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INHIBITION OF AUTONOMIC INDICATORS OF AROUSAL BY SUGGESTION-INDUCED RELAXATION: A VERIFICATION AND EXTENSION OF THE RECIPROCAL INHIBITION PRINCIPLE

by
David Katz

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of the requirements for the degree of
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ABSTRACT

INHIBITION OF AUTONOMIC INDICATORS OF AROUSAL BY SUGGESTION-INDUCED RELAXATION: A VERIFICATION AND EXTENSION OF THE RECIPROCAL INHIBITION PRINCIPLE

by
David Katz

Chairman: James V. McConnell

Wolpe's principle of reciprocal inhibition (based on the assumed inhibition of fear-related autonomic nervous system (A.N.S.) arousal by competing muscle relaxation responses) was analyzed and re-interpreted within a more general framework of excitation and inhibition of A.N.S. arousal.

An experiment was undertaken to demonstrate that inhibition of A.N.S. arousal could be produced without training in muscle relaxation procedures, or hypnotic induction, under conditions of arousal presumably unrelated to fear. It was hypothesized that repeated instructions suggestive of calmness, relaxation and tranquility (elements common to all relaxation training) would be sufficient to inhibit arousal.

Three groups of ten randomly assigned Ss participated in a series of five experimental trials. Each trial consisted of a basic sequence of a one-minute period of mental arithmetic (to excite arousal) followed by a two-minute recovery period. During the recovery periods, the E ("Relaxation") group heard verbal relaxation

suggestions, while one control group ("Listening") heard irrelevant verbal material, and the other control group ("Waiting") waited in silence. All groups did identical multiplication problems during mental arithmetic periods. It was predicted that the E group would show greater inhibition of arousal during recovery periods.

The results, based on two indices of autonomic activity which vary monotonically with arousal level (basal skin resistance /B.S.R./ and rate of non-specific skin resistance fluctuations /G.S.R.'s/ revealed significantly lower arousal during recovery periods for the E group, and no differences between the two control groups.

The results were interpreted to suggest that the symbolic referents of the instructions were associated with the inhibitory effects, and that instructional variables rather than reduced muscle tonus may be effective in diminishing fear in reciprocal inhibition therapy.

The phenomenon of arousal-inhibiting stimulation was reinterpreted within the paradigm of Pavlovian conditioned inhibition. It was hypothesized that a number of stimulus conditions may operate to directly inhibit arousal, irrespective of its source, and that the effective elements of reciprocal inhibition reduce fear, not because of a special inhibitory relationship to fear, but because they are general arousal inhibitors, and arousal is a necessary but not a sufficient condition for fear.

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INTRODUCTION

The capacity to control or attenuate the distressing physiological effects of unpleasant emotions (fear, anxiety, tension, etc.), particularly under conditions of unavoidable noxious stimulation, is considered highly adaptive and desirable (Lykken, 1968).

The most widely known current therapy which is presumed to reduce fear by directly influencing the physiological aspects of the emotion is systematic desensitization (Wolpe, 1958). Wolpe based his treatment method on the assumption that fear is essentially an intense response of the sympathetic branch of the autonomic nervous system, (A.N.S.) to a noxious conditioned stimulus. High levels of sympathetic-adrenal activity and muscle tension were assumed to mediate escape and avoidance behavior and to be perceived as unpleasant emotion and tension. Wolpe argued that other responses existed which were "antagonistic" to fear and presumably would inhibit fear-related A.N.S. arousal. Wolpe reasoned that directly reducing the level of fear-related A.N.S. arousal in the presence of a fearful stimulus would favor the extinction of fear responses. He designated this proposition the principle of reciprocal inhibition.

> If a response inhibitory to anxiety can be made to occur in the presence of anxiety evoking stimuli, so that it is accompanied by a complete or partial suppression of the anxiety response, the bond between these stimuli and the anxiety responses will be weakened. Wolpe (1958), p. 71.

The best known and most widely utilized "anxiety inhibiting" response Wolpe endorses is muscle relaxation, hypnotically induced

or taught by the Jacobson (1938) method of "progressive relaxation."

Some of Wolpe's theoretical assumptions about the nature of fear have been questioned as oversimplifications. The identification of fear as primarily a sympathetic arousal response has been disputed on several grounds. While noxious or fearful stimulation is usually associated with high levels of sympathetic arousal, the converse need not be true. Induced sympathetic arousal may lead to a number of emotions unrelated to fear (Schachter, 1964), while the weight of evidence from modern psychophysiological study indicates that a wide variety of innocuous stimulus conditions result in sympathetic arousal (Malmo, 1958; Duffy, 1962; Lykken, 1968; Shapiro and Crider, 1969). It is likely that sympathetic arousal is a necessary rather than a sufficient condition for the experience of unpleasant or fearful emotion or tension (Lykken, 1968; Bandura, 1969). Whatever the desirability of extending and reinterpreting the psychophysiological bases of fear, it would not appear to change Wolpe's clinical assumption, i.e., that the ability to control or attentuate the level of sympathetic arousal by psychological means is of great adaptive value in overcoming fear.

Despite questionable assumptions about the nature of fear, Wolpe's principle of reciprocal inhibition raises some issues which are very worthy of experimental inquiry:

1. If increased sympathetic arousal associated with fear may be directly attentuated by muscle relaxation, inducing relaxation ought

to result in observable changes in arousal level opposite to those associated with fear. This also suggests a paradigm for determining the value of any other condition presumed to attentuate fear (or arousal).

2. Since arousal occurs in many situations unrelated to fear, or even emotion, stimulus conditions which inhibit fear-elicited arousal may also inhibit arousal unrelated to fear. This prompts the speculation that Wolpe may have discovered a general method for inhibiting sympathetic arousal which has clinical applications for the attenuation of fear.

3. Although the attenuation of arousal is ascribed by Wolpe to a hypothetical physiological or neurological incompatibility of the muscle relaxation response with anxiety, it is also clear that certain stimulus conditions must be present to elicit this or other inhibitory responses. A reinterpretation of the reciprocal inhibition principle into psychological terms suggests that stimulus conditions (arousal inhibitors) exist which influence A.N.S. response in a direction opposite to that of sympathetic arousal. If this reinterpretation is accepted, it becomes salient to investigate the essential elements of stimulus conditions associated with the inhibition of sympathetic arousal.

This work will attempt an analysis of some of the issues raised by the reciprocal inhibition paradigm and a reinterpretation of the reciprocal inhibition principle within a more general framework of

excitation and inhibition of A. N. S. arousal.

It is the writer's intention to : 1) review the relevant literature dealing with sympathetic arousal and its excitation and inhibition by psychological means; 2) inquire into the stimulus conditions associated with inhibition of arousal in the reciprocal inhibition techniques; 3) report an experiment demonstrating that inhibition of arousal can be produced without training Ss in muscle relaxation procedures, or hypnosis, under conditions of arousal presumably unrelated to fear; utilizing instructions suggestive of relaxation, calmness, and tranquility, 4) briefly discuss the implications of the experimental findings for a theory of excitation and inhibition of arousal.

I. REVIEW OF THE LITERATURE

Arousal as a Psychophysiological Concept

The psychophysiological study of arousal most often involves the measurement of changes in autonomic response systems which occur as a result of the manipulation of stimulus conditions. It is customary to distinguish between transitory changes in autonomic response and slowly changing background levels upon which transitory changes are superimposed. Background levels of autonomic activity, usually designated "tonic levels" (Sharpless and Jasper, 1956) or "autonomic tension" (Lacey and Lacey, 1958) are generally held to be related to the organisms level of arousal, while the designation of "phasic" changes or "autonomic lability" is usually reserved for autonomic response to discrete stimulation. Shifts in long-term background level of autonomic tonus toward increased sympathetic-adrenal activity are conventionally interpreted as arousal (Sternbach, 1966). Some common A.N.S. indices of increased sympathetic-adrenal arousal are: increased heart rate; increased palmar sweating; decreased skin resistance; increased rate of spontaneous skin resistance fluctuations; peripheral vaso-constriction; pupillary dilitation; and increased muscle tonus.

Arousal or activation theory developed out of attempts to objectify and find physiological referents for psychological concepts such as emotion, motivation, drive, etc., which had traditionally been studied introspectively.

Contemporary interest in the function of the autonomic nervous system as a mediator of psychological states probably dates from James's (1890) physiological theory of emotion. James's theory was based on the idea that afferent feedback from differential autonomic nervous system response was responsible for variation in emotional response.

James's theory was criticized by Cannon (1929) who held that the autonomic nervous system is constrained to respond in a diffuse manner unlikely to provide differential afferent feedback, and proposed that sympathetic-adrenal arousal to intense stimulation constituted an "emergency" function, mobilizing the organism for vigorous activity.

There is yet no generally acceptable theory of the relationship between autonomic arousal and its motivational, mediating and adaptive significance for behavior. The issue of whether arousal is diffuse and unitary, or differentially patterned in different stimulus situations, has not been satisfactorily resolved. Several major theories will be briefly reviewed insofar as they are likely to relate to the problems of the definition and measurement of excitation and inhibition of arousal.

