibition of arousal plays an important part in the arousal theory proposed by Seymour Epstein (1961, 1967). Findings concerning anxiety associated with sport parachuting (Fenz and Epstein, 1967) demonstrated that two processes occurred. Parachutists generalized

their anxiety and so became reactive to cues increasingly remote from the exciting event. Over time they also increasingly inhibited reactivity to highly relevant and anxiety provoking parachuting stimuli. This dual process of spreading excitation and spreading inhibition allowed awareness of threat to be expanded without increasing stress. For the experienced jumpers, physiological indicators of arousal were actually lower immediately before a jump than in early stages of the flight, presumably as a result of an inhibitory function that countered their excitation.

On the basis of this and similar evidence Epstein proposed a Law of Excitatory Modulation (LEM). He postulated a law of strength between stimulus intensity and the magnitude of the excitation produced. The law of strength also applies for the activation of inhibitory processes, which have a higher threshold for activation than excitatory processes. A crucial assumption is that the gradient of inhibition is steeper than that of the excitation it inhibits. As with Pavlov's system, because protective inhibition is a reaction against over-excitation, the more that the excitation exceeds the threshold for protective inhibition, the more inhibition will be provoked. Epstein's LEM is assumed to work between, as well as within, levels of brain organization. Over-excitation of a subsystem necessitates inhibition at a more general level, and fine-tuned modulation becomes replaced by a diffuse "all-or-none" level of

inhibition.

The conclusion derived from the studies cited is that perceptual changes in awareness of, or reactivity to, a stimulus as a function of simultaneous stimulation, can be mediated by modulation of reticular activity. Under this model, heteromodal facilitation would take place by way of increased reticular activation, which has been shown to increase cortical arousal. Increased cortical arousal lowers the threshold for reactivity. Heteromodal inhibitory effects would be the result of a decrease in reticular activation. This process could occur in at least two ways. Stimulation from the senses is transmitted to the reticular system in a diffuse manner, and stimulation received at the cortical level may be transmitted to the reticular formation. These brain processes have been reported by neuro-physiologists. Other processes are possible but have not been demonstrated in research. These include cortico-cortico connections from one sensory field to another, or the involvement of other subcortical regions.

The thesis of this study is that heteromodal inhibitory effects upon reticular activation can occur as a quick reflex that functions to preserve homeostatic limits. An alternative process that could account for protective inhibition is of a more complex and slower acting function, involving processes best described as shifts in attention or adaptation. It may be that both a quick acting reflex,

and slower processes both occur. The purpose of this study is to find effects attributable to a quick acting inhibitory effect upon reticular activation, while controlling for slower processes.

Studies Relevant to Inhibitory Modulation of Arousal to Brief Stimulation

Assuming that paradoxical reactivity is a real effect, why is evidence for its existence so meager? The meager data concerning paradoxical effects in autonomic reactivity to simple stimuli may be due to a difficulty in producing sufficient excitation to produce central inhibitory effects using a single sensory mode. That inhibitory effects within one sensory mode do occur at some levels of brain activity has been shown by studies conducted by Buchsbaum and Silverman (1968) and by Silverman and Buchsbaum (1969) who studied electroencephalographic average evoked responses (AER) to simple stimulation of varying intensity. They reported that for the majority of subjects, AER magnitude to light flashes increased with intensity of stimulation as the law of strength assumes. Other subjects could be typed as being more sensitive to weak stimulation, but their AER decreased as light intensity increased. This paradoxical diminution of response was interpreted as being a Pavlovian type of protective inhibition, associated with hypersensitivity and over-stimulation.

Studies concerning the effect of relatively intense heteromodal stimulation upon skin conductance measures of arousal are rare, but are suggestive of paradoxical effects attributable to arousal modulation. Mefferd, Sadler, and Wieland (1969) found that skin conductance responses to a combined photoflash and a 75 decibel banging noise were only slightly greater than to the flash presented alone, and less than to the noise alone.

The concept of the law of excitatory modulation has resulted in a series of studies that can be viewed as precursors to the present heteromodal study. Epstein, Boudreau, and Kling (1975) measured autonomic reactivity as skin conductance response (SCR) magnitude. They found that responses to the combined stimulus of a 112 decibel noise and a dynamometer squeeze were greater than reactivity to the squeeze alone, but less than the reactivity to the noise alone. An unpublished study by Szpiler and Epstein (personal communication, 1975) matched four noises (0, 75, 83, and 90 decibels) with four light levels. Subjects were presented with five blocks of all sixteen combinations of simultaneous stimulation of ½ second duration. It was found that the addition of light flashes of increasing intensity to the lower intensity noises increased the SCR magnitude. When flashes of increasing intensity were added to the loudest noise, SCR magnitude increased over the 0, 75, and 83 "db" light intensities, but the SCR magnitude to the loudest noise combined

with the 90 "db" light was near that of the 75 "db" light. The finding of a drop-off in reactivity suggested that a Pavlovian type of protective inhibition was involved. If this were the cause, then a further increase in stimulation should theoretically increase the inhibitory effect.

Alexander and Epstein (1977) replicated the former study using more subjects and increased stimulation. The noise (and matched light) intensities were 75, 83, 90, and 104 decibels of ½ second duration. To determine the effect of arousal caused by physical activity, half of the twenty subjects squeezed a dynamometer during stimulation. Subjects rated their trait anxiety prior to testing, using the Fenz and Epstein Manifest Anxiety Scale (1965). The results supported the initial prediction of an increase in paradoxical drop-off in reactivity over two levels. Although the light had an additive effect upon reactivity to the moderate noises, the reactivity to the loudest noise decreased as light intensity increased from 83, 90, and 104 "db". This effect developed over trials. During the third block of stimulus combinations, two-thirds of the subjects showed paradoxical decreases in reactivity. Findings concerning the effects of the dynamometer task upon reactivity were indefinite. Further analysis of the data revealed that manifest anxiety was negatively correlated with the subjects' degree of paradoxical effect, suggesting that subjects reporting high trait anxiety are

not as able to inhibit their reactivity as subjects reporting lower trait anxiety. This finding supports Malmo's (1957, 1959) contention that chronic anxiety is caused by an impaired inhibitory ability. The finding of protective inhibition did not exactly support Pavlov's concept of a reflexive response to an absolute level of stimulation. Rather, the inhibition seemed to be a complex adaptation to stimulus intensity, in which inhibition occurred only with the most intense noise.

Rationale of the Present Study

The present experiment was designed to further study the paradoxical effect observed in the Alexander and Epstein study. That study was largely replicated but with several major modifications to ensure a more carefully controlled design. The present study used a larger subject sample (48) and selected experimental subjects from a pool of young men who had previously taken Eysenck's neuroticism and extroversion scales (1968) and an experimental scale of temperament developed by Alexander and Epstein (the scales are included in the appendix). The investigation of muscular strain was improved by making constant a weight that was lifted. The requirement that subjects observe and correctly report a digit that flashed just prior to the light stimulus eliminated doubts arising in the previous study concerning blinking or visual avoidance behavior. The most important

modification was the shortened noise duration from ½ second to 0.08 second. Although the intensity of stimulation was increased, the shortened time of presentation meant that subjects received about one-third the noise stimulation that they received in the previous study. Light stimulation was probably decreased, but was more certain because subjects could not blink to avoid the quick flash of light.

The previous studies which found inhibitory effects could not discriminate between a complex cortical type of inhibition and a reflexive lower brain inhibition of reactivity. The stimulus duration used in the previous study of ½ second was long enough to allow eye-blinks to reduce visual stimulation, or to allow shifts of attention to affect reactivity. The present study used briefer stimuli under the assumption that a complex inhibition of arousal would take time to develop. Using brief stimulation any reflex taking more than 0.08 second could have no effect by decreasing sensitivity to further stimulation. Autonomic reactivity could be reduced only by a brain function that can reduce activation with 0.08 second. This is because the skin conductance response, being purely sympathetic, is affected by arousal, but not by inhibition. Once the SCR starts in the sympathetic system, further stimulation can superimpose new reactions, but decreases in central excitation can not cancel out the reaction. Thus, if the study obtains paradoxical results, then

the study would support the concept that protective inhibition can occur as a quick acting reticular reflex that presumably is quick because of its short arc length and autonomic nature. If the study does not find paradoxical effects, the search for this effect would shift to slower and presumably more complex processes, or to increasing the intensity of the stimulation to magnitudes used in the previous study.

CHAPTER III

METHOD AND PROCEDURE

Subjects

The subjects were 48 male undergraduate students at the University of Massachusetts. They were selected from a sample of 97 males who had, in a previous study, taken the Eysenck Personality Inventory and a temperament scale developed for this study by Alexander and Epstein to measure manifest anxiety, extroversion, and various aspects of inhibition (all scales are included in the appendix). For subject selection the major scales were expressed as Z-scores and were averaged to give a combined extroversion score and a combined neuroticism score. An attempt was made to select subjects over a wide range of scores on these two dimensions. There were eight subjects in each of four corner cells, as well as sixteen subjects who fell in the center on both of these scales. The selecting score for both dimensions was ± .41 standard deviation units. All subjects were screened for hearing loss with a Beltone audiometer. All were able to hear 20 decibel tones of 500, 1000, and 3000 cycles per second in each ear. Most of the subjects were taking an introductory psychology course and received partial credit toward a grade. All subjects were paid $2.00 for participation.

Stimuli

Simultaneous light and noise bursts were presented to the subjects while they were comfortably seated in a dark and sound isolated room. A Grass-Stradler model 901B noise generator made white noise which was amplified and emitted from a speaker one meter before the subjects at head level. A sound level meter located at the position of the subjects' heads was used to adjust the noise intensities to 83, 95, 105, and 115 decibels. Noise duration was 0.08 second. The rise time of the relay was instantaneous, but due to the nature of white noise, the rise time could take up to .003 second.

Light was emitted from a box covered on the viewing side with a rectangle of translucent tracing paper (20 cm x 26 cm), one meter in front of the subjects at eye level. The viewing angle was approximately fifteen degrees. The stimulus flash was produced by a Vivitar #271 xenon photoflash unit rated at 1600 beam-candle-power-second, which illuminated the tracing paper from behind. The actual light duration was 0.001 second, although retinal after-discharge makes the time of sensory stimulation closer to one-tenth of a second. The four intensities of stimulation were produced by moving one of four neutral transmission filters before the photoflash, by means of an automobile choke cable from the next room. Care was taken to

slide the filters twice before each stimulus, so the subjects could not guess from the sliding sounds which intensity of light was coming. Each filter allowed ten times the light of the step before. A precise measurement of flash intensity was not possible. An estimate of intensity was made by shining a constant light through the filters, and measuring the transmitted light at the subjects' head location with a MacBeth Illuminometer. Calculations using data provided by the photoflash manufacturer estimated light intensities at eye location to be: 1.4×10^{-4}; 1.7×10^{-5}; 1.7×10^{-6}; and 1.0×10^{-7} watts per square centimeter. A digital readout light meter was used to measure the photoflash stimulation but it was impossible to accurately read the display. The estimate of the peak reading was 2.0×10^{-4} w/cm^2, which is supportive of the validity of the mathematical estimate.

In the center of the tracing paper was a dark spot five centimeters in diameter. At its center was a light-emitting diode display digit of 1.3 centimeter height. The digit flashed 0.003 second prior to the photoflash stimulus. If the subject could read the digit there was no possibility of blinking to avoid the stimulus flash.

Light and noise stimuli were presented together according to a randomized Latin Square design, with each combination occurring once in each block of sixteen trials. Order was determined by shuffling cards prior to each experiment. Each subject was presented with

four blocks of trials, totaling 64 presentations.

While receiving the stimulation, all subjects pulled on a handle above their heads, that was attached by a rope through a pulley system to a weight platform. For half of the subjects the platform was empty and this motion involved minimal exertion. For the other half, a weight was added that was one fourth of each subject's pulling capacity to the nearest kilogram. A signal light assured the experimenter that the subject was actually pulling the weight into the air on each trial. A knot in the rope prevented the subject from pulling his elbow much below shoulder height.

Procedure

Following preliminary introductions, each subject was asked to indicate his present mood state, using a short adjective self report scale (included in the appendix) measuring nervous tension, weariness, arousal, and enthusiasm. Each subject then entered the sound-isolated room where his hearing was tested. Next, the strength of his dominant arm was measured using a dynomometer on a special stand. Subjects were asked to pull as strongly as possible three times "as if doing a pull-up." One half of the subjects later lifted a weight equal to one quarter of the median of these three pulls. Subjects were not told about the weight task until after the strength test.

Subjects were then given written instructions (included in the

appendix) which explained that each stimulus would occur several seconds after a dim green "ready" light, which served as a target for focusing. The dim ready light outlined the dark circle in the center of which the red digit would flash just before the photoflash. After a waiting period designed to reduce spurious reactivity, an automatic sequence of dimly lit instructions would signal him to call out the digit that he saw, and then to rate his internal reaction to the stimulus combination using a push-button response box. If he was mistaken as to the digit presented, he could expect a repetition of that trial. Half of the subjects were to pull a weight, the other half would go through the same motions, but without exertion.

After the subjects read these instructions and signed their consent to participate, skin conductance electrodes were applied. The instructions were summarized orally by the experimenter, and any questions regarding procedure were answered. At this time the response box was demonstrated. Its position was within easy reach on a board that fitted over the arms of the subject's easy chair. The signals to call out the red digit and to rate subjective reactions were backlit in red, dimly so as not to interfere with dark adaptation. The subjective reaction scale was also backlit and was labeled "low, medium, high, very high." Ratings were made by pushing one of nine buttons situated over this scale. The buttons were connected in

series by resistors so that the drop in voltage from a battery could be recorded on the polygraph in the next room. After having the equipment explained, each subject rested during a 5-minute dark adaptation period. Then each subject was presented with five combinations of light and noise to familiarize him with the procedures and the total range of intensities.

The experiment began immediately after the introductory trials. Each stimulus combination was preceded by a 10-second dim green focusing light. At that time the handle connected to the weight was to be pulled. Ten seconds after focus light onset, the red digit at the center of the target lit 0.003 second before the stimulus, and continued until stimulus onset. Because this time between the digit and the photoflash was so brief, subjects did not have time to blink. Thus, a correct recall of the test digit was an assurance that the photflash was also seen. Ten seconds after the stimulus, the green focus light was turned off, signalling the subject to release the weight handle. A panel on the response box lit for three seconds indicating that the subject was to call out the digit he had viewed. Communication was by intercom. Next the subjective reaction scale on the response box was illuminated, and the subject had three seconds to rate his reaction to the stimulus combination using a 9-point scale. Following this rating there was a 10-second rest period in darkness before the focus light signaled

the subject to prepare for the next trial. The total time between each stimulus presentation was 36 seconds.

Immediately after the 64 trials, the subject filled out another mood-state scale (included in the Appendix) indicating his mood during the latter part of the experiment.

Physiological Measurement

Skin conductance was continually recorded using a Beckman RM dynograph, located in an adjacent room. Beckman Ag-AgCl electrodes, one centimenter in diameter, were applied to the thenar and hypothenar surfaces of the non-dominant palm. A Beckman model 9844 skin conductance coupler was used to impress a constant 0.5 volts between the electrodes. The conducting cream was Johnson and Johnson KY lubricant.

Predictions

Previous experiments have found several effects that were also expected to be found in the present study. Skin conductance response (SCR) magnitude was expected to increase over increasing noise intensity. SCR magnitude was also expected to increase over increasing light intensity, but not as reliably as over noise intensity. SCR magnitude was also expected to habituate over blocks of trials. Ratings of reactivity were expected to vary reliably with both noise and light intensity but no predictions were made regarding block effects.

Of special interest to this study was the possibility that high levels of brief stimulation would produce paradoxical decreases in reactivity over increasing intensities of stimulation. If paradoxical reactivity is found, and is associated with introversion, this finding would support the concept that introversion is associated with a reactive arousal system, which causes introverts to be closer to their limit of reflexive protective inhibition. A different prediction concerning traits of temperament and paradoxical reactivity was derived from the Alexander and Epstein study. Further analysis of that study found manifest anxiety to be negatively correlated with the degree of paradoxical drop-off, suggesting that anxious subjects are not as able to selectively inhibit overexcitation as less anxious subjects.

Data Reduction and Analysis

Physiological measures. The magnitude of skin conductance response (SCR) for each of the 64 stimulus presentations was measured as the maximum increase in skin conductance (measured in micromhos) that occurred between one and seven seconds after stimulation. The SCR's were corrected for individual differences in reactivity by dividing each subject's scores by his maximum SCR over the 64 trials (cf. Lykken, 1972). In order to determine whether the range correction seriously distorted the range of reactivity for any

subject, the scatter of SCR magnitude was examined for each subject. A problem could occur if a subject produced a maximum SCR far greater than his typical responses, which would reduce variance for the remaining range corrected SCRs. This was found to be no problem, for only five subjects had a second-highest SCR magnitude less than 80% of his maximum SCR, and the most extreme subject had a second-highest response that was 68% of his maximum.

Both range corrected SCR and SCR in micromhos were analyzed in identical manners. Because the range corrected SCRs were more reliable, and the results were almost identical, the term SCR will refer to range corrected SCR unless otherwise noted.

Tonic skin conductance was measured seven times during the experiment: the lowest point during dark adaptation; the low point just prior to the first practice trial; prior to the first stimulus in each of the four blocks of sixteen trials; and just prior to the final stimulus. Tonic skin conductance was defined as the lowest skin conductance in the period between two seconds prior to the stimulus until one second after the stimulus. Tonic skin conductance was range corrected by expressing each subject's scores relative to his range of skin conductance during the experimental period (cf. Lykken, 1972). Parallel analyses were done for tonic skin conductance expressed in micromhos, and for range corrected tonic skin conductance. The range corrected tonic measures were slightly more reliable and

will be presented unless otherwise noted.

Several physiological measures were obtained for use as between-subject variables for correlational analysis. They included each subject's average skin conductance, maximum SCR in micromhos, average SCR in micromhos, and average range corrected SCR. The degree of SCR habituation over blocks was measured as the difference in average range corrected SCR in block 1 compared to block 4. One measure of reactivity to noise stimulation was to compare the average range corrected SCR to the least intense noise as compared to the most intense noise (collapsed over light levels). A similar measure of differential light reactivity was to compare the average range corrected SCR to the least and most intense light. A "paradoxical curve form" measure derived from the previous study which found the degree of paradoxical reactivity to the most intense noise over increasing light levels to be related to self report measures. To score for curve type the 4-point curves of the most intense noise over 4 light levels were reduced to 3-point curves by averaging the SCRs to the two middle light intensities. This produced curves which could only have four forms: increasing, inverted V-shaped, decreasing, or V-shaped. With the latter type deleted, the other curve types can be considered as increasing degrees of paradoxical reactivity ranging from the normal increase over increasing stimulation, to the completely paradoxical decrease. Curve typing was done for each of the four

blocks, using the subject's SCRs averaged over blocks 1 and 2, his SCRs averaged over blocks 3 and 4, and his SCRs when all four blocks were averaged. An identical curve typing was done for subjects' ratings of reactivity.

Self Report measures. Eysenck's Personality Inventory includes scales of extroversion, neuroticism, and a lie scale. The Alexander-Epstein temperament scale developed for this study included scales termed extroversion, manifest anxiety, and weariness, as well as several minor subscales. The standardized scale scores on the first two scales of each test were averaged to create a combined extroversion score and a combined neuroticism score. These combined scores were the ones used in the initial selection of subjects in order to obtain a balanced and representative range of trait scores.

Subjects were asked to rate their current mood state when they first arrived at the laboratory, and again immediately after the final stimulus for the latter part of the experimental period. The mood state items were condensed into four scales termed nervous tension, weariness, arousal, and enthusiasm. Comparing subjects' initial mood ratings to their mood ratings at the end of the experiment produced measures indicative of how the experiment affected their subjective state.

One measure of possible interest was calculated by correlating, within subjects, their 64 SCRs with their 64 ratings of reactivity.

Next, the effects of noise and light levels were partialled out of the correlations, producing a score relating each subject's self ratings of reactivity and his autonomic reactivity. Presumably a strong correlation would indicate sensitivity to internal processes.

Statistical analysis. The data were analyzed by two methods. In the first method, an analysis of variance (BMDP2V) was performed upon the 64 skin conductance responses, with noise levels, light levels, and blocks treated as independent repeated measures variables and subjects grouped as to whether they lifted a weight or not. In one series of analyses of variance, subjects were also grouped by a trisection of each of the self report scale scores. In another series of analyses of variance, subjects were grouped on the two dimensions of extroversion and neuroticism simultaneously, once by a split-half method and once using the most extreme two-thirds of the subjects in order to determine any interactive effects. The 64 subjective ratings of reactivity were analyzed in an identical manner. Tonic pre-stimulus skin conductance, which was measured seven times during the experiment, was analyzed in a similar manner to the phasic measures, as to block effects and grouping of subjects, although noise and light effects were not relevant to the analysis of pre-stimulus conductance.

The second method of analysis was correlational. Trait and state self ratings were intercorrelated, as were the physiological

measures. Correlations were also performed between the self rating scales and physiological measures.

CHAPTER IV

RESULTS

Analyses of variance were done grouping subjects on all the major trait and state scales. Each subscale was analyzed separately, grouping subjects by trisection. In addition, the scales of extroversion and neuroticism were analyzed simultaneously by split half grouping. All of the analyses of variance produced essentially the same results. In reporting the results regarding stimulus intensity, habituation, and the interactive effects of stimuli, the most central analysis of variance will be reported. This is the one splitting the 48 subjects three times simultaneously as to whether they lifted a weight or just went through the motions, whether they were high or low on the combined extroversion scale, and whether they were high or low on the combined neuroticism scale. Noise levels, light levels, and blocks were treated as repeated measures.

Skin Conductance Responses

Main effect of noise intensity. Noise intensity was found to be a highly reliable effect ($F\ (3/120) = 236.35$, $p < .001$). Increasing intensity of noise produced increasing magnitude of skin conductance response. The main effect of noise intensity with the data collapsed over light levels and blocks may be seen in Figure 1.

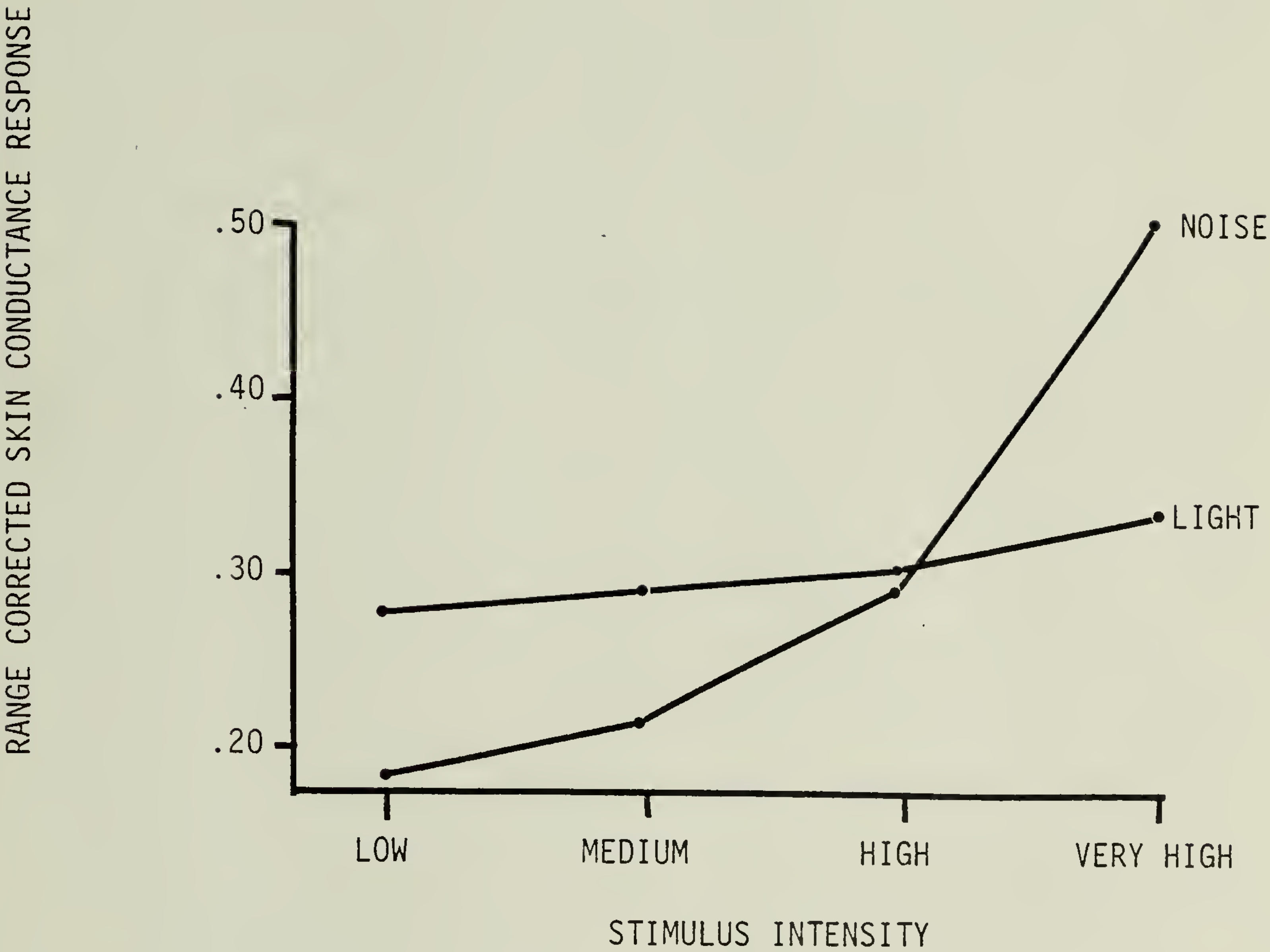

Figure 1. Magnitude of skin conductance response as a function of stimulus intensity, for light levels collapsed over noise levels, and for noise levels collapsed over light levels. The data are averaged over four blocks of trials.