Arousal or "activation theorists" such as Duffy (1962), Lindsley (1951), and Malmo (1962), although by no means representing a unitary view, tend to follow Cannon's position that A.N.S. response is not generally differentiated and functions to mobilize

energy preparatory to behavior. The key notion of arousal theory, according to Shapiro and Crider (1969), is the division of behavioral processes into directional and intensive components. The intensive component (arousal) is considered to be related to the degree of excitation of the central nervous system (C.N.S.), which is conceived of as a continuum from deep sleep, through alertness, to emergency states such as fear and rage. There is a clear implication that autonomic correlates of different emotional and motivational states may differ only with regard to degree of excitation. The best index of activation is considered to be electrical activity of the C.N.S. (Lindsley, 1951), but peripheral measures such as autonomic or electro-myographic excitation may also be taken as convenient indices. The degree of arousal is also presumed to be reflected in measures of response organization, i.e., performance efficiency. It is assumed that efficiency increases with arousal to some optimum level and then becomes progressively more disorganized as arousal continues to increase (an inverted "U" configuration).

A uni-dimensional theory of arousal demands that E.E.G. measures of activation and various autonomic and behavioral measures of arousal ought to covary predictably. Lacey's (1967) review of the recent literature concluded that while covariation has often been demonstrated, exceptions which are not encompassed by a unitary view of arousal make revision of arousal theory necessary. He particularly emphasized recent evidence of dissociation between

autonomic, behavioral, and C.N.S. indices of arousal. He reported a series of experiments from his laboratory which purport to show that increased heart rate (a sympathetic response) may actually serve to inhibit cortical activation. He also demonstrated that a stimulus input may result in either H.R. acceleration or deceleration depending on whether the organism seeks or rejects the stimulus while skin conductance increases under both conditions. The dissociation phenomenon which Lacey (1959) designates as directional fractionation is an instance of what he terms situational specificity, or his conception of arousal as a multi-dimensional rather than uni-dimensional phenomenon. He hypothesizes that arousal reflects both an intensity dimension and the aim or goal of action or behavior, and that arousal patterns have functional afferent properties.

Aside from the striking findings reported by Lacey, the few other cases in which differential response patterns have been obtained have generally involved differences in the level of sympathetic activation among various indicators, but not reversals of direction. Most notable of such reports are those of Ax (1953) and Schachter (1957), who found some differences in autonomic response patterns between elicited fear and anger.

Psychophysiologists have usually been most concerned with phenomena associated with the excitation of arousal. Historically, this fact probably arises from an emphasis on seeking correlates of active behaviors or emotions. The problem of inhibition of arousal

has usually not received adequate attention in theoretical or experimental work.

A physiological model encompassing both excitation and inhibition of arousal has been suggested by Gellhorn (1967), a physiologist. Gellhorn proposed a theory of reciprocal syndromes of excitation (ergotrophic) and inhibition (tropotrophic) of arousal. The ergotophic syndrome corresponds to sympathetic-adrenal events (e.g. rise in blood pressure, heart rate (H.R.), somato-motor activity, palmar sweating, cortical activation, etc.), while the "tropotrophic syndrome" is associated primarily with parasympathetic activity which exerts an inhibitory effect on the previously mentioned systems. He has proposed that afferent feeback from the skeleto-muscular system can influence the ergotrophic-tropotrophic balance through the hypothalamus. He provides a theoretical framework for supposing that muscle relaxation acts as an inhibitor of arousal through a negative feedback effect on activation. He also suggested (Gellhorn, 1965) that an attitude of fear may be maintained by muscle tension, and presumably may be changed by relaxing the muscles.

In conclusion, psychophysiology has yet to develop an adequate theory of the integration of autonomic and behavioral processes. Arousal as a uni-dimensional energizing process has been seriously challenged, primarily because the highly correlated changes in the several autonomic response systems predicted by this view have not been demonstrated. Shapiro and Crider (1969) con-

clude in their recent review, "...it is an almost indisputable fact that autonomic effectors are differentially aroused as a function of the nature of the impinging stimuli and the behavioral demands of the environment." At the present time, it would appear most parsimonious to conclude with Lacey (1967) that arousal responses may include both a general (intensive) component, and patterns specific to stimulus conditions and behavioral requirements.

Measurement of Arousal

The possible multi-dimensional nature of arousal creates problems in measurement and makes it necessary for the experimenter to choose whether he is most interested in the intensive component of arousal, or in the differential response patterns introduced by his experimental variables. The measures he chooses may reflect either. If an index is desired to measure the intensive factor of arousal, it should to the greatest degree possible vary monotonically with some intensity dimension, e.g. stimulus intensity, or response demand, rather than with non-intensive situational factors.

It has been strongly implied in the previous section that the response systems measured may have a crucial bearing on the evaluation of the excitatory and/or inhibitory potential for arousal of a given experimental situation. It has become the custom among psychophysiologists, particularly since Lacey's (1959) comprehensive review in which he concluded "no single indicator can be used to

assign a unique arousal value to a stimulus", to measure as many response systems as feasible in hopes of getting as much information as possible. The use of multiple measures is indicated when differential patterning of response is of paramount interest. However, this practice may prove misleading when the intensive dimension of arousal is of major interest. In this latter case, the rationale for choosing an indicator variable should be its monotonic co-variation with some other intensity dimension which is defined as or asserted to be associated with increased arousal across a wide variety of stimulus situations.

The best known and perhaps most studied of the uni-directional and monotonic indicators of arousal are skin resistance (S.R.) and its reciprocal, skin conductance (S.C.). A more recent measure, the rate of spontaneous fluctuations in skin resistance (non-specific G.S.R.'s), has also been demonstrated to have a uni-directional and monotonic relation to arousal.

Burch and Greiner (1960), and Perez-Reyes et al. (1962), reported that drugs which inhibit cortical alertness (sedatives) produce an increase in skin resistance and a decrease in non-specific G.S.R.'s (both indicating a decrease in arousal).

Davis et al. (1955) studied the effects of a wide variety of stimuli on S.C. responses and found that S. C. always increased during stimulation, while other measures of autonomic activity tended to be bi-directional.

Silverman, Cohen, and Shmavonian (1959) confirmed that a wide variety of stimulus inputs and stimulant drugs resulted in significantly decreased basal (tonic) skin resistance and an increased rate of non-specific G.S.R.'s. In addition they also found that an increase in skin resistance was associated with a decrease in the rate of non-specific G.S.R.'s, although the converse was not always true.

Lacey and Lacey (1958) reported finding that individual rates of non-specific G.S.R.'s invariably increased during experimental conditions's in relation to resting levels.

Duffy (1962), in an extensive review, reported that situations of activity or preparation for activity are associated with low levels of skin resistance, while relaxation is associated with high levels of skin resistance. She concluded that basal (tonic) skin resistance and non-specific G.S.R.'s change in a consistent fashion with the demands of the situation on an individual.

Lykken (1968) reported in a more recent review: "...the tonic S.C. of the volar region of the palm displays marked diurnal variations. It is lowest during sleep and rises sharply when the S is awakened. Tonic S.C. tends to increase during the morning hours and to decrease toward evening, falling somewhat faster as the S goes to sleep. In the waking S, S.C. will be lowest during quiet relaxation, higher during listening or active work, and higher yet during excitement." He concludes: "The mass of findings available

supports quite firmly the general conclusion that S.C. ....and non-specific G.S.R.'s vary monotonically with some basic dimension of psychological arousal."

Individual rates of spontaneous electrodermal activity (non-specific G.S.R.'s) appear to be relatively stable, and related to some personality dimensions. Mundy-Castle and McKiever (1953) reported that persons exhibiting high rates of non-specific G.S.R.'s habituate more slowly to repeated simple stimulation than do persons with normally low rates. Johnson (1963) and Koepke and Pribram (1966) report similar findings.

Silverman, Cohen and Shmavonian (1958), Johnson (1963), and Kaiser and Roessler (1968), reported finding that normal rates of non-specific G.S.R.'s are stable in individuals over long periods of time. Furthermore, Johnson, reported finding spontaneous G.S.R. activity independent of heart rate.

Lader and associates (Lader, 1967; Lader and Wing, 1966; Lader, Gelder and Marks, 1967) reported that patients with clinical phobias had significantly higher S.C., higher rates of non-specific G.S.R.'s, and slower adaptation than normals when exposed to repetitions of a simple tone stimulus in an experimental situation. Lader, Gelder and Marks found that Ss with specific phobias behaved more like normals in their adaptation rates than did Ss with agoraphobia (a most difficult variety of phobia to treat). They reported evidence suggesting that the high rate of spontaneous fluctuations and

slow adaptation to repetitions of a simple stimulus were positively related to degree of anxiety, and were also related to a poor prognosis for desensitization therapy.

It is clear that most autonomic nervous system responses are subject to many physiological constraints. Heart rate and respiration particularly are primarily bound by the organism's oxygen requirements and subject to homeostatic control. The electrodermal response, however, according to Lykken (1968) "...seems to be unique in its lack of any apparent peripheral homeostatic control. There is no mechanism to monitor the rate of palmar sweating and provide negative feedback."

The only apparent limitation on the monotonic relationship of S.C. with sympathetic arousal stems from the cholinergic innervation of the palmar sweat glands which are associated with tonic skin resistance. Prolonged arousal may result in a decrease in palmar sweating as a result of sustained high levels of adrenalin in the system (Harrison, 1964).

To conclude, it would appear from the literature that changes in basal skin resistance level and rate of non-specific G.S.R.'s are among the best indicators of changes in general level of arousal.