Main effect of light intensity. Light intensity was found to be a reliable effect (F (3/120) = 11.20, p < .001), although it was not as strong as the effect of noise levels. The main effect of light intensity with the data collapsed over noise levels and blocks may be seen in Figure 1.

Main effect of muscular exertion. The effort of lifting a weight did not produce a reliable effect upon the average magnitude of skin conductance response (F (1/40) = .24). It should be noted that the subjects began to lift 10 seconds prior to each stimulus and continued to lift until 10 seconds after each stimulus. This time delay avoided confusing the SCR activity produced by the initial physical activity with the SCR produced by the heteromodal stimulus. It may be concluded that ongoing muscular exertion did not effect the magnitude of reactivity to the sensory stimulation.

Habituation over trials. Four blocks of 16 light-noise combinations were presented to the subjects. The block effect is a measure of change over time. The effect of blocks was significant (F (3/120) = 13/38, p < .001), demonstrating a reliable reduction in SCR magnitude over time. The block effect may be viewed in Figure 2. There were no reliable interactions of blocks of trials with other variables.

Heteromodal interaction effects. The noise by light interaction (see Figure 3) was not a reliable effect (F (9/360) = .54). The same

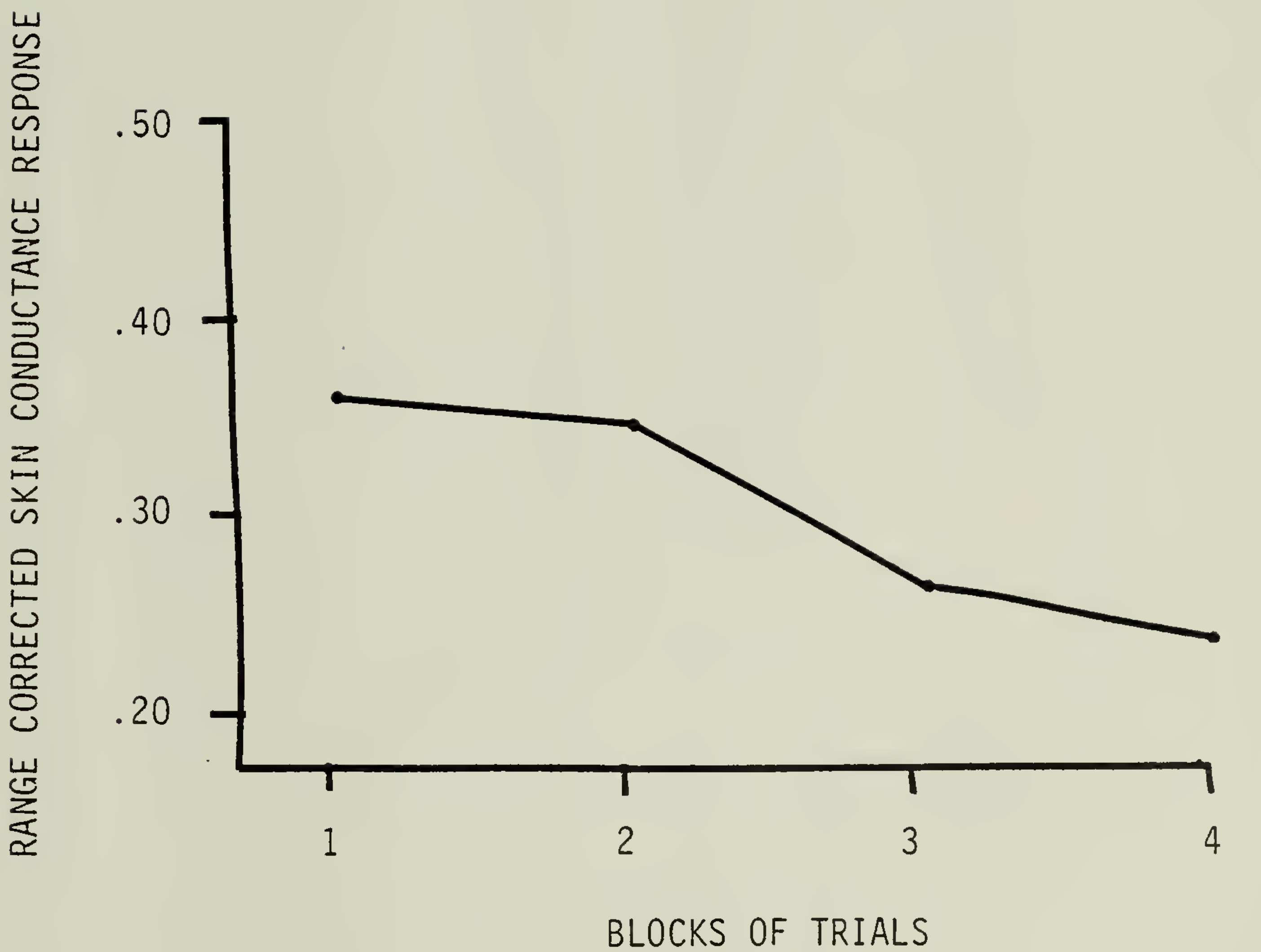

Figure 2. Magnitude of skin conductance response as a function of blocks of trials. The data are collapsed over noise and light levels.

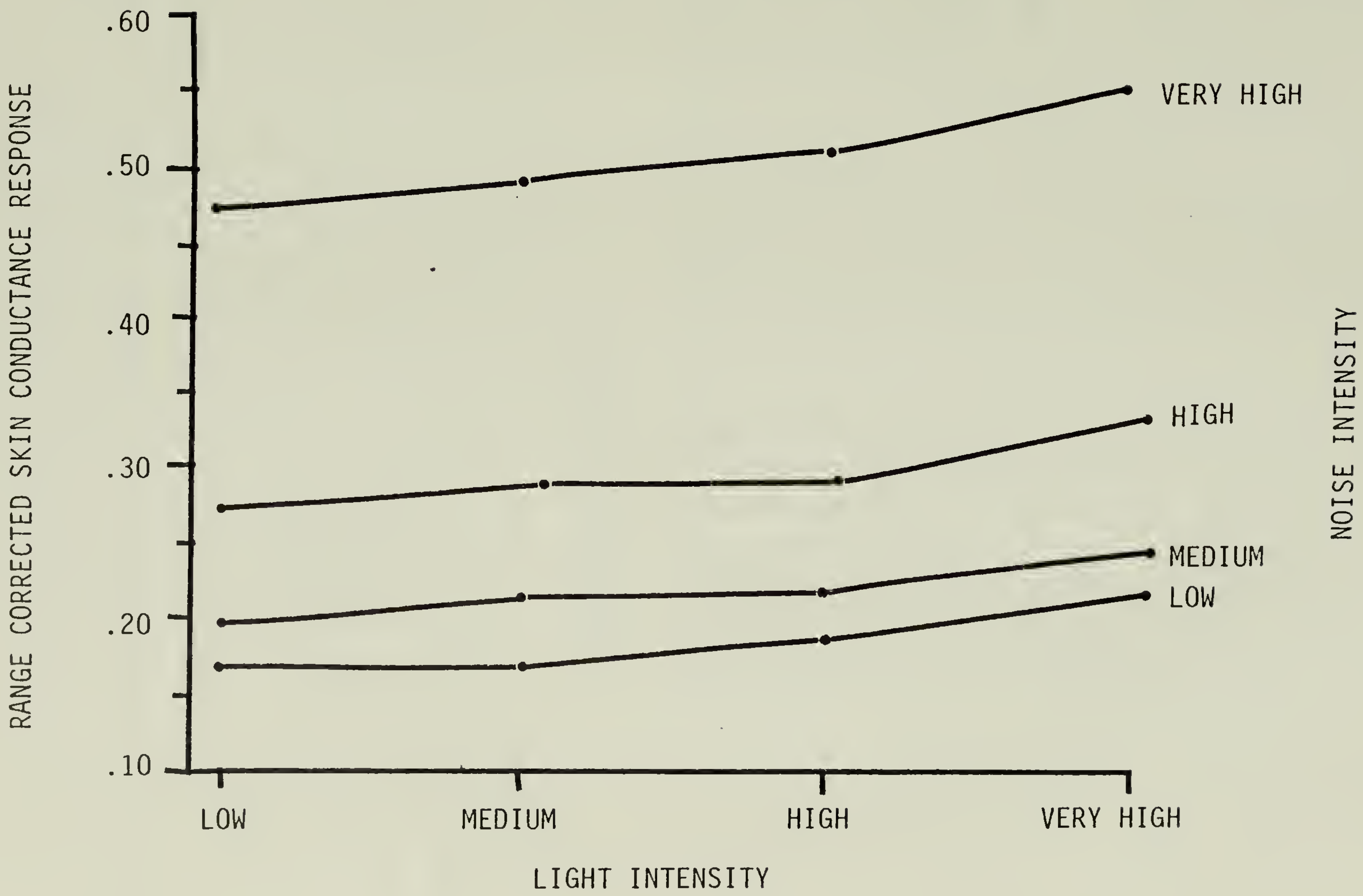

Figure 3. Magnitude of skin conductance response as a function of light and noise intensity. Noise levels are treated as background stimuli and represented as a family of curves. The data are averaged over four blocks of trials.

lack of effect was found in the noise by muscular exertion interaction (F (3/120) = .11), and the light by muscular exertion interaction (F (3/120) = .65). The third order interaction of noise by light by muscular exertion was also not reliable (F (9/360) = .59).

Because the paradoxical effect was expected to occur during the most intense stimulation, the most intense noise was analyzed separately. The effect of light intensity was significant (F (3/120) = 4.90, p = .003) as was the effect of blocks (F (3/120) = 2.98, p = .03). However there was no block by light interaction (F (9/360) = .91), indicating that there were no reliable effects of blocks of trials upon the slope of reactivity over light levels.

Tonic Skin Conductance

Tonic skin conductance was measured during seven periods; the lowest skin conductance during the five minute dark adaptation period, the low in the three seconds prior to the first trial in each block, and the final trial of the experiment. An analysis of variance on tonic skin conductance during the trial period found the effects of time to be highly significant (F (4/160) = 5.77, $p < .001$). This effect is graphed in Figure 4, which demonstrates an increase and then a leveling in tonic skin conductance over blocks of trials.