The Psychological Manipulation of Arousal

Many stimulus conditions have characteristic excitatory or inhibitory effects on arousal. A sampling of the literature provides

substantial evidence that stimulus conditions involving novelty, acquisition of a response, anticipated performance, high task difficulty and/or a high degree of information processing, as well as stimulus conditions having emotional referents, are associated with increased arousal in relation to resting levels; and stimulus conditions involving instructions or suggestions to relax, instructions or suggestions which counter threat, and stimuli which have been conditioned to removal of an aversive stimulus are all associated with decreased arousal under conditions where preexisting arousal is high enough to permit observation of a decrement.

Effects of Novelty and Intensity

Pavlov (1960) observed that novel or unfamiliar stimuli elicited an investigatory or "what-is-it?" reflex in dogs. This reflex, reflecting increased attention to the environment (now commonly called an orienting response /$\underline{\bar{O}}$. R$\underline{\bar{.}}$/), was short lived, extinguishing after a few repetitions of an unpaired stimulus. Sokolov (1963), in an extensive monograph on the orienting response, reported that tonic skin resistance in human $\underline{S}$s tended to decrease (increased arousal) during the first few presentations of a novel but innocuous stimulus, slowly returning to pre-stimulus levels with continued repetitions. Intense stimulation, by contrast, resulted in a sustained elevation of arousal. Phasic responses to discrete stimulation tended to diminish over trials for innocuous stimuli, but not for intense stimuli. The relationship of phasic response to arousal is

complex and will not be considered here.

The phenomenon of increased arousal during the first few trials with a simple non-painful stimulus has been confirmed by Davis et al. (1955), Galbrecht et al. (1965), Hagdahl et al. (1967), and Lader and Wing (1966).

The transitory increase in arousal during novel situations, as well as the decline of arousal with repetitious trials, must be taken into account in any investigation of the arousal properties of a stimulus situation.

Associative Properties of a Stimulus

Symbolic associations and conditioned referents of a stimulus, which will be designated the associative properties of the stimulus, may be expected to influence arousal.

The experimental literature suggests that verbal instructions, suggestions, and symbols have the capacity to effect changes in arousal in the same direction as their real-world referents. Barber and Hahn (1962, 1964) have reported that both hypnotically suggested pain and pain merely imagined while awake resulted in increased arousal, while suggested analgesia resulted in decreased arousal during both hypnotized and wakeful states. Shor (1967) reported similar findings with respect to analgesia.

Barber's (1965) comprehensive review of the physiological effects of hypnotic phenomena reported the conclusion that "...in

both hypnotized and wakeful Ss, suggestions to try to imagine painful stimulation were sufficient to elicit some autonomic effects. Waking-imagined analgesia was as effective in reducing autonomic responses to a pain-producing stimulus as hypnotically suggested analygesia."

Damasser, Shor and Orne (1963), utilizing good hypnotic Ss in trance and waking states and poor hypnotic Ss simulating trance behavior, found that consistent physiological changes resulted in conjunction with requests that Ss feel particular emotions. States of trance, waking, or simulating did not result in significant differences in physiological response. There was a tendency for suggested fear to show the most arousal and suggested calmness, the least.

Wegner, Averill and Smith (1968) found significant increases in skin conductance and non-specific G.S.R.'s in male Ss reading sexually stimulating material. This finding, incidentally, is at variance with theories of parasympathetic dominance during sexual responses (i.e. Wolpe, 1958).

Averill (1969) found that S.C. and non-specific G.S.R.'s increased for Ss watching a sad film as well as for Ss watching a funny film.

Grosberg and Wilson (1968) had Ss read and imagine self-selected fearful and neutral scenes. They found that, during imagining, fearful scenes were associated with significantly greater increases in S.C. than neutral scenes. This effect tended to adapt

over trials.

Effects of Instructional Sets on Fear-Conditioning and Arousal

Grings (1965) observed that changes simulating fear-conditioning can often be obtained from Ss merely by telling them that a stimulus might well be followed by shock.

Katkin (1965) found that Ss led to expect electric shock showed a significant decrease in skin resistance and increase in non-specific G.S.R.'s during the period of threat. These findings were replicated by Miller and Shmavonian (1965) and Katkin (1966).

Bridger and Mandel (1965) reported that Ss in a fear-conditioning experiment who were informed that they would no longer be shocked showed almost immediate extinction of G.S.R. responses. The expected differences in rate of extinction between Ss who were continuously or partially reinforced during acquisition did not occur.

Lazarus (1968) reviewed a series of studies in which he and his associates subjected Ss to presumably stressful situations, while presenting accompanying messages intended to create threatening or benign sets and/or to encourage Ss to engage in various cognitive activities. In one such study (Lazarus, 1965) Ss were shown a movie dealing with a primitive genital mutilation rite, "subincision." Different sound tracks were used emphasizing the harmful or painful aspects of the operation or suggesting detachment or intellectualization. Arousal (skin conductance level) was found to be significantly higher for those groups hearing the sound track emphasizing pain than

for those hearing a detached commentary.

Counterconditioning Arousal with an Inhibitory Stimulus

Several workers have reported conditioning an inhibitory association to a stimulus and subsequently using it to inhibit an autonomic arousal response.

Dean, Martin, and Streiner (1968), paired the word "tense" with shock onset and the word "relax" with shock offset in a series of shock trials. Following Mowrer's (1960) theory that stimuli associated with onset of an aversive stimulus would elicit fear and stimuli associated with the offset of an aversive stimulus would develop into cues for "relief", the authors hypothesized that Ss could voluntarily mediate the excitation or inhibition of spontaneous G.S.R.'s by imagining the words "tense" or "relax". In subsequent trials increased and decreased rates of non-specific G.S.R.'s were reinforced by shock avoidance. Ss who received preliminary training with word cues and were instructed to think of the cues as a way of increasing or inhibiting the rate of spontaneous G.S.R.'s, had significantly better instrumental control over their rate of G.S.R.'s under both exitatory and inhibitory conditions than did control Ss who did not receive training with the word cues, even when instructed to think of the words "tense" and "relax".

Grings and Uno (1968) trained Ss in muscle relaxation and instructed them to practice relaxation when the word "now" was projected on a screen. The Ss were also given shock-conditioning trials

with a visual C. S. In subsequent tests, Ss displayed the strongest autonomic response (G.S.R.) to the C.S. for shock, the weakest response to a compound of the word "now" and the C.S., and an intermediate response to a compound of the C.S. and a neutral (unconditioned) word.

Effects of Task Difficulty and Response Requirements

Variables related to task difficulty, increased response requirement, or information processing load, etc., have been shown to effect the arousal potential of stimulus conditions.

Davis (1934) continuously monitored skin resistance while Ss did mental arithmetic problems. He found decreased skin resistance (higher arousal) during periods of mental arithmetic in relation to rest periods. The effect failed to adapt markedly over five successive days of trials. Furthermore, instructions to work faster resulted in an overall increase in arousal.

Geldrich (1953) compared changes in arousal during four stimulus conditions presented to Ss in random order: 1) mental work (Stroop /color-naming/ Test); 2) thinking about a color; 3) slow finger tapping; and 4) rest. He found that mental work resulted in a significantly larger increase in S. C. (higher arousal) than any of the other conditions. The author also reported that higher S.C. is associated with faster rates of work, and concluded that increasing S.C. is related to task difficulty.

In a study of arousal and task difficulty, Schnore (1959), concluded that mental arithmetic tasks lead to consistent increases in S.C., with more difficult problems leading to greater arousal.

Lacey et al. (1963) reported that S.C. increased monotonically from a resting baseline, through an alerting period preparatory to a mental arithmetic task, and reached its highest levels during the actual mental computation and reporting of answers.

Tursky, Schwartz, and Crider (1970) studied the effects of task difficulty and response requirements during a mental arithmetic task, precisely dividing trials into problem reception, computation and reporting periods. They concluded that arousal increased with task difficulty and with the requirement to make an overt response. The highest arousal resulted from an interaction between task difficulty and response requirement. The highest arousal levels were found during response periods rather than during computation periods.

Inability to monitor mental effort in the absence of a response requirement may result in paradoxical findings in a situation where task difficulty is so great that Ss may stop working. Pishkin and Shurley (1968) reported an investigation of the effects of task difficulty (solvable and insolvable concept-identification problems). These authors found that non-specific G.S.R.'s declined as problem solutions became more difficult. It is quite possible that this paradoxical effect resulted from the Ss' "giving up".

Effects of Response Acquisition

Early acquisition trials in a learning task have been associated with increased arousal which diminishes after successful learning.

Grings and Lockhard (1966) tested the hypothesis that successful avoidance would reduce the presumed fear response to a conditioned stimulus during shock-conditioning. They found that when Ss learned a correct response to avoid shock, a rapid reduction in anticipatory G.S.R.'s took place. Instructing Ss in the relationship between a correct response and shock avoidance led to faster acquisition and quicker decrement in anticipatory G.S.R.'s. They interpreted this finding as supporting their fear mediation hypothesis.

Andreassi and Whales (1967) studied the effects of rote learning of nonsense syllables on arousal. They reported that arousal (S.C.) increased until successful response acquisition, and declined with continued overlearning. This finding suggests that acquisition of learning may itself result in arousal.

Germana (1968), in a review of the correlates of conditioned reflex acquisition, concluded that arousal or activation during conditioning increases up to the point where the conditioned response is acquired, and subsequently declines as the response becomes well-learned.

Effects of Brief Relaxation Training or Hypnotically-Induced Relaxation On A.N.S. Activity

To date, only a few controlled studies have been undertaken to

verify Wolpe's reciprocal inhibition principle by investigation of inhibitory effects of brief muscle relaxation training and/or hypnotic suggestion on autonomic nervous system activity.

Grossberg (1965) compared two groups of Ss on three indicators of physiological arousal: electromyographic activity (E.M.G.), skin conductance (S.C.) and heart rate (H.R.). The experimental group received brief muscle relaxation training while the control group was simply asked to rest and listen to music. No significant overall differences between the groups were found for any response measure.

Barber and Hahn (1963) compared a group of hypnotized Ss instructed to relax with a control group which was merely requested to rest quietly. No significant differences were found between groups on E.M.G., S.C. and H.R. measures of arousal. Both groups showed considerable adaptation of the S.C. response over a 20 minute test period. Barber and Hahn concluded that hypnotic induction did not produce a relaxing effect superior to resting quietly.

Matthews and Gelder (1969) reported two experiments using phobic patients instead of normals as Ss. In the first experiment, matched groups of five phobics each were randomly assigned to six weekly sessions of relaxation training, or to a control procedure involving discussion of practical problems with a psychiatrist. Following the training, both groups were asked to relax for 20 minutes in a specially prepared room while polygraphic measures were

taken. There were no significant differences between groups on measures of background level of S.C., and rate of spontaneous fluctuations in conductance (non-specific G.S.R.'s), or other polygraphic measures.

In a second experiment, 14 phobics were given two weeks of brief passive muscle relaxation training. Each S served as his own control in two test trials, the order of which was randomly assigned. On one trial Ss were instructed to perform passive muscle relaxation exercises, while on the other Ss listened to 20 minutes of irrelevant speech while instructed to rest but not to practice relaxation. Both trials were given in a specially prepared room while polygraphic measures were recorded. Matthews and Gelder found significantly lower E.M.G. scores during relaxation sessions. They also reported significantly lower levels of non-specific G.S.R.'s during relaxation sessions. H.R. and respiration rate (R.R.) failed to show significant differences between sessions.

The authors concluded that continuous instructions to perform muscle relaxation during the second experiment probably accounted in large part for their finding significant inhibitory effects on sympathetic arousal. They further suggested that spontaneous electrodermal fluctuations (non-specific G.S.R.'s) are probably particularly sensitive indicators of the inhibitory effects of muscle relaxation.

Paul (1969a, 1969b) reported two aspects of a single investi-

gation in separate journal articles. He evaluated the comparative effects of three treatments on subjective distress and physiological arousal. The treatments were: a) "abbreviated progressive relaxation training as used in desensitization therapy"; b) "hypnotic induction emphasizing relaxation, warmth, drowsiness and sleep"; and c) "merely resting quietly". His Ss were 60 female college students randomly assigned among the three groups, who participated in two test sessions one week apart. Ss were asked to visualize individually-chosen, fear-eliciting stimuli at the beginning of session 1 and at the beginning and end of session 2. Following the visualization in session 1 and between the visualizations in session 2, the muscle relaxation and hypnosis groups were given relaxing instructions for 24-27 minutes while the control group sat quietly resting. Background levels of physiological arousal were measured four times during the interval between visualizations. Paul reported (1969a) that H.R. and E.M.G. showed significantly greater reduction in arousal level for the relaxation group than the hypnosis and control groups. The relaxation and hypnosis groups showed significantly lower levels of H.R., respiration rate, E.M.G., and subjective distress than the control group, while skin conductance showed no significant differential effects, falling uniformly for all groups.

Paul (1969b) also measured changes in the Ss' most active autonomic response to imaginal fear stimuli before and after treatment. Significant post-treatment reductions in autonomic response

to the imagined stimuli were obtained for the relaxation and hypnosis groups in comparison with the control group; but no differences appeared between the relaxation and hypnosis groups. The post-treatment response of the control group to the presentation of the imaginal stimuli actually increased.

Paul generally concluded that he had demonstrated significantly larger long-term physiological changes opposite to those associated with anxiety (inhibition of arousal) for abbreviated relaxation training and hypnotic suggestion than for a resting control group, and had also demonstrated that hypnosis and muscle relaxation treatment could result in significantly larger reduction in post-treatment response to a fearful stimulus. He further concluded that "...the manner in which the relaxation is brought about does not appear to strongly influence the suppression of physiological responses to stressful imagery".

In a study undertaken to investigate the electrodermal correlates of hypnotic depth, O'Connell and Orne (1968) studied changes in skin potential (S.P.) level in 51 hypnotic Ss during alternate short periods of hypnotic induction and wakefulness. They unexpectedly found that shifts in S.P. toward relaxation, which they had expected to be related only to hypnotic depth, were significantly related to the degree of arousal prior to hypnosis. The greater the initial arousal level, the more likely a shift toward relaxation during hypnosis. Their interpretation of this finding suggests that an initial

S. P. level indicating high arousal reflects alterness and good rapport, which leads to good hypnotic behavior and a noticeable reduction in S. P. during trance, while initial S. P. levels indicating low alertness reflect disinterest in the experimental tasks.

It may be tentatively concluded on the basis of these five experiments that both brief muscle relaxation training and hypnotic relaxation suggestions can result in decreasing the levels of some indicators of physiological arousal under favorable circumstances. The most salient circumstance favoring a finding of decreased arousal appears to be a preexisting state of arousal prior to relaxation (O'Connell and Orne, 1968). Paul (1969a, 1969b) initially had his Ss visualize fearful scenes, and established what might be termed an "anxiety set" by informing Ss that the experiment concerned the "physiological manifestation of anxiety." Matthews and Gelder (1969) used phobic Ss, for whom a relatively high level of arousal may be reasonably assumed (Lader and Matthews, 1968). Barber and Hahn (1963) and Grossberg (1965), who did not report finding significant differences between hypnotic induction or muscle relaxation and uninstructed rest, did not indicate that their Ss were aroused prior to the experimental treatment.

The relationship between high initial arousal and its subsequent inhibition by hypnosis or muscle relaxation is open to at least two interpretations. It may be ascribed to the Law of Initial Values (Wilder, 1957), which suggests that an individual initially functioning

at the upper level of his arousal continuum is more likely to exhibit a decrement with no treatment than an individual initially functioning at a low level of arousal. Alternatively, it is more likely that the inhibitory potential of a relaxation treatment is optimally demonstrable against a background of an existing state of arousal.

A second condition favorable to demonstrating decreasing arousal is suggested by Matthews and Gelder's (1969) finding that prior training of phobics in muscle relaxation did not result in significantly greater inhibition of physiological arousal unless concurrent instructions were given during the relaxation period. Concurrent instructions may be an important factor in maintaining inhibitory effects.

Several methodological issues arise concerning proper control procedures in investigating the effects of relaxation procedures. With the exception of Matthews and Gelder (1969), control groups in the aforementioned relaxation experiments were asked to merely relax without any further instruction for 20 to 30 minutes. This procedure fails to control for the possible non-instructional effects of listening to speech. Speech itself may be diverting, calming, or have other unintended stimulus properties. Waiting in silence during an experiment may conceivably induce unwanted effects of isolation such as heightened startle or orienting response during post-treatment stimulation. This effect may partially account for Paul's (1969b) finding that uninstructed control Ss showed greater autonomic

responsiveness to an imaginal fearful stimulus following 27 minutes of silent waiting than they had in a pre-treatment test. To overcome these possible unintended confounding factors, it would be desirable to include a control group receiving continuous speech which is not relevant to relaxation procedures. Matthews and Gelder (1969), however, vitiated their use of an irrelevant speech control by instructing their Ss not to attempt to relax their muscles but merely to rest during the control period.

While the preceding review of controlled experiments indicates some support for the view that progressive muscle relaxation or hypnotically induced relaxation may be sufficient to inhibit sympathetic physiological arousal, doubt has been raised whether muscle relaxation per se is necessary for inhibiting arousal.

Davison (1966) criticized the hypothesis that muscular relaxation is incompatible with anxiety on several counts. He cited previous studies which have indicated that avoidance responses (usually considered to be mediated by fear) can be acquired under total absence of muscular feedback (flaccidity due to curarization). He further suggested that a peripheralist view that decreased proprioceptive feedback from muscle relaxation is a necessary mechanism of anxiety inhibition, ignored evidence that other responses (sexual, assertive, emotive imagery) have been reported to counter-condition fear. He offered an interpretation that "...all (anxiety inhibiting responses) generate in the person strong positive affect

states," which may be the common factor in attenuating fear.

Rachman (1968) argued that muscular relaxation has not been shown to be a necessary component of desensitization. He presented evidence that: 1) very brief training in relaxation has led to positive therapeutic outcomes; 2) successful outcomes have been reported for Ss who have been physically active during treatment sessions; 3) there have been instances of patients reporting states of calmness in the absence of muscle relaxation (recorded E. M. G.); and 4) purely imaginal devices, i.e., imagining a calm scene, have been successfully used in desensitization. Rachman proposed that a necessary ingredient for desensitization may not be muscular relaxation so much as mental relaxation. He suggested that such a state could be induced by verbal instructions and suggestions given in a monotonous fashion, combined with suggestions of imaginery scenes of a peaceful nature.