The task of lifting the weight and the muscular exertion involved did not reliably affect the average tonic skin conductance (F (1/40) =

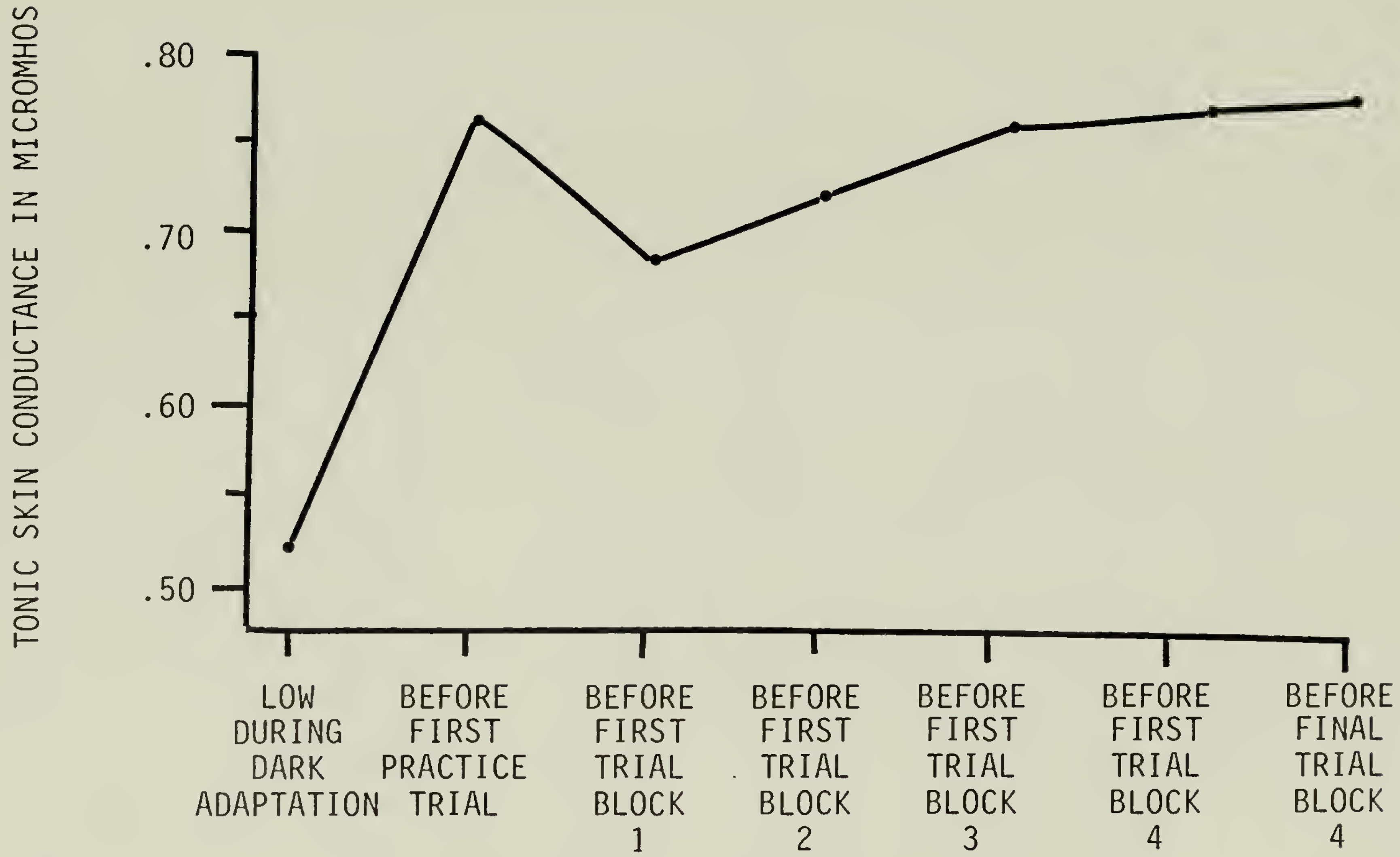

Figure 4. Tonic skin conductance as a function of time.

.01), and there was no block by muscular exertion interaction (F (4/160) = .28).

Subjects' Ratings of Reactivity

Main effect of noise intensity. Noise intensity was found to be a highly reliable effect (F (3/120) = 205.76, p < .001). Subjects reported increasing magnitude of reactivity as noise intensity increased. The main effect of noise intensity with the data collapsed over light levels and blocks may be seen in Figure 5.

Main effect of light intensity. Light intensity was found to be a highly reliable effect (F (3/120) = 51.09, p < .001), although not as strong as the effect of noise levels. The main effect of light intensity with the data collapsed over noise levels and blocks may be seen in Figure 5.

Main effect of muscular exertion. The weight lifting task did not produce any reliable effect upon the average magnitude of the subject's estimate of reactivity (F (1/40) = .02).

Habituation over trials. The main effect for blocks of trials was not significant (F (3/120) = 2.05, p = .11). The trend was for subjects to report less reactivity over blocks of trials.

There was a significant interaction between blocks of trials and the muscular exertion task (F (3/120) = 5.03, p = .003). This interaction may be viewed in Figure 6. It indicates that the subjects

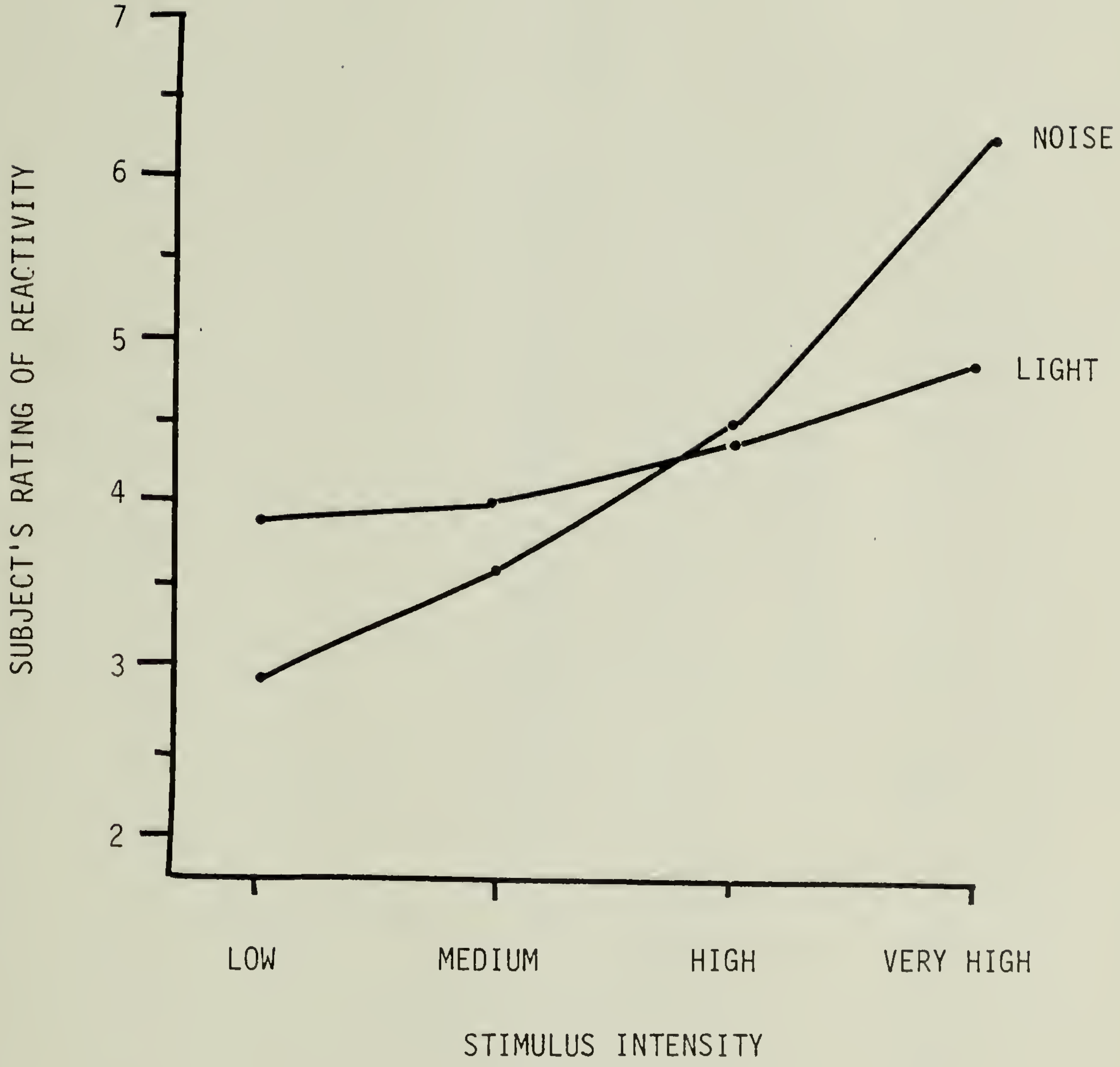

Figure 5. Magnitude of subjects' rating of reactivity as a function of stimulus intensity, for light levels collapsed over noise levels, and for noise levels collapsed over light levels. The data are averaged over four blocks of trials.

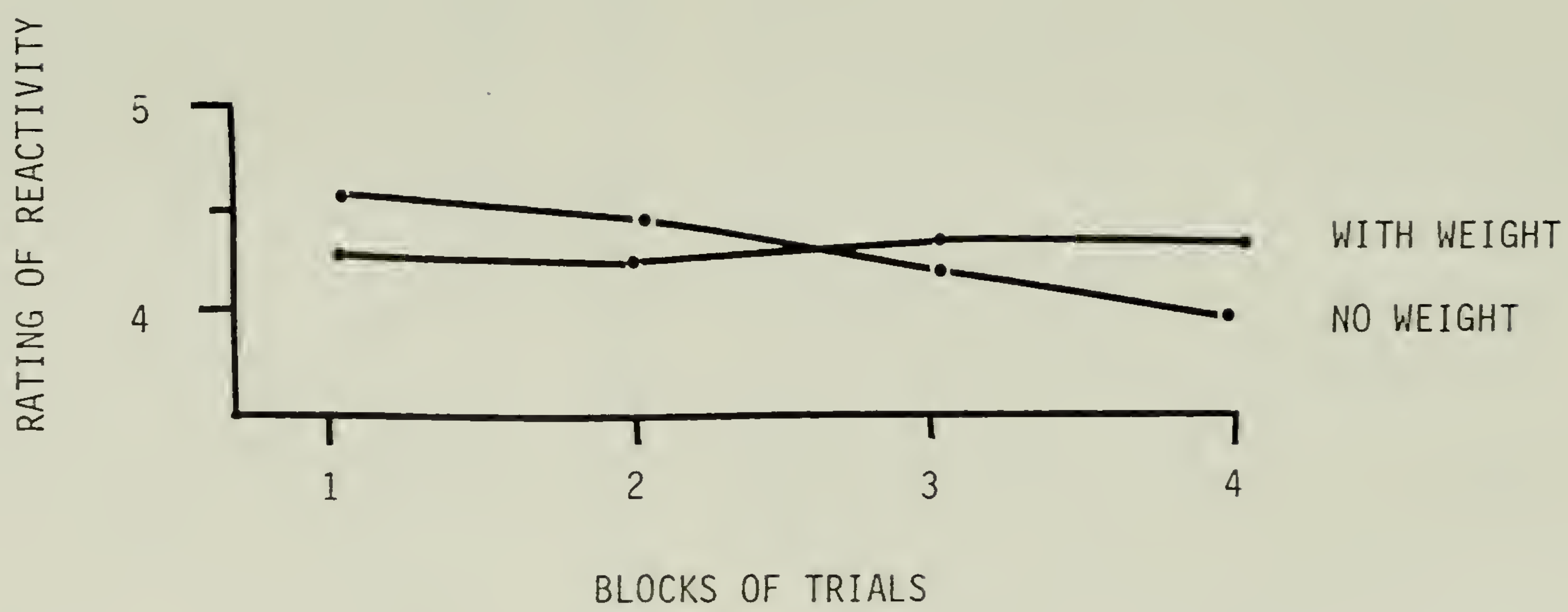

Figure 6. Magnitude of subjects' rating of reactivity as a function of blocks of trials. Subjects are grouped as to whether they lifted a weight or not.

who did not lift a weight rated their reactivity as decreasing over blocks of trials, while the subjects who lifted a weight rated their reactivity as increasing over blocks of trials.

Heteromodal interaction effects. There was a significant interaction of noise intensity and light intensity upon subjects' rating of reactivity ($F (9/360) = 4.02, p < .001$). The light by noise interaction has been graphed in Figure 7. The graph shows that light intensity had a greater effect upon ratings of reactvity in combination with lower intensity noise than in combination with higher intensity noise, producing an orderly decrease in slope over light levels as noise intensity increased.