Lader and Matthews (1968) have proposed a theory for explaining the effects of desensitization by hypothesizing that relaxation training creates optimum conditions (low arousal) for adaptation of unreinforced (fear-eliciting) stimuli. They state, "...the need to train the patient to relax is not because of the musclar relaxation per se, but because the instructions inherent in relaxation training subserve the function of engendering a low level of arousal."

Previously reviewed studies (Barber 1965; Damaser, Shor and Orne 1963; etc) have reported finding that hypnotic induction

does not produce relaxation or arousal inhibition superior to waking suggestion. Since both brief relaxation training and hypnotically-induced relaxation are sufficient to inhibit physiological arousal, it would appear logical to suspect that potent inhibitory factors may reside in elements common to both procedures. When the differences between procedures, tensing and relaxing muscles, and hypnotic-induction are eliminated, the common elements of "calming suggestions of tranquility and relaxation and positive imagery" (Bandura 1969, p. 42) emerge as likely inhibitory stimuli.

Interpretation of Inhibition of Arousal

If an increase in the level of peripheral autonomic arousal associated with a stimulus situation is presumed to reflect a process of C.N.S. activation (Lindsley 1951; Malmo 1958), or energy mobilization preparatory to an intensification of behavioral activity (Duffy, 1962), or increased response requirements (Germana, 1969), it would then appear logical to consider a decrease in arousal to be associated with a stimulus situation reflecting a process of reduced C.N.S. activation, reduced energy mobilization, or decreased response requirements.

The interpretation of inhibition of arousal is often complicated by a failure to distinguish between its passive and active forms. In its passive form, inhibition of arousal is associated with the withdrawal of an excitatory stimulus. This phenomenon is conventionally

referred to as "recovery". In addition to passive inhibition of arousal, there is considerable support for the view that some stimulus conditions actively inhibit arousal. A stimulus associated with active inhibition of arousal may be conceptualized as acting in a manner symmetrically opposite to an arousal-exciting stimulus. If the application of an arousal-exciting stimulus results in an increase in sympathetic-adrenal activity and its withdrawal results in a decrease in this activity, application of an inhibitory stimulus may be expected to effect a decrease in sympathetic-adrenal activity and its withdrawal should result in an increase in activity.

The relationship between conditioned stimuli exciting arousal and those inhibiting arousal may be conceptualized within the framework of Pavlovian conditioning as the relationship between an excitatory stimulus ($C.S.^{+}$) and an inhibitory stimulus ($C.S.^{-}$). Rescorla (1969) suggests the following working definition of Pavlovian conditioned inhibition: "As a result of past experience...a stimulus becomes capable of reducing some behavioral change that is normally attributed to excitation...The stimulus comes to control a tendency opposite to conditioned excitation." Reconceptualizing inhibition of arousal in psychological terms as an instance of Pavlovian conditioned inhibition has several advantages. It is well known that excitatory A.N.S. responses are subject to Pavlovian conditioning, and stipulating that inhibitory responses may also be thus conditioned is not only logical, but provides an experimental

paradigm for studying the relationship between excitatory and inhibitory stimulus conditions. If it is assumed that the intensive dimension of arousal is composed of essentially the same response elements, irrespective of the varying properties of eliciting stimulus conditions, then any stimulus condition exciting arousal can be defined as a $C.S.^{+}$ and any stimulus condition inhibiting arousal can be defined as a $C.S.^{-}$. Pavlov (1960) considered $C.S.^{+}$ and $C.S.^{-}$ to summate subtractively. Thus the addition of $C.S.^{-}$ to a stimulus situation would be expected to result in a decrement of arousal.

Measurement of the effects of inhibitory stimuli poses some special problems. It is evident that it is impossible to demonstrate that a stimulus is inhibitory unless there is arousal present for it to inhibit. It would be very difficult to demonstrate that an inhibitory stimulus lowered the arousal level of a subject whose arousal level was initially at a low level. This may account for the failures of Barber and Hahn (1963) and Grossberg (1965) to find reductions in arousal when relaxation instructions were given to already resting Ss. In a similar fashion, it would be difficult to demonstrate an increment in arousal level in Ss already near maximum arousal.

Figure 1 illustrates three possible paradigms for the measurement of conditioned inhibition of arousal. Paradigm A illustrates the presentation of a compoud of an excitatory and inhibitory stimulus. Pavlovian theory predicts that the effects would summate, and that the summated arousal level would lie somewhere between the ex-

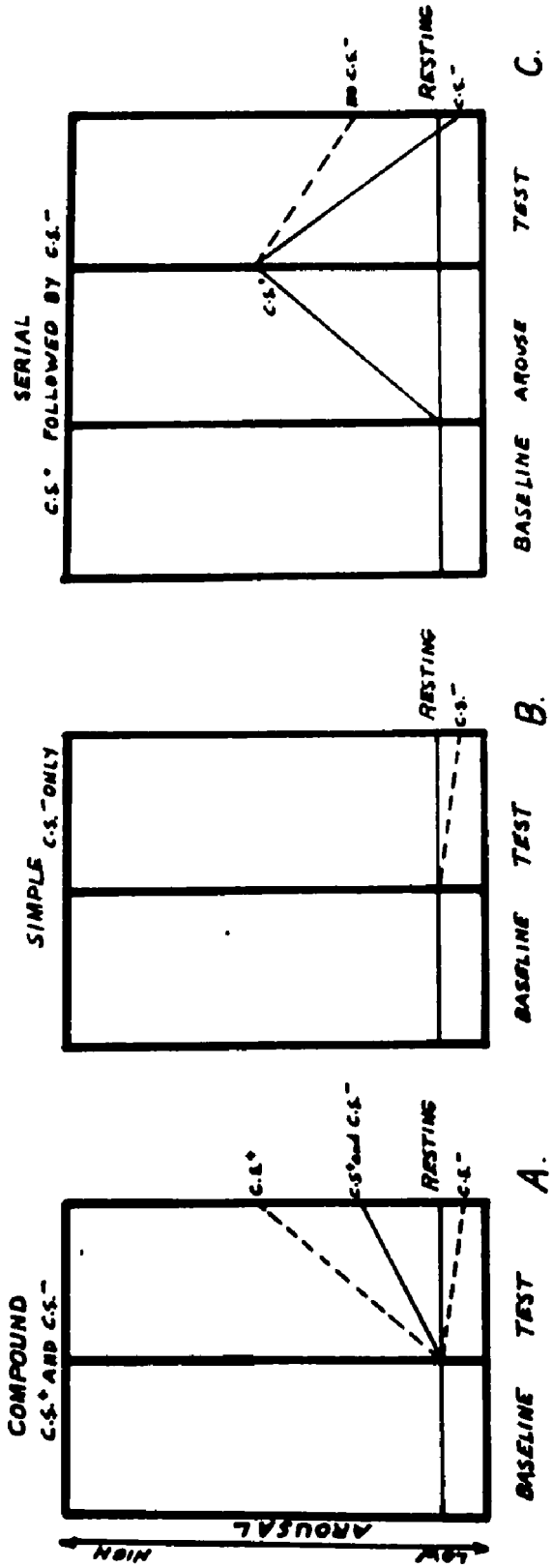


Figure 1. Hypothetical paradigms for measuring the effects of conditioned inhibition of arousal.

pected arousal levels of C.S.$^{+}$ and C.S.$^{-}$. Paradigm B illustrates the hypothetical effect of applying a general C.S.$^{-}$ to an already resting organism. The inhibitory effect would be limited by the low level of preexisting arousal. Paradigm C illustrates a method for establishing a preexisting arousal state, which can be followed by an inhibitory stimulus. It is presumed that the inhibitory effect would be rendered more observable by the creation of an arousal state, while avoiding the problem of differences in relative potencies between the excitatory and inhibitory stimuli in a compound stimulus. This paradigm is somewhat similar to the familiar differential conditioning paradigm, where a non-reinforced stimulus results in greater inhibition of a response than does no stimulus.

The generality of conditioned inhibition is a significant issue in the study of arousal. While a stimulus which is present as a C.S.$^{-}$ or S^{Δ} during differential conditioning develops inhibitory properties for a particular response, there is reason to believe that stimuli previously associated with relief, relaxation, distress inhibition, and reduced behavioral intensity may exert general inhibitory effects on arousal in a wide variety of situations. There is some evidence from the animal experimentation literature to suggest that a stimulus conditioned to non-reinforcement during shock trials may later serve as a C.S.$^{-}$ under different learning conditions also involving shock. Rescorla and Lolordo (1965) reported that such a C.S.$^{-}$ successfully reduced responding during Sidman avoidance trials, reduced the

amount of response suppression during conditioned emotional response (C.E.R.) trials, and served as a positive reinforcer (animals performed contingent responses for it) during trials with an aversive stimulus. The previously reviewed study of Dean, Martin and Streiner (1968) demonstrated the classical conditioning of a relief response during shock trials in human Ss, which when self-administered by the Ss inhibited non-specific G.S.R.'s in order to avoid shock on instrumental trials. The studies of O'Connell and Orne (1968), Matthews and Gelder (1969) and Paul (1969a, 1969b) imply that verbally-induced relaxation may be a conditioned arousal inhibitor in a variety of situations.

II. SUMMARY AND STATEMENT OF EXPERIMENTAL HYPOTHESIS

Recent evidence that Ss induced to relax through hypnosis or progressive muscle rel axation training show an inhibition of arousal has been interpreted by Matthews and Gelder (1969) and Paul (1969a, 1969b) primarily within the framework of Wolpe's (1958) theory of the reciprocal inhibition of anxiety by an incompatible response.

Consideration of two major lines of evidence raises the possibility that inhibition of fear-related arousal may be a special case of a more general phenomenon--the conditioned inhibition of arousal.

1. The questionable necessity of muscular relaxation or hypnotic trance for inhibition of arousal.

Grounds for questioning the necessity (though not the sufficiency) of muscular relaxation have been advanced by Davison (1966) and Rachman (1968) who favor a hypothesis that mental calmness is the active principle in reciprocal inhibition. Barber (1965) disputes the superiority of trance induction for eliciting effects associated with hypnosis. The common factors in studies purporting to have achieved reciprocal inhibition through hypnosis or relaxation training appear to be repeated suggestions of calmness, tranquility, and relaxation. Furthermore, other workers--Lazarus (1968) or Grings (1965), for instance--have reported inhibition of stress-related arousal through the manipulation of instructional sets. These findings suggest that language-mediated inhibition may be an active principle in reducing arousal.

2. The generality of the arousal phenomenon.

There is preponderance of evidence in support of the view that arousal is a general property of stimulus conditions calling for increased behavioral activity including, but not specific to, fear and stress. There is also considerable evidence suggesting an undifferentiated "intensive" dimension of arousal common to all arousal situations.

These findings suggest that the generality of the reciprocal inhibition principle may be extended by demonstrating that the phenomenon of active inhibition of arousal occurs under conditions presumably unrelated to fear and does not depend on the effects of muscle relaxation training (Jacobson, 1938) or hypnotic trance induction.

Hypothesis

The following hypothesis is offered for an experimental study of the effects of verbal communication as an arousal inhibiting stimulus:

Hypothesis--Verbal communication suggestive of calmness, tranquility, relaxation, and diminished activity favors inhibition of arousal in normal Ss in the absence of hypnotic trance or relaxation training.

III. METHOD

An experiment was designed to test the hypothesis that suggestions of calmness, relaxation and tranquility would result in inhibition of arousal, without concomitant training in muscle relaxation or hypnotic trance.

Design

The experimental design is based upon the definition of an inhibitory stimulus as one which controls response tendencies opposite to those controlled by an excitatory stimulus (Rescorla, 1969).

For the purposes of this experiment, excitatory and inhibitory response tendencies refer only to changes in the level of A.N.S. activity; thus the relationship of an excitatory to an inhibitory stimulus is defined solely on the basis of the autonomic response tendencies they favor and not their other behavioral concommitants. It is consistent with the literature to designate stimuli favoring an increase in sympathetic-adrenal A.N.S. activity as excitatory or arousing, and stimuli favoring an opposite tendency as inhibitory.

It has been noted that the effects of an inhibitory stimulus are most observable when the stimulus is applied to an existing state of arousal. Where a state of arousal cannot be assumed (as in the case of phobias), it is desirable that one be induced. On the basis of evidence previously presented on the relative merits of different paradigms for measuring the effects of conditioned inhibition, a

sequential method of following an excitatory stimulus with an inhibitory stimulus was chosen (Fig. 1, C). It was assumed that an excitatory stimulus would increase the level of arousal, which would then tend to return to pre-stimulus levels following termination of the excitatory stimulus--the well known phenomenon of "recovery". It was predicted that application of an inhibitory stimulus during a period of recovery would result in greater reduction of the arousal level than would otherwise be attainable without the inhibitory stimulus.

Mental arithmetic was chosen as an arousing stimulus for a number of reasons. Mental arithmetic tasks involve primarily information processing and reporting. They have little relationship to fear-producing or painful stimuli, other than a common tendency to excite arousal, thus permitting the generalization of conclusions about inhibition of arousal to non-fearful conditions. Mental arithmetic tasks also show little tendency toward diminished arousal responses (adaptation) as a result of repetition (Davis, 1934). This property is important for providing a reliable increase in arousal prior to the application of the inhibitory stimulus, and for determining whether the inhibitory stimulus does facilitate unexpected adaptation in the arousal response. Furthermore, it was assumed that Ss would be more willing to perform mental arithmetic than to accept electric shock or some other painful stimulus.

Arousal levels were operationally defined by two indices of

skin resistance response: 1) background level of tonic skin resistance (B.S.R.); and 2) the rate of spontaneous fluctuations in skin resistance of at least 600 ohms (non-specific G.S.R.'s) per unit of time (minutes). Previously reviewed literature supports the use of these measures as monotonic indicators of arousal, with increasing B.S.R. and decreasing non-specific G.S.R.'s interpreted as a decreasing level of arousal.

Three groups of Ss, corresponding to three treatment conditions were given five repetitions of a basic sequence of an arousal period followed by a recovery period in a 3x5 factorial design. Each arousal period consisted of one minute of mental arithmetic problems to be answered aloud. Each group received a different stimulus condition during the two-minute recovery periods. The experimental group ("Relaxation") heard communications suggestive of calmness, relaxation and tranquility. One control group ("Listening") heard extracts from a scientific journal, and the second control group ("Waiting") received two minutes of silent rest. The predicted effects of the various stimulus inputs are presented in Table 1.

It was predicted that some recovery or inhibition of arousal would take place in all groups during the recovery period as a result of the cessation of excitatory stimulation. Four sources of inhibition were postulated to have an effect on arousal level during the recovery periods (and possibly on the mental arithmetic periods) over trials. They are listed in Table 2 with their methodological

TABLE 1

PREDICTED EFFECTS OF STIMULUS CONDITIONS DURING A SEQUENCE OF EXCITATION AND INHIBITION OF AROUSAL

	Input	Hypothetical Central Nervous System Activity	Predicted Response
Arousal Period (1 min.)			
All Groups	mental arithmetic	Information processing	Verbal and motor response; increased A.N.S. arousal
Recovery Period (2 min.)			
"Waiting" Group	silence	Decrease in information processing; random attention	No verbal response; decreased motor response; A.N.S. recovery
"Relaxation" Group	verbal communications suggestive of relaxation	Information processing, listening, imagining	No verbal response; decreased motor response; A.N.S. recovery
"Listening" Group	communication irrelevant to relaxation	Information processing, listening, imagining	No verbal response; decreased motor response; A.N.S. recovery

TABLE 2

SOURCES OF INHIBITION DURING RECOVERY PERIODS

Source of Inhibition	Stimulus Conditions	Control
1. Adaptation	Repeated presentation of a stimulus situation leading to familiarity	1. Identical stimulus conditions during arousal periods for all groups 2. Try to maintain equal degrees of novelty for groups receiving communications during recovery periods
2. Reactive Inhibition	Response-produced inhibition due to fatigue	Identical response demands during arousal periods for all groups
3. Non-symbolic or non-associational aspects of verbal communication		
a. discrimination	Speech acts as an S^{Δ} for mental arithmetic	Control group listens to speech which is irrelevant to relaxation
b. stimulation effects	Human voice may have soothing effects, or restrict attention, or distract the Ss	
4. Symbolic aspects of verbal communication	Predicted inhibitory effects of verbal suggestions of calmness and relaxation	Dependent variable

controls.

It was predicted by the hypothesis that suggestion-induced inhibition of arousal during recovery periods would be greater than inhibition due to any of the other three sources. A control group hearing irrelevant speech during recovery periods was utilized in addition to a control group resting in silence because of the possible non-symbolic inhibitory effects of speech.

Stimulus Program

An initial baseline period of four minutes was followed by five test trials, each consisting of a one-minute mental arithmetic period and a two-minute recovery period. After the fifth recovery period Ss were informed that they had completed their mental arithmetic problems and were asked to sit a few minutes longer. Following a three-minute final baseline period, the experiment was terminated (see Fig. 2).

Each of the five one-minute periods of mental arithmetic consisted of six different problems requiring the S to multiply a two-digit number by a one-digit number and report the answer aloud as soon as he had computed it. Problems were given at approximately 10" intervals, and the S was instructed to leave an unsolved problem when the next problem was presented. All Ss received the same mental arithmetic problem sets which were different for each new period.

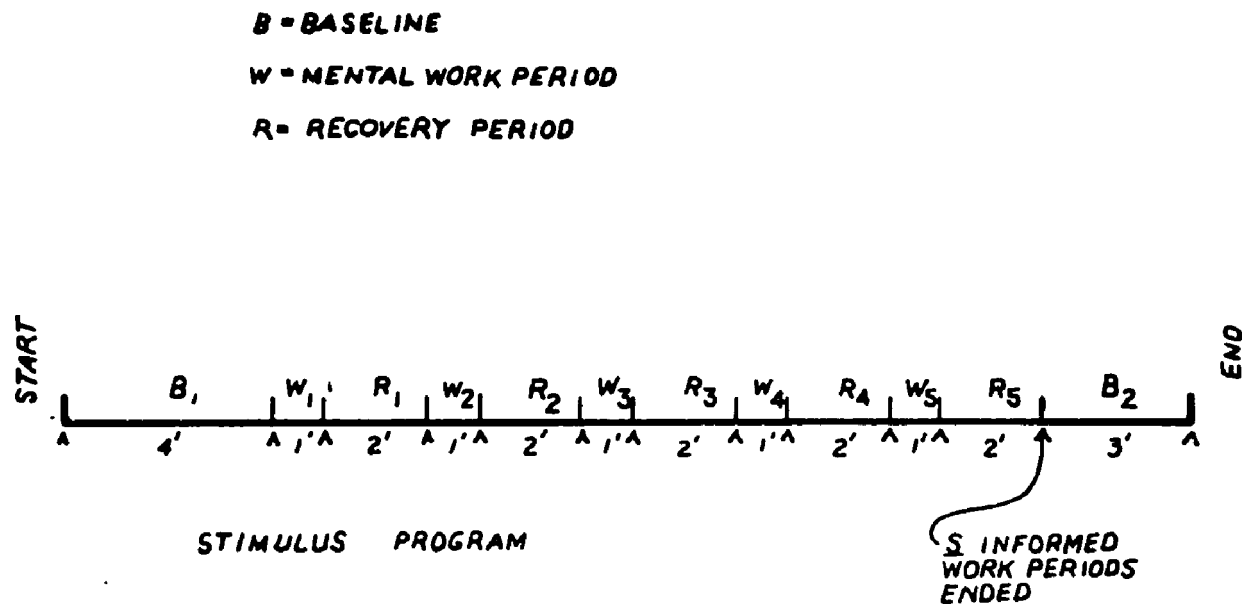


Figure 2. Stimulus program.