Effects of Grouping Subjects by Trait Scales

Skin conductance responses. In the central analysis with subjects grouped simultaneously by bisections on muscular exertion, combined extroversion, and combined neuroticism, a significant main effect upon the average SCR was found for the bisection of subjects by the combined extroversion scale ($F (1/40) = 8.11, p = .007$). The effect of extroversion was also found in the trisection analysis. Trisecting the subjects into three groups of sixteen subjects each, on the basis of the combined extroversion scale, produced a significant main effect of extroversion upon the average magnitude of range corrected SCR ($F (2/45) = 5.92, p = .005$). The means for the

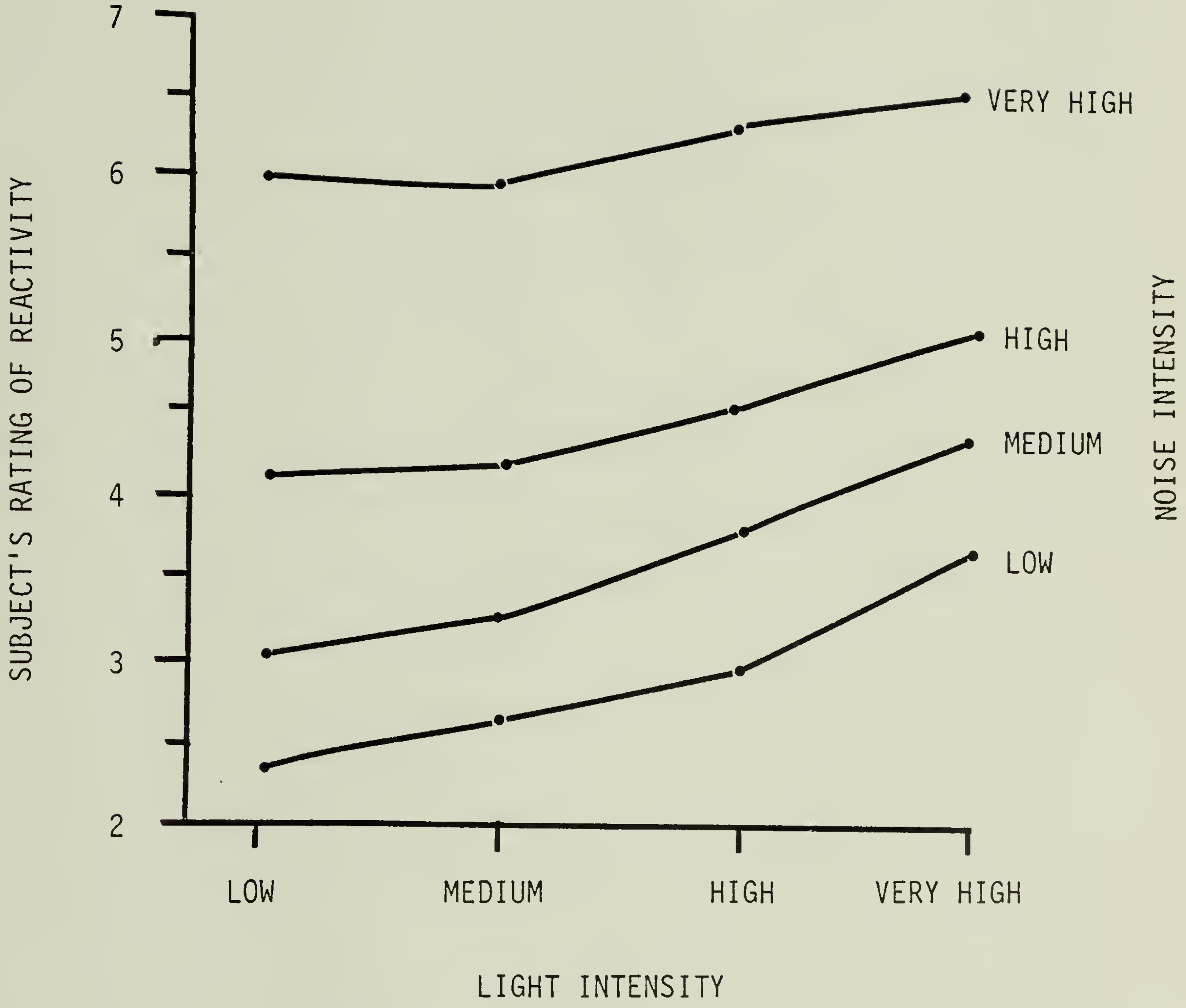

Figure 7. Magnitude of subjects' rating of reactivity as a function of light and noise intensity. Noise levels are treated as background stimuli and represented as a family of curves. The data are averaged over four blocks of trials.

introverted third of the subject sample, the average third, and the extroverted third of the subject sample were, respectively, .35, .30 and .25 of their maximum response during the experiment. Trisecting subjects by the Eysenck extroversion scale was slightly more reliable ($F(2/45) = 6.97$, $p = .002$) while the Alexander-Epstein extroversion scale constructed for this study only approached an acceptable level of significance ($F(2/45) = 2.95$, $p = .06$). The mean SCRs for subjects grouped by the latter two scales are almost identical with the mean SCRs for subjects grouped by the combined extroversion scale. Thus the more extroverted the subject reported himself to be, the lower his average magnitude of autonomic reactivity as compared to his maximum reactivity. This effect was not found to be significant when analyzing the non-range corrected SCR in micromhos. Because Eysenck's scale was a better predictor than the other extroversion scales, correlational analyses were done to determine the nature of the items that were associated with differences in range corrected reactivity. These analyses are reported later in the section on correlational analyses.

There were no other significant effects upon SCR for any of the trait scales, either in interactions with stimulus intensities, or in interactions over blocks of trials.

Tonic skin conductance. There were no significant effects for any of the trait scales upon average tonic skin conductance, or

interactions over blocks of trials.

Subjects' ratings of reactivity. There was a significant interaction between the combined extroversion score and the muscular exertion task upon the average rating of reactivity (F (1/40) = 4.97, p = .03). The interaction may be seen in Figure 8. The introverted half of the subjects who lifted a weight reported more reactivity than the introverted subjects who did not lift a weight. The opposite effect was reported by the extroverted half of the subjects. The extroverted subjects who lifted a weight reported less reactivity than the extroverted subjects who did not lift a weight. When subjects were bisected by Eysenck's extroversion scale the same effect was found (F (1/40) = 4.92, p = .03). This effect was not as reliable when subjects were bisected by the Alexander-Epstein extroversion scale (F (1/40) = 2.96, p = .09).

There were no other effects of trait scales upon ratings of reactivity.

Effects of Grouping Subjects by State Scales

The scales of mood states used to group subjects for analyses of variance were the self ratings of nervous tension, weariness, neutral arousal, and enthusiasm prior to instructions, and the same rated immediately following the last trial when they were asked to rate their mood during the last part of the experimental period.

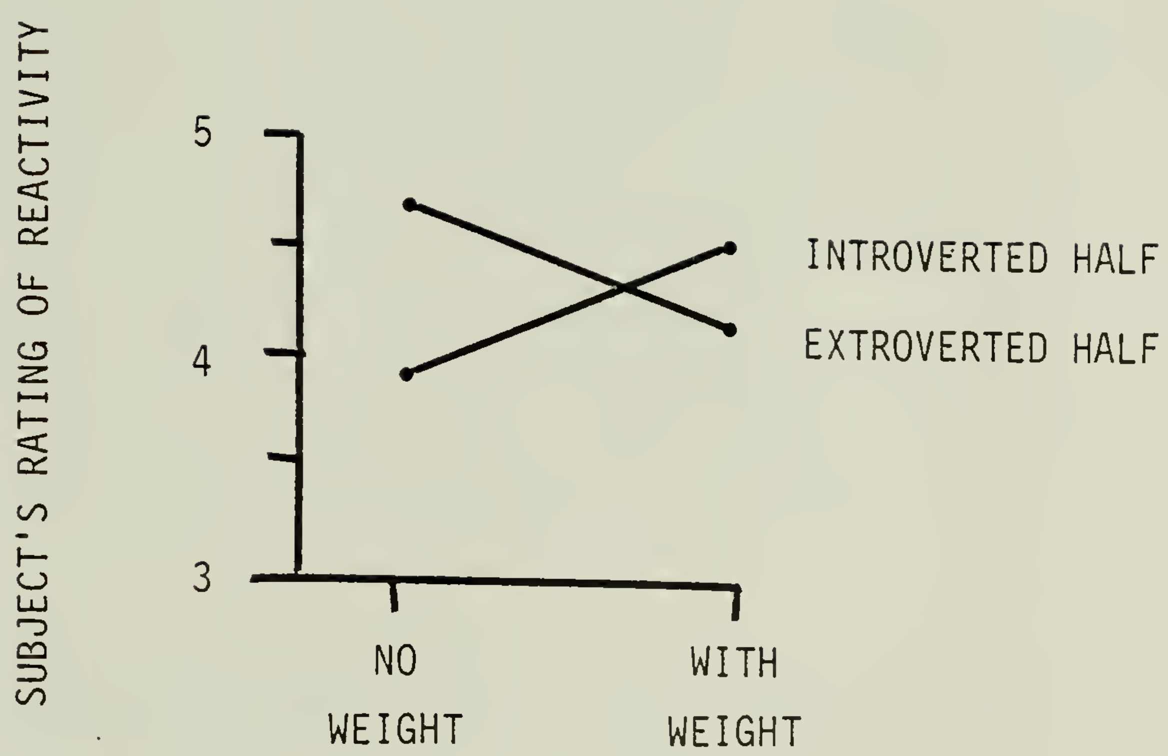

Figure 8. Average magnitude of subjects' rating of reactivity as a function of grouping by extroversion and muscular exertion.

Analyses of variance were done grouping subjects by trisections separately on each state scale.

Skin conductance responses. A significant interaction was found between the scale of weariness, rated before instructions, and the range of SCR magnitude over noise levels (F (6/135) = 2.81, p = .01). The subjects who reported being weary did not react as much to the high intensity noises as the less weary subjects, although the groups were similar in SCR magnitudes for the low intensity noises.

The scale of weariness, rated for the final part of the experimental period, interacted with SCR magnitude over blocks of trials (F (6/135) = 2.39, p = .03). The subjects high on weariness habituated more than the subjects who rated themselves low on weariness.

Tonic skin conductance. There were no significant interactions of state scales with average tonic conductance or with changes in tonic conductance over blocks of trials.

Subjects' ratings of reactivity. There was a significant interaction between the initial rating of weariness and blocks of trials on subjects' ratings of reactivity (F (6/135) = 4.36, p < .001). The subjects high on weariness rated their reactivity as declining over trials, while subjects low on weariness rated their reactivity as increasing over trials.

The initial rating of state arousal was significantly related to

subjects' average rating of reactivity ($F\ (2/45) = 3.78$, $p = .03$). Subjects who rated themselves high on arousal prior to instructions also rated their reactivity during the experiment as being greater than subjects who rated themselves as being low on arousal prior to instructions.

The initial rating of enthusiasm significantly interacted with the range of self rated reactivity over the light levels ($F\ (6/135) = 3.84$, $p = .001$). Subjects reporting high enthusiasm reported a greater range of reactivity as a function of variation in light intensity than did subjects of low enthusiasm. The initial rating of enthusiasm also had a similar effect upon the rating of the effect of noise intensities upon reactivity ($F\ (6/135) = 3.21$, $p = .006$). Subjects of high enthusiasm reported a greater effect of noise levels upon their reactivity than did subjects of low enthusiasm.

No other significant effects were found when grouping subjects by state scales.

Correlational Analyses

Intercorrelations of physiological measures. Correlations over the 48 subjects between the physiological measures may be viewed in Table 1. There were significant correlations between tonic conductance and magnitude of skin conductance response when expressed in micromhos and when range corrected. There was also a correlation between range

	AVERAGE TONIC CONDUCTANCE IN MICROMHOS	AVERAGE SCR IN MICROMHOS	LARGEST SCR IN MICROMHOS	AVERAGE RANGE CORRECTED SCR
AVERAGE TONIC CONDUCTANCE IN MICROMHOS	–	.60	.51	.36
AVERAGE SCR IN MICROMHOS	.60	–	.91	.51
LARGEST SCR IN MICROMHOS	.51	.91	–	.20
AVERAGE RANGE CORRECTED SCR	.36	.51	.20	–

Table 1. Correlations among physiological measures (N = 48). For a one-tailed test of significance, $p = .05$ at $r = \pm .24$, $p = .01$ at $r = \pm .33$, $p = .005$ at $r = \pm .37$, $p = .001$ at $r = \pm .43$.

corrected SCR and SCR expressed in micromhos. These correlations indicate a direct relationship between tonic conductance and phasic skin conductance reactivity.