All groups had a two-minute recovery period following each of the mental arithmetic periods. The experimental (Relaxation) group heard two minutes of speech intended to induce calmness and relaxation; this stimulus condition represented an attempt to incorporate the verbal-suggestive elements of relaxation training and hypnotic relaxation. Ss heard a pleasant female voice speaking softly and slowly. The speech consisted primarily of passive suggestions: a) that the S felt very calm and peaceful; b) that the S's body felt very relaxed and comfortable; and c) that the S visualized images of tranquil scenes (see Appendix A).

During the two-minute recovery period, the Listening control group heard the same pleasant female voice speaking slowly and softly (in an attempt to maintain the same pace and intonation as during the relaxation speech) reading clinical material from a medical journal (see Appendix A). The use of this material represented an attempt to avoid an unintended relaxation effect by choosing language with rather unpleasant symbolic referents, while keeping the non-symbolic aspects as similar as possible to the relaxation speech.

The Waiting control group rested in silence during the recovery period.

The stimulus program for each group was prepared on a separate tape. The different communications presented to the Relaxation and Listening groups during the five recovery periods were dubbed into the two-minute intervals between the mental arithmetic

periods. The Waiting control group, of course, heard no speech during recovery periods. The entire taped stimulus program consisted of 22 minutes, plus a short introduction.

In the introduction (see Appendix A), Ss were told that the purpose of the experiment was to measure physiological changes during mental arithmetic, and were informed that their task would involve solving multiplication problems. They were urged to work as quickly as possible, to answer aloud before hearing the next problem, and to try to refrain from physical movement. They were told to expect pauses between problem sets and advised to relax during these intervals. It was suggested that relaxation would help improve their subsequent performance. They were also requested to pay close attention to any other instructions they might hear. Finally, they were informed that there would be an initial rest period "to get accustomed to the experimental room" before the problems began.

Subjects

Paid subjects were recruited through a college newspaper advertisement. Fifteen male and fifteen female Ss, ranging in age from 17 to 26, were chosen for the experiment. Five males and five females were randomly assigned to each experimental group. There were presumably no age differences between groups. None of the Ss admitted to using tranquilizing drugs which might have influenced the

outcome of the experiment.

Apparatus

Ss were tested individually in a small, windowless, 8' by 10' experimental room; they were seated on a comfortable upholstered chair. Temperature was maintained at a constant 70° F by central air conditioning. Two incandescent lamps dimmed by a variable transformer furnished a low level of illumination, which the S could adjust.

The stimulus program was presented over a pair of cushioned headphones (Grayson-Stadler H. D. 1) at a pleasant volume, which the S could ask to have varied if he wished. A microphone was placed in front and to the left of the S for communication with the E. Skin resistance pickups were two fingertip electrodes on the second and fourth fingers of the left hand taped in place over corn plasters filled with Grass electrode cream. Leads from microphone, headphone, and skin resistance pickups were fed through a duct to an adjacent room where the experimental appartus was located, out of the S's sight and hearing. The E remained in this adjacent room during the experiment. Stimulus tapes were played over one channel of a Wollensak stereo tape recorder (type 1580) through the S's headphones. The microphone was connected to the other channel and served as an amplifier for the E to hear the S.

Skin resistance was measured with a Fels "Dermohmeter" (Yellow Springs Instrument Company, Model 22A) utilizing a con-

stant-current bridge circuit delivering 75 microamperes of current to the S. The instrument which was set to operate with a full range sensitivity of 60 kilohms, used an automatic range reset. This sensitivity setting allowed measurement of 600 ohm resistance changes without requiring too many range-resets to complicate scoring of the B.S.R. Output from the "Dermohmeter" was used to drive the stylus of a Nesco Model JY00A2 D.C. paper recorder, operating at a paper speed of 2" per minute. The onset of each stimulus interval was marked on the paper tape by the E.

Procedure

The first five minutes following S's entry into the experimental room was spent seating him comfortably and applying the fingertip electrodes. If the S asked whether he would be shocked (almost half did so), he was told that he would not be. The S was informed that he would be doing mental arithmetic while the E monitored his responses. He was asked to work as rapidly as possible and to speak aloud into the microphone. The level of illumination was then adjusted for the S's comfort, and he was informed that he could request that the sound level of his headset be changed if he wished. Following this the E withdrew, and the stimulus tape was started.

Scoring of Physiological Variables

Background level skin resistance and rate of non-specific G.S.R.'s, the dependent variables, were scored in the following

manner.

Skin Resistance--Background level of skin resistance (B.S.R.) was scored at the end of a stimulus period, just prior to the onset of the subsequent stimulus period. Scores were taken just prior to the onset of stimuli W_1, R_1, W_2, R_2, W_3, R_3, W_4, R_4, W_5, R_5, B_2, and at the end of B_2 (see Fig. 2). The purpose of this method of scoring was to obtain an estimate of skin resistance change following the full period of stimulus activity. Most of the scores were taken 2 seconds prior to the onset of the next stimulus. However, in several cases temporal conditioning occurred, and the score was taken just prior to the anticipatory decrease in B.S.R. preceding a mental arithmetic period. An initial baseline period, B_1, was utilized to permit estimation of a resting level B.S.R. for each individual. A four-minute baseline period was chosen pragmatically when it was observed that the Ss seemed to get restless and the B.S.R. more variable with longer periods.

B.S.R. scores were transformed into "recovery ratios" by dividing every score for each individual by his own initial baseline score (B_1). This procedure permits consideration of each individual's B.S.R. change relative to his own resting level, and permits inter-subject comparisons which are to a large extent free of the problems due to the great inter-subject variability in absolute ohmic value of B.S.R. The "recovery ratio" also facilitates the ease of inter-

pretation of arousal level. A score of less than 1.00 indicates an arousal level greater than the initial resting level, and a score greater than 1.00 indicates an arousal level lower than the initial resting level.

Non-Specific G.S.R.'s--The number of skin resistance fluctuations greater than 600 ohms were counted for each stimulus period. A fluctuation was operationally defined as a transient decrease in skin resistance reaching an inflection point within 5 seconds. In case a fluctuation crossed the borderline between two stimulus periods, it was arbitrarily scored in the period in which its inflection point occurred. The number of non-specific G.S.R.'s during a given period was divided by the number of minutes in that period to determine the rate of non-specific G.S.R.'s/minute.

While it would have been desirable to transform the rate of non-specific G.S.R.'s into a "recovery ratio", this was not possible because one S had no non-specific G.S.R.'s during his initial baseline period (B_1).

IV. RESULTS

Recovery ratio scores and non-specific G.S.R. scores for each subject will be found in Tables 12 through 15--Appendix B.

A one-way analysis of variance of non-specific G.S.R. scores during the initial baseline (B_1) period yielded no significant pre-test differences due to groups (Table 11--Appendix B). No analysis of the absolute values of initial baseline (B_1) skin resistance was undertaken. By transforming resistance values into recovery ratio scores, each S's initial baseline score was set to 1.00.

Sign tests(Hays, 1963) confirmed that the initial mental arithmetic period led to significantly ($p < .01$) increased arousal over baseline levels for both variables.

The dependent variables were subjected to separate analyses for recovery periods and for mental arithmetic periods.

Recovery Ratio Variable

Recovery Periods--Mean recovery ratio scores for recovery periods are illustrated in Figure 3.

A two way analysis of variance of recovery ratio scores for recovery periods confirms a significant effect due to groups. The data are summarized in Table 3.