Intercorrelations of trait and state self report measures. The correlations between the trait and state scales may be viewed in Tables 2 through 4. Looking only at the trait scales (Table 2), it can be seen that the Eysenck temperament scales and the ones developed for this study are significantly correlated in a way that mildly supports the validity of each scale. Looking only at the state scales (Table 3), it can be seen that the scales were significantly correlated in logical directions. However, when trait scales were correlated with the state scales (Table 4), very few scales were found significantly correlated. The only significant expected correlation between trait and state scales was for the trait scale of weariness to be correlated with weariness rated during the experiment. Less expected findings were for the trait scales of manifest anxiety and weariness to be positively correlated with enthusiasm rated prior to instructions, and for the trait scale of weariness and Eysenck's extroversion scale to both be negatively correlated with nervousness rated for the experimental period.

Correlations between trait scales and physiological measures. So few significant correlations were found that presenting them in a table is unnecessary. The major finding was for Eysenck's extroversion

TRAIT SCALES

	Alexander-Epstein Extroversion	Alexander-Epstein Manifest Anxiety	Alexander-Epstein Weariness	Eysenck Extroversion	Eysenck Neuroticism	Eysenck Lie Scale	Combined Extroversion	Combined Neuroticism
ALexander-Epstein Extroversion	—		-.30	.57			.86	
Alexander-Epstein Manifest Anxiety		—	.56		.77			.94
Alexander-Epstein Weariness	-.30	.56	—		.39			.51
Eysenck Extroversion	.57			—		-.32	.91	
Eysenck Neuroticism		.77	.39		—			.94
Eysenck Lie Scale				-.32		—	-.31	
Combined Extroversion	.86			.91		-.31	—	
Combined Neuroticism		.94	.51		.94			—

Table 2. Correlations among trait scales (N = 48_, significant at the $p < .05$ level.

STATE SCALES

	NERVOUS TENSION	WEARINESS	AROUSAL	ENTHUSIASM	NERVOUS TENSION	WEARINESS	AROUSAL	ENTHUSIASM
	RATED PRIOR TO INSTRUCTIONS				RATED FOLLOWING FINAL TRIAL			
BEFORE INSTRUCTIONS								
NERVOUS TENSION	—				.43			
WEARINESS		—	-.42	-.35		.55		
AROUSAL		-.42	—	.65		-.29	.31	.29
ENTHUSIASM		-.35	.65	—	-.29			(.22)
DURING EXPERIMENT								
NERVOUS TENSION	.43			-.29	—		.26	
WEARINESS		.55	-.29			—	-.34	-.47
AROUSAL			.31		.26	-.34	—	.81
ENTHUSIASM			.28	(.22)		-.47	.81	—

Table 3. Correlations among state scales (N = 48), significant at the $p < .05$ level.

TRAIT SCALES

TRAIT SCALES	Rated Prior to Instructions				Rated for Last Part of Experiment			
	Nervous Tension	Weariness	Arousal	Enthusiasm	Nervous Tension	Weariness	Arousal	Enthusiasm
Alexander-Epstein Extroversion								
Alexander-Epstein Manifest Anxiety	(.22)			.25		.25		
Alexander-Epstein Weariness		(.14)		.37	-.28	.34		
Eysenck Extroversion				(.21)	-.26			
Eysenck Neuroticism	(.12)				(.04)			
Eysenck Lie Scale								
Combined Extroversion								
Combined Neuroticism	(.12)				(.04)			

Table 4. Correlations between trait and state scales (N = 48), significant at the $p < .05$ level. Non-significant correlations that may be of interest are bracketed.

scale to be negatively correlated with the average SCR over the 64 trials when expressed in micromhos ($r = -.25$, $p = .04$) and when range corrected ($r = -.42$, $p = .002$). The Alexander-Epstein scale of extroversion was correlated with the average range corrected SCR in the same direction but not to an acceptable level of significance ($r = -.18$, $p = .11$). The combined extroversion scale was also significantly correlated with the average range corrected SCR ($r = -.35$, $p = .007$). The Alexander-Epstein scales of manifest anxiety and weariness approached a significant degree of correlation with the average range corrected SCR ($r = .22$, $p = .07$ and $r = -.21$, $p = .07$, respectively).

To further analyze this relationship between self reports of temperament traits and the average range corrected SCR, each trait item was correlated with the average SCR. Twenty-seven items were found to be significantly related at the $p \leq .05$ level, and all of those items seemed indicative of an inability to inhibit stimulation, emotions, and behavior. A post hoc scale was constructed by purifying the items by means of an item analysis between each item and the whole scale. The result was a 21-item scale weighted fairly equally with items indicating inability to ignore distractions when studying, impulsivity, uncontrolled emotionality, and worrying (see Table 5). The post hoc scale of inability to inhibit was correlated with the average tonic skin conductance in micromhos ($r = .26$), with average

Table 5

Trait Statements the Ratings of Which Were Correlated with Average Range Corrected Skin Conductance Response (AVRCSCR)

Corr. with AVRCSCR	Corr. with these items as a scale	Items in the Order They Were Presented
-.25	-.40	I usually act on the spur of the moment.
-.41	-.77	I can't concentrate unless I have complete peace and quiet.
-.27	-.28	I sometimes notice my heart pounding wildly for no good reason.
.36	.64	I am able to study even when others around me are talking.
-.30	-.43	When I start laughing it seems that I can't stop myself.
-.35	-.14 X	I almost always enjoy meeting people.
-.27	-.61	When studying I am easily distracted by things happening around me.
-.25	-.45	At time I have fits of laughing or crying that I cannot control.
-.30	-.66	I sometimes feel like beating or smashing things.
-.44	-.61	Sometimes I lie in bed for hours before falling asleep.
.34	.68	When studying I am able to ignore almost any distraction.
.24	.44	I do not startle easily.
-.24	-.40	I tend to fall apart under stress.
-.28	-.70	I need absolute quiet when studying.
.31	.35	Do you stop and think things over before doing anything?

Table 5 (continued)

Corr. with AVRCSCR	Corr. with these items as a scale	Items in the Order They were Presented
.25	.06 X	If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?
-.24	-.46	Do you generally do and say things quickly without stopping to think?
.29	.04 X	Generally do you prefer reading to meeting people?
-.46	-.34	Do you like going out a lot?
-.31	-.38	When people shout at you, do you shout back?
-.40	-.59	Are you often troubled by feelings of guilt?
-.26	-.27	Are you most quiet when you are with other people?
.23	.35	Do you like the kind of work that you need to pay close attention to?
.36	.20 X	Do you hate being with a crowd who play jokes on one another?
-.24	-.49	Do you worry about awful things that might happen?
-.32	-.17 X	Would you be very unhappy if you could not see lots of people most of the time?
-.23	-.12 X	Do you suffer from sleeplessness?

An "X" indicates that the item was deleted from the final scale because item correlation with scale was too weak.

SCR in micromhos (r = .31) and with the average range corrected SCR (r = .61). Because these are post hoc tests, no conclusions can be reached, but the new scale of inhibitory ability can be used in further research as a predictive scale.

Correlations between state scales and physiological measures. The only significant correlation between a state scale and physiological measures was between the scale of weariness rated prior to instructions and the degree of habituation of the range corrected SCR from block 1 to block 4 (r = .28, p = .03). The subjects higher on the scale of weariness habituated more over trials.

Correlations of trait and state scales with the measures of paradoxical dropoff. A measure of paradoxical dropoff in autonomic reactivity was created by sorting subjects by the curve type they exhibited for SCR to the most intense noise over light levels, as described in the section concerning data reduction. This study did not find a significant correlation with any of the major trait or state scales.

A similar measure was created using reactivity as rated by the subjects. The degree of paradoxical responding when averaged over four blocks was negatively correlated with the scale of arousal rated prior to instructions (r = -.35, p = .02) and with enthusiasm rated prior to instructions (r = -.32, p = .03). The same state scales rated for the experimental period were also correlated with the

degree of paradoxical responding for self ratings of reactivity ($r = -.25$, $p = .08$, $r = -.35$, $p = .02$, respectively).

Correlations of trait and state scales with the measure of sensitivity to autonomic reactivity. A correlation was made for each subject between his 64 SCRs and his 64 ratings of reactivity, partialling out the effects of noise and light levels. This correlation was used to measure each subject's awareness of his autonomic reactivity. This measure was not found to be significantly correlated with any of the trait or state scales.

CHAPTER V

CONCLUSIONS AND DISCUSSION

Effects of Stimulus Intensity within each Sensory Modality

This study found the expected result that increasing intensities of noise and light stimulation produce increasing magnitudes of reactivity, both for SCR and for subjects' ratings of their reactivity. It is interesting that although a wide range of light stimulation was presented, ranging up to the almost painful flash of a direct photoflash, the range of reactivity over light levels was less than the range of reactivity over noise levels. The difference in effectiveness of the two sensory modes was especially true for the SCR measure. This effect was also found in the previous study from which the initial predictions were made. In the present study a far greater range of light intensity was used, while the range of noise intensity was about the same as before. In terms of energy emitted, the range of each mode was roughly equivalent--ten decibel spacings. It seems that a much narrower range of noise intensity must be used if one wishes to equate the reactivity of the two sensory modes at each level of intensity.

The finding that noise has a greater effect upon SCR than light of similar subjective intensity has also been reported by White (1964). This suggests that our alerting system is constructed to

respond more to sudden noises than sudden lights. In terms of survival, sudden noises are often associated with danger, while it is difficult to think of a natural situation in which sudden light would have to be reacted to as a signal for danger. It is of interest that the White study found mild shock (a touch sensation) to be the most effective stimulus for SCR, although subjects rated the shock as being less intense than the noise.

Ongoing muscular exertion had no effect upon reactivity to brief stimulation of moderate to high intensities. This finding certainly does not rule out all possibility of inhibition of reactivity by physical activity. It does seem to indicate that such interactive effects are not reflexive and quick acting, but are more complex functions involving attention and distraction.

Interactive Effects of Sensory Stimulation

Skin conductance responses. As the purpose of this study was to find effects attributable to a reflex of protective inhibition, particular attention was paid to interactive effects, especially at the most intense levels of stimulation. The SCR measure did not exhibit any such noise by light interaction. For SCR, noise and light had a simple additive effect upon the magnitude of skin conductance responses.

The results of this study fail to support the concept that

protective inhibition can occur as a reflex that quickly inhibits reticular activation. The failure to find inhibitory heteromodal effects upon SCR may be because Pavlovian type paradoxical responses are of a more complex nature, requiring more time to develop. The effect as first reported by Pavlov and as refined by later psychologists, is of a cortically mediated reflex that inhibits the reticular system, which in turn reduces cortical arousal.

That some type of inhibitory effect can occur has been shown by the two heteromodal studies that directly led to the present study. These studies used stimuli of ½ second duration. Because inhibitory effects were twice found using that time span, but not when using heteromodal stimulation of less than 1/10 second duration, it seems that the paradoxical effect is due to inhibition that requires more time to develop and have an influence upon autonomic reactivity. Because of the shortened time span, subjects received only 1/3 the noise stimulation, although the light stimulation was roughly equivalent to the former studies. There is the possibility that the reduction in the absolute magnitude of noise stimulation resulted in stimulus intensities below that necessary for protective inhibition. This possibility remains, but is contradicted by the findings of the former studies, that the effect was due to an adaptive "intensity learning" effect in which relative, rather than absolute, magnitudes of stimulation determined the level at which overstimulation occurred.

This study, using 48 subjects, repeated measurements, and well controlled stimulation, was designed to find such a quick-acting inhibitory effect upon arousal. If a paradoxical effect were present, the statistical power of the experimental design was enough to have found significant results. The failure to find inhibition runs counter to the concept that protective inhibition is a quick-acting homeostatic reticular reflex. The results of this study lead to the conclusion that protective inhibition needs time to develop, even when a person knows that a noxious stimulus is coming. The importance of time duration may be because neuronal inhibition takes time to develop, or because the effect is associated with eyeblinks to avoid visual stimulation. Another possibility is that more intense stimulation would produce inhibitory effects with brief stimulation. Only further research can answer these questions.

Subjects' ratings of reactivity. The ratings showed a reliable, although not dramatic, noise by light interaction, indicative of a levelling-off of reactivity. This effect was in the predicted direction, but few subjects showed paradoxical decreases. The finding that the subjects' ratings of reactivity exhibited a less than additive effect at higher levels of stimulation suggests an inhibiting factor, but from the shape of the curve there is no way to discriminate between a passive limit to subjective reactivity and an inhibition that reacts against overstimulation by actively (on a neuronal level)

inhibiting the reaction. If the slope of the curve of reactivity of the most intense noise over increasing intensities of light showed a paradoxical decrease, then an active inhibition would have been supported. Instead, this study only demonstrated that for subjective reactivity, the effect of combined heteromodal stimulation is less than additive at relatively high intensities of stimulation, possibly indicative of a "ceiling effect" on the rating scales.

Effects of Self Report Measures

Trait scales. This study was designed to test the effects of extroversion and neuroticism as both trait and state measures. Two predictions derived from Eysenck's theory were tested by this study. He said that his trait scale of extroversion is associated with less reticular reactivity, which causes introverts to be closer to their threshold for protective inhibition. The first half of Eysenck's prediction was supported, for extroversion was associated with a lower magnitude of average skin conductance responses. The second half of the prediction derived from Eysenck's theory of temperamental traits was not testable, as paradoxical responses do not seem to be caused by a quick-acting reticular reflex.

State scales. One of the most striking findings of this study was that the trait scores for each subject were quite poor at predicting the mood state of the subject prior to instructions or at

the end of the experiment. The only significant relationships between trait and state scales were between reported traits of being anxious and weary with a reported state of being initially enthusiastic about the experiment. This correlation might be taken as evidence of a greater desire to please the experimenter in anxious subjects. In general there was no reliable predictive power of trait scales in this situation. The trait scale of weariness was the most reliable predictor, for it was related to self reports of weariness during the experiment.

Subjects high on the state scale of enthusiasm rated their reactivity as being greater than subjects low on the state scale of enthusiasm. Subjects high on the state scale of weariness also rated their reactivity as habituating more than subjects low on the state scale of weariness. On the SCR measure, subjects high on the state scale of weariness did not react as much to the loud noises as the subjects low on the state scale of weariness, and also habituated more over trials. These results indicate that subjects could reliably report being unreactive.

REFERENCES

Alexander, R. B., & Epstein, S. Reactivity to heteromodal stimulation as a function of intensity of the stimuli and inner arousal (Submitted for publication, 1977).

Broen, E., & Storms, H. Lawful disorganization: The process underlying a schizophrenic syndrome. Psychological Review, 1966, 73, 4, 265-279.

Buchsbaum, M., & Silverman, J. Stimulus intensity control and the cortical evoked response. Psychosomatic Medicine, 1968, 30, 12-22.

Burch, N. R., & Greinder, T. H. A bioelectric scale of human alertness: Concurrent recording of the EEG and GSR. Psychiatric Research Reports, 1960, 12, 183-193.

Child, L., & Wendt, G. R. The temporal course of the influence of visual stimulation upon the auditory threshold. Journal of Experimental Psychology, 1939, 23, 2, 109-127.

Davis, R. C., Buchwald, A. M., & Frankman, R. W., Autonomic and muscular responses and their relation to simple stimuli. Psychological Monographs: General and Applied, 1955, 69, 20, 1-71.

Dell, P., Bonvallet, M., & Hugelin, A. Mechanisms of reticular deactivation. In G. E. W. Wolstenholme and M. O'Connor (Eds.), The nature of sleep. Boston, Massachusetts: Little and Brown, 1961 (pp. 86-102).

Duffy, E. Activation and behavior. New York: Wiley, 1962.

Epstein, S. Food-related responses to ambiguous stimuli as a function of hunger and ego strength. Journal of Consulting Psychology, 1961, 25, 6, 463-469.

Epstein, S. Toward a unified theory of anxiety. Progress in Experimental Personality Research, 1967, 4, 1-89. New York: Academic Press.

Epstein, S., Boudreau, L., & Kling, S. Magnitude of the heart rate and electrodermal response as a function of stimulus input, motor output, and their interaction. Psychophysiology, 1975, 12, 1, 15-24.

Eysenck, H. J. Dimensions of personality. London: Kagan Paul, 1947.

Eysenck, H. J. The dynamics of anxiety and hysteria. New York: Praeger, 1957.

Eysenck, H. J. Conditioning, introversion-extroversion, and the strength of the nervous system. Proceedings of the 17th International Congress of Experimental Psychology, Moscow, 1966, 33-34.

Eysenck, H. J. The biological basis of personality. Springfield, Illinois: Charles C. Thomas, 1967.

Eysenck, H. J., & Eysenck, S. B. G. Manual for the Eysenck Personality Inventory. San Diego: Educational Testing Service, 1968.

Eysenck, S. B. G., & Eysenck, H. J. Physiological reactivity to sensory stimulation as a measure of personality. Psychological Reports, 1967, 20, 45-46.

Fenz, W. D., & Epstein, S. Manifest anxiety: Unifactorial or multi-factorial composition? Perceptual and Motor Skills, 1965, 20, 773-780.

Fenz, W. D., & Epstein, S. Gradients of physiological arousal in parachutists as a function of an approaching jump. Psychosomatic Medicine, 1967, 29, 1, 33-51.

French, J. D. Corticofugal connections with the reticular formation. In H. H. Jasper (Ed.), Reticular formation of the brain. Boston, Massachusetts. Little and Brown, 1958 (pp. 491-505).

French, J. D., Van Ameronger, F. K., & Magoun, H. W. Activating system in the brainstem of the monkey. A. M. A. Archives of Neurological Psychiatry, 1952, 68, 577-590.

Freud, S. Beyond the pleasure principle (J. Strachey, trans.). New York: Bantam, 1928.

Furster, J.M. Effects of stimulation of brain stem on tachistoscopic perception. Science, 1958, 127, 150.

Gescheider, G. A., & Niblette, R. K. Cross-modality masking for touch and hearing. Journal of Experimental Psychology, 1967, 74, 3, 313-320.

Gilbert, G. M. Inter-sensory facilitation and inhibition. Journal of General Psychology, 1941, 24, 381-407.

Gray, J. A. Pavlov's typology: Recent theoretical and experimental developments from the laboratory of B. M. Teplov. Oxford: Pergamon Press, 1964.

Hartman, G. W. Changes in visual acuity through simultaneous stimulation of other sense organs. Journal of Experimental Psychology, 1933, 16, 393-407.

Hartman, G. W. The facilitating effect of strong general illumination upon the discrimination of pitch and intensity differences. Journal of Experimental Psychology, 1934, 17, 813-822.

Hebb, D. O. Drives and the C. N. S. (conceptual nervous system). Psychological Review, 1955, 62, 243-254.

Heymans, G. "Untersuchungen Über psychisch Hemmung: V. Die Verdrängung von Schallempfindungen durch elektrische Hautempfindungen." Zsch. f. Psychol., 1904, 34, 15-28. In G. M. Gilbert, Intersensory facilitation and inhibition. Journal of General Psychology, 1941, 24, 381-407.

Hovland, C. I., & Riesen, A. H. Magnitude of galvanic and vasomotor response as a function of stimulus intensity. Journal of General Psychology, 1940, 23, 103-121.

Hull, C. L. Principles of behavior. New York: Appleton Press, 1943.

Hull, C. L. Essentials of behavior. New Haven, Connecticut: Yale University Press, 1951.

Ide, A. L. *The influence of temperature on the formation of judgements in lifted weight experiments*. Unpublished Ph.D. dissertation, 1919, University of Pennsylvania. In G. M. Gilbert, Intersensory faciliation and inhibition. *Journal of General Psychology*, 1941, *24*, 381-407.

Jacobson, E. Experiments on the inhibition of sensations. *Psychological Review*, 1911, *18*, 24-53.

Kravkov, S. V. Der Lichtirradiationseffekt im Auge in seiner Abhängigkeit von den Gesichts-, Gehörs-, und Geruchsnebenreizen. *Arch. f. Ophthal.*, 1933, *132*, 421-429. In G. M. Gilbert, Intersensory facilitation and inhibition. *Journal of General Psychology*, 1941, *24*, 381-407.

Kravkov, S. V. Changes of visual acuity in one eye under the influence of the illumination of the other or of acoustic stimuli. *Journal of Experimental Psychology*, 1934, *17*, 805-812.

Lacey, J. I. Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley and R. Trumball (Eds.), *Psychological stress: Issues in research*. New York: Appleton-Century-Crofts, 1967.

Lavine, R., Buchsbaum, M. S., & Poncy, M. Auditory analgesia: Somatosensory evoked response and subjective pain rating. *Psychophysiology*, 1976, *13*, 3, 140-148.

Lykken, D. T. Range correction applied to heart rate and to GSR data. Psychophysiology, 1972, 9, 373-379.

Magoun, H. W. Physiological interrelationships between cortex and subcortical structures. Electroencephalography and Clinical Neurophysiology, 1953, 4, 163-167.

Malmo, R. B. Anxiety and behavioral arousal. Psychological Review, 1957, 64, 5, 276-287.

Malmo, R. B. Activation: A neurophysiological dimension. Psychological Review, 1959, 66, 6, 367-386.

Mednick, S. A. A learning theory approach to research in schizophrenia. Psychological Bulletin, 1958, 55, 5, 316-327.

Mefferd, R. B., Sadler, T. G., & Wieland, B. A. Psychophysiology, 1969, 6, 2, 186-196.

Melzack, R., Weisz, A. Z., & Sprague, L. T. Strategems for controlling pain: Contributions of auditory stimulation and suggestion. Experimental Neurology, 1963, 8, 239-247.

Moruzzi, G., & Magoun, H. W. Brainstem reticular formation and activation of the EEG. Electroencephalograpy and Clinical Neurophysiology, 1949, 1, 455-473.

Newhall, S. M. Effects of attention on the intensity of pressure and brightness. Archives of Psychology, 1923, 9, 61, 1-75.

Pavlov, I. P. Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex, G. V. Anrep (translator and editor). London: Oxford University Press, 1927.

Pavlov, I. P. Conditioned reflexes and psychiatry: Lectures on conditioned reflexes, Vol. 2, W. H. Gantt (translator and editor). New York: International Publishers, 1941.

Serrat, W. O., & Karwoski, T. An investigation of the effect of auditory stimulation on visual sensitivity. Journal of Experimental Psychology, 1936, 19, 604-611.

Silverman, J., Buchsbaum, M., & Henkin, R. Stimulus sensitivity and stimulus intensity control. Perceptual and Motor Skills, 1969, 28, 71-78.

Sokolov, Y. N. Perception and the conditioned reflex, S. W. Waydenfield (trans.). New York: MacMillan, 1963.

Stennet, R. G. The relationship of performance level to level of arousal. Journal of Experimental Psychology, 1957, 54, 1, 54-61.

Szpiler, J. A., & Epstein, S. The effect of simultaneous light and noise stimulation upon autonomic reactivity. Unpublished study, University of Massachusetts, 1975.

Taylor, S. P., & Epstein, S. The measurement of autonomic arousal: Some basic issues illustrated by the covariation of heart rate and skin conductance. Psychosomatic Medicine, 1967, 29, 4, 514-525.

Thorne, F. C. The psychophysical measurement of the temporal course of visual sensitivity. Archives of Psychology, 1934, 25, 170, 1-66.

Uno, T., & Grings, W. W. Autonomic components of orienting behavior. Psychophysiology, 1965, 1, 311-321.

Urbantschitsch, V. Eeber den einfluss von Trigeninus-Keizen auf die sinnesempfindungen insbesondere auf den Gesichtsinn. _Arch. Ges. Physiol._, 1883, _30_, 129-175. In G. M. Gilbert, Intersensory facilitation and inhibition. _Journal of General Psychology_, 1941, _24_, 381-407.

White, E. H. Subjectively equated stimulus intensities and autonomic reactivity. _Journal of Experimental Psychology_, 1964, _68_, 3, 297-300.

Appendix

Frequency of Feelings Questionnaire.

(Includes the Alexander-Epstein experimental temperament scale and the Eysenck Personality Inventory.)

Subject Instructions.

Mood State Questionnaires.

(One at the beginning of the experiment.
One at the end of the experiment.)

RA-SE 75

Frequency of Feelings Questionnaire

These adjectives describe feelings that most people experience at one time or another. Estimate how often you feel the way described, using the frequency scale below. Mark your answers using a soft pencil on the IBM form. All data is confidential.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

How often do you feel:

1	alert	6	enthusiastic	11	fragmented
2	calm	7	excited	12	jittery
3	dazed	8	exhausted	13	lively
4	disorganized	9	extroverted	14	nervous
5	energetic	10	fatigued	15	on-edge
16	relaxed	21	sluggish	26	unexcitable
17	restless	22	spontaneous	27	unsettled
18	scared	23	tense	28	vigorous
19	secure	24	tired	29	weary
20	shy	25	unafraid	30	worried

For the following statements indicate how true each is for you, using the scale below:

1	2	3	4	5
Strongly Disagree	Tend to Disagree	Undecided	Tend to Agree	Strongly Agree

31 I sometimes have feelings of anxiety for no special reason.

32 I usually act on the spur of the moment.

33 I am often awakened at night by small noises.

34 I am usually able to snap into alertness within a minute of waking.

35 I am troubled by a nervous stomach.

1	2	3	4	5
Strongly Disagree	Tend to Disagree	Undecided	Tend to Agree	Strongly Agree

36 I feel right at home at a lively, talkative party.

37 I can't concentrate unless I have complete peace and quiet.

38 I usually need an hour to become fully awake in the morning.

39 I sometimes notice my heart pounding wildly for no good reason.

40 I am startled more easily than most people by sudden surprises.

---

41 I am able to study even when others around me are talking.

42 I make friends easily.

43 When I start laughing it seems that I can't stop myself.

44 I break out in a nervous sweat.

45 Photographic flashbulbs seem to startle me less than most people.

---

46 I like lots of stimulation.

47 I have a startle response when a telephone rings.

48 My sleep is fitful and disturbed.

49 I almost always enjoy meeting people.

50 I find it difficult to prevent myself from crying when badly upset.

---

51 I am an impulsive person.

52 When studying I am easily distracted by things happening around me.

53 At times I have fits of laughing or crying that I cannot control.

54 I feel like beating or smashing things.

55 When studying I can ignore a radio or TV in the room with me.

---

56 At night I usually fall asleep in a minute or less.

57 I sweat easily even on cool days.

58 I start to work on a new project with a great deal of enthusiasm.

59 I am a nervous person.

60 Sometimes I lie in bed for hours before falling asleep.

1	2	3	4	5
Strongly Disagree	Tend to Disagree	Undecided	Tend to Agree	Strongly Agree

61 I am more easily startled by sudden flashes of light than most people.

62 I often feel depressed.

63 I am less startled by sudden noises than most people.

64 I seem to lack the drive necessary to get a lot of work done.

65 I frequently play with my lips and teeth.

---

66 I am an active person, on the go all day long.

67 When I study I am able to ignore almost any distraction.

68 I feel that I am about to go to pieces.

69 I am a heavy sleeper, not easily awakened by noises at night.

70 I often feel the urge to stir up excitement.

---

71 I do not startle easily.

72 I tend to fall apart under stress.

73 I can sleep through almost any commotion.

74 I need absolute quiet when studying.

75 I often feel disorganized and confused.

---

76 Given free choice, what time would you go to bed most nights?

before 10 p.m. = 1, 10-11 = 2, 11-12 = 3, 12-1 = 4, 1 or later = 5

77 Given free choice, what time would you wake most mornings?

before 7 a.m. = 1, 7-8 = 2, 8-9 = 3, 9-10 = 4, after 10 = 5

78 Have you ever experienced an epileptic attack? No = 1, Yes = 2

79 Are you taking anti-depressant drugs? No = 1, Yes = 2

80 Are you taking tranquilizing drugs? No = 1, Yes = 2

For the following statements try and decide whether Yes or No represents your usual way of acting or feeling. We want your first reaction so work quickly.

1 = NO 2 = YES

81 Do you often long for excitement?

82 Do you often need understanding friends to cheer you up?

83 Are you usually carefree?

84 Do you find it very hard to take no for an answer?

85 Do you stop and think things over before doing anything?

---

86 If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?

87 Does your mood often go up and down?

88 Do you generally do and say things quickly without stopping to think?

89 Do you ever feel "just miserable" for no good reason?

90 Would you do almost anything for a dare?

---

91 Do you suddenly feel shy when you want to talk to an attractive stranger?

92 Once in a while do you lose your temper and get angry?

93 Do you often do things on the spur of the moment?

94 Do you often worry about things you should not have done or said?

95 Generally do you prefer reading to meeting people?

---

96 Are your feelings rather easily hurt?

97 Do you like going out a lot?

98 Do you occasionally have thoughts and ideas that you would not like other people to know about?

99 Are you sometimes bubbling over with energy and sometimes very sluggish?

100 Do you prefer to have few but special friends?

---

101 Do you daydream a lot?

102 When people shout at you, do you shout back?

1 = NO 2 = YES

---

103 Are you often troubled about feelings of guilt?

104 Are all your habits good and desirable ones?

105 Can you usually let yourself go and enjoy yourself a lot at a lively party?

---

106 Would you call yourself tense or "highly-strung"?

107 Do other people think of you as being very lively?

108 After you have done something important, do you often come away feeling you could have done better?

109 Are you mostly quiet when you are with other people?

110 Do you sometimes gossip?

---

111 Do ideas run through your head so that you cannot sleep?

112 If there is something you want to know about, would you rather look it up in a book than talk to someone about it?

113 Do you get palpitations or thumping in your heart?

114 Do you like the kind of work that you need to pay close attention to?

115 Do you get attacks of shaking or trembling?

---

116 Would you always declare everything at the customs even if you knew that you could never be found out?

117 Do you hate being with a crowd who play jokes on one another?

118 Are you an irritable person?

119 Do you like doing things in which you have to act quickly?

120 Do you worry about things that might happen?

---

121 Are you slow and unhurried in the way you move?

122 Have you ever been late for an appointment or work?

123 Do you have many nightmares?

124 Do you like talking to people so much that you would never miss a chance of talking to a stranger?

1 = NO 2 = YES

---

125 Are you troubled by aches and pains?

---

126 Would be very unhappy if you could not see lots of people most of the time?

127 Would you call yourself a nervous person?

128 Of all the people you know are there some whom you definitely do not like?

129 Would you say you were fairly self-confident?

130 Are you easily hurt when people find fault with you or your work?

---

131 Do you find it hard to really enjoy yourself at a lively party?

132 Are you troubled with feelings of inferiority?

133 Can you easily get some life into a rather dull party?

134 Do you sometimes talk about things you know nothing about?

135 Do you worry about your health?

---

136 Do you like playing pranks on others?

137 Do you suffer from sleeplessness?

Please note your sex by filling in A if woman, B if man in the box above the label "sex". You need not identify yourself further.

If you wish to give me your name and telephone number, you may have feedback as to your place in the sampled distribution on two scales: manifest anxiety and social extroversion. You will also have a chance to participate in two follow-up experiments, for 3 experimental credits. The experiments involve 1) attending to a series of brief light and noise stimuli, testing a probable brain reflex that controls arousal, and 2) a test of alpha conditioning (brain wave feedback) ability. If you are interested fill in your name, and in the space marked "student number" write the telephone number where you can be reached in the evenings.

Thank you for your help!

S75-23

Robert Alexander
Seymour Epstein
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Arousal Reflex Experiment

The startle response is a lower brain reflex that arouses us following any significant change in stimulation. In general, more intense stimuli provoke more intense startle responses. This experiment is designed to study the interaction effects of light and noise stimuli, and also the effects of stress, both physical and emotional, upon reactions to simple stimuli.

In the experiment, your task will be to view a series of brief light and noise bursts of varying intensities. Your skin conductance will be measured from one hand, while you lift a weight with your favored hand. After each trial I waill ask you to rate your reaction to the stimulus.

To be more specific, the lights and noises are each of four intensities which we label low, medium, high, and very high. The light comes from a camera photoflash, through one of four moveable light filters. The noise stimuli are also of four intensities, and are roughly equivalent to the light intensities. I wish to assure you that the stimuli are not at all harmful. The very high light is less intense than if you were having your picture taken, and the very high noise does not approach the loudness of a rock band. However as the room is soundproofed and as you will be in near darkness, the very high stimuli will seem plenty intense. The duration of the noise is .08 second and the light lasts .001 second.

Because the light is so brief, a blink could invalidate some trials. One method for viewing the light is to blink your eyes several times before the flash, and then stare intently when the flash is expected. A dim green light will enable you to focus on the correct spot. To be certain that you see the flash, a red number will flash at the same time as the stimulus, in the center of the target-light. Remember the number, and also the way each stimulus affects you, as I will ask you later.

To study the effects of physical stress, half of the subjects will be lifting a weight at 1/4 strength, and the other half will go through the motions but without any exertion. Begin to pull when the green target-light turns on, view the stimulus, and continue pulling and wait until the target-light turns off. Then set the weight down slowly. A light will then signal you to call out the red number you saw. Errors are no crime, it just means that the trial will be repeated later.

The next signal asks you to rate your reaction to the stimulus, how much it affected you, such as produced a startle reaction. You will rate your reaction by pressing one of nine buttons ranging from low to very high intensity. Push the button down for a full second. After the ratings there is a brief rest period. Then the green target-light begins the next trial.

With 4 lights × 4 noise intensities, it takes 16 trials to present every combination once. Each combination will be repeated 5 times, so the experiment will be somewhat tedious (80 trials, 40 minutes). Because the task is boring, in addition to the 2 hours of experimental credit we are also giving a bonus of $2.00. You may also expect a copy of the results next fall.

As in any psychology experiment, you have the right to leave at any time, now or later. If you don't wish to continue, you will receive one credit for your help so far. If you do wish to be a part of this experiment, please sign below.

Signature

Descriptive Adjectives Questionnaire

Please recall your mood of the last few minutes. Some of these adjectives might describe your feeling-state better than others. Indicate how descriptive each word is, using the following scale and circling your answer.

1	2	3	4	5
not at all	only slightly	moderately	definitely	very much

alert	1	2	3	4	5	weary	1	2	3	4	5
enthusiastic	1	2	3	4	5	on-edge	1	2	3	4	5
tense	1	2	3	4	5	energetic	1	2	3	4	5
relaxed	1	2	3	4	5	secure	1	2	3	4	5
tired	1	2	3	4	5	exhausted	1	2	3	4	5
dazed	1	2	3	4	5	excited	1	2	3	4	5
lively	1	2	3	4	5	fatigued	1	2	3	4	5
scared	1	2	3	4	5	sluggish	1	2	3	4	5
calm	1	2	3	4	5	vigorous	1	2	3	4	5
nervous	1	2	3	4	5	worried	1	2	3	4	5

Thank you for your help.

Recall your mood during the experiment, say 5 minutes ago. Rate how descriptive each word is.

1	2	3	4	5
not at all	only slightly	moderately	definitely	very much

alert	1	2	3	4	5	weary	1	2	3	4	5
enthusiastic	1	2	3	4	5	on-edge	1	2	3	4	5
tense	1	2	3	4	5	energetic	1	2	3	4	5
relaxed	1	2	3	4	5	secure	1	2	3	4	5
tired	1	2	3	4	5	exhausted	1	2	3	4	5
dazed	1	2	3	4	5	excited	1	2	3	4	5
lively	1	2	3	4	5	fatigued	1	2	3	4	5
scared	1	2	3	4	5	sluggish	1	2	3	4	5
calm	1	2	3	4	5	vigorous	1	2	3	4	5
nervous	1	2	3	4	5	worried	1	2	3	4	5

How did you prepare when the light and noise stimuli were coming?

I tensed my muscles. (not counting your working arm)	never	seldom	sometimes	often	always
I deliberately relaxed my muscles.	never	seldom	sometimes	often	always
I squinted.	never	seldom	sometimes	often	always
I mentally prepared to control my reaction.	never	seldom	sometimes	often	always
I took a deep breath before the stimulus.	never	seldom	sometimes	often	always
I held my breath during the stimulus.	never	seldom	sometimes	often	always

I made no preparation other than pulling and focusing on the target.	never seldom sometimes often always

Thanks for your help!

Please tell me anything that you don't think was covered on this questionnaire.