In order to determine how the groups differed from each other, Duncan's New Multiple Range Test (Edwards, 1960) was used to analyze differences between group means. It was determined that

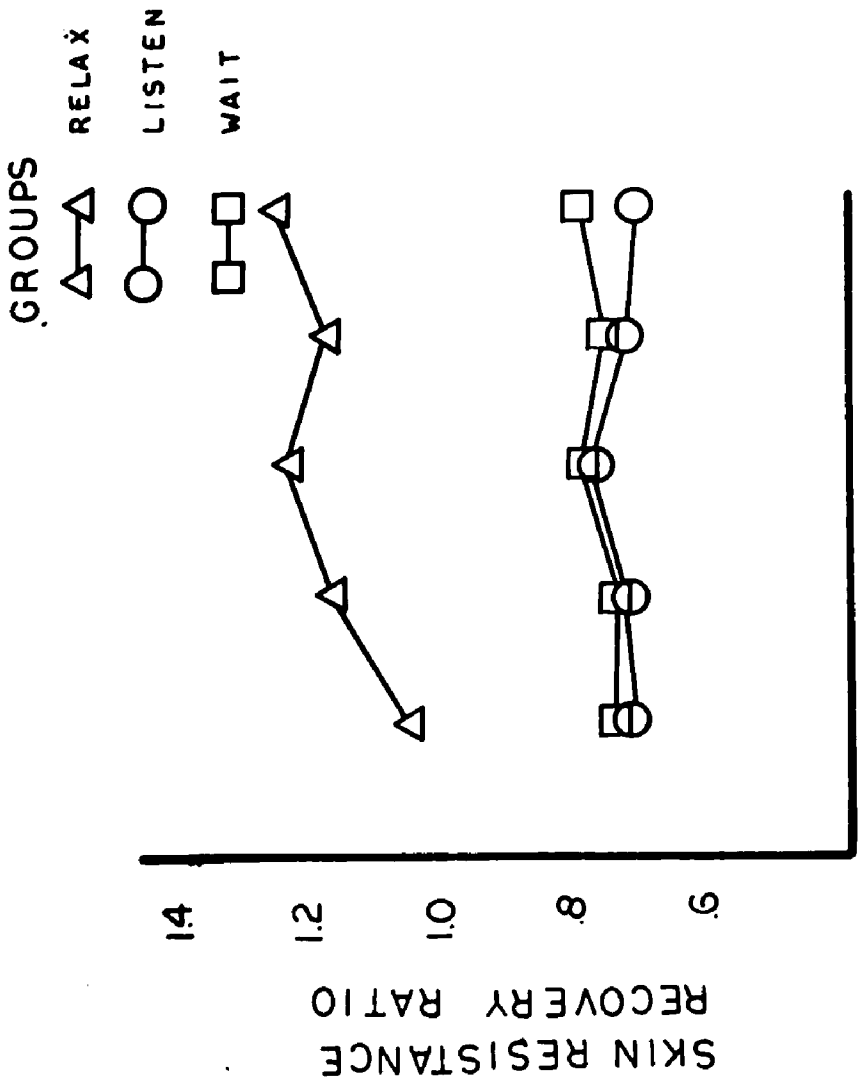


Figure 3. Mean recovery ratio scores for recovery periods.

TABLE 3

SUMMARY OF ANALYSIS OF VARIANCE OF RECOVERY RATIO SCORES FOR RECOVERY PERIODS

Source	S.S.	df	M.S.	F
Groups (A)	6.070	2	3.040	70.58**
Recovery Periods (B)	.206	4	.052	1.27
(A x B)	.176	8	.022	< 1
Error	5.810	135	.043	

** $p < .001$

the mean recovery ratio score for the Relaxation group was significantly higher ($P < .001$) than that of the Listening or Waiting groups which did not differ from each other (Table 16--Appendix B).

In order to determine whether the larger recovery ratio scores of the relaxation group were due to a few high scores affecting results through the statistical grouping, or were attributable to a response characteristic of a large majority of the Relaxation group, all 150 individual recovery ratio scores for recovery periods were partitioned into those $\geq$ to 1.00 and those < 1.00. The data are summarized in Table 4.

TABLE 4

PARTITION OF INDIVIDUAL RECOVERY RATIO SCORES FOR RECOVERY PERIODS

Recovery Ratio Scores	Groups		
	Relaxation	Waiting	Listening
≥ 1.00	40	2	2
< 1.00	10	48	48

A Chi-square analysis (df = 1) combining the two control groups indicated that the number of recovery scores ≥ 1.00 was significantly higher ($P < .001$) for the Relaxation group.

Mental Arithmetic Periods--Mean individual recovery ratio scores for mental arithmetic periods are illustrated in Figure 4.

A two-way analysis of variance performed on the recovery ratio scores during mental arithmetic periods revealed a significant effect due to groups. The data are summarized in Table 5.

Analysis of the mean group differences with Duncan's Multiple Range Test indicates that the mean of recovery ratio. scores for the Relaxation group is significantly higher ($P < .01$) than the mean of recovery ratio scores for the Waiting or Listening groups, which are not significantly different from each other (Table 17--Appendix B).

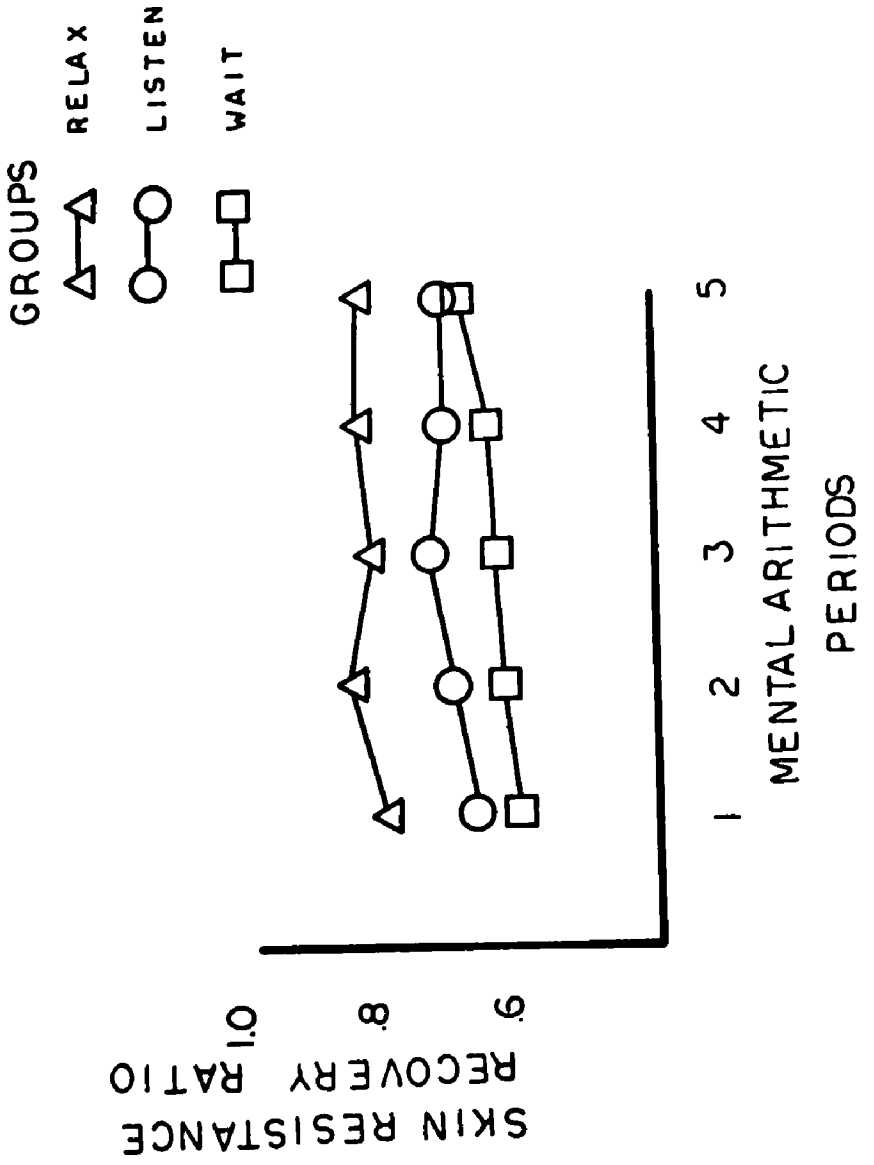


Figure 4. Mean recovery ratio scores for mental arithmetic periods.

TABLE 5

SUMMARY OF ANALYSIS OF VARIANCE OF RECOVERY RATIO SCORES FOR MENTAL ARITHMETIC PERIODS

Source	S.S.	df	M.S.	F
Groups (A)	.997	2	.499	10.20**
Mental Arithmetic Periods (B)	.067	4	.017	<1
(A x B)	.001	8	$<.001$	<1
Error	6.660	135	.049	

** $P < .01$

The results of partitioning the individual recovery ratio scores for the last 4 mental arithmetic periods following the first recovery period are summarized in Table 6.

TABLE 6

PARTITION OF INDIVIDUAL RECOVERY RATIO SCORES FOR THE LAST 4 MENTAL ARITHMETIC PERIODS

Recovery Ratio Scores	Relaxation	Waiting	Listening
≥ 1.00	9	1	4
< 1.00	31	39	36

A Chi-square analysis (df = 1) with control groups combined indicated that the relaxation group showed a significantly larger ($P < .025$) distribution of recovery ratio scores ≥ 1.00, although the overall direction of scores showed the expected preponderance of scores less than 1.00.

Non-Specific G.S.R. Variable

Recovery Periods--Figure 5 illustrates mean non-specific G.S.R. scores for recovery periods.

A two-way analysis of variance of non-specific G.S.R. scores for recovery periods yielded significant effects due to groups and recovery periods. The data are summarized in Table 7.

TABLE 7

SUMMARY OF ANALYSIS OF VARIANCE OF NON-SPECIFIC G.S.R. SCORES FOR RECOVERY PERIODS

Source	S.S.	df	M.S.	F
Groups (A)	32.0	2	16.0	5.7**
Recovery Periods (B)	26.5	4	6.6	2.5*
(A x B)	3.0	8	.4	<1
Error	382.8	135	2.83	

** $P < .01$

* $P < .05$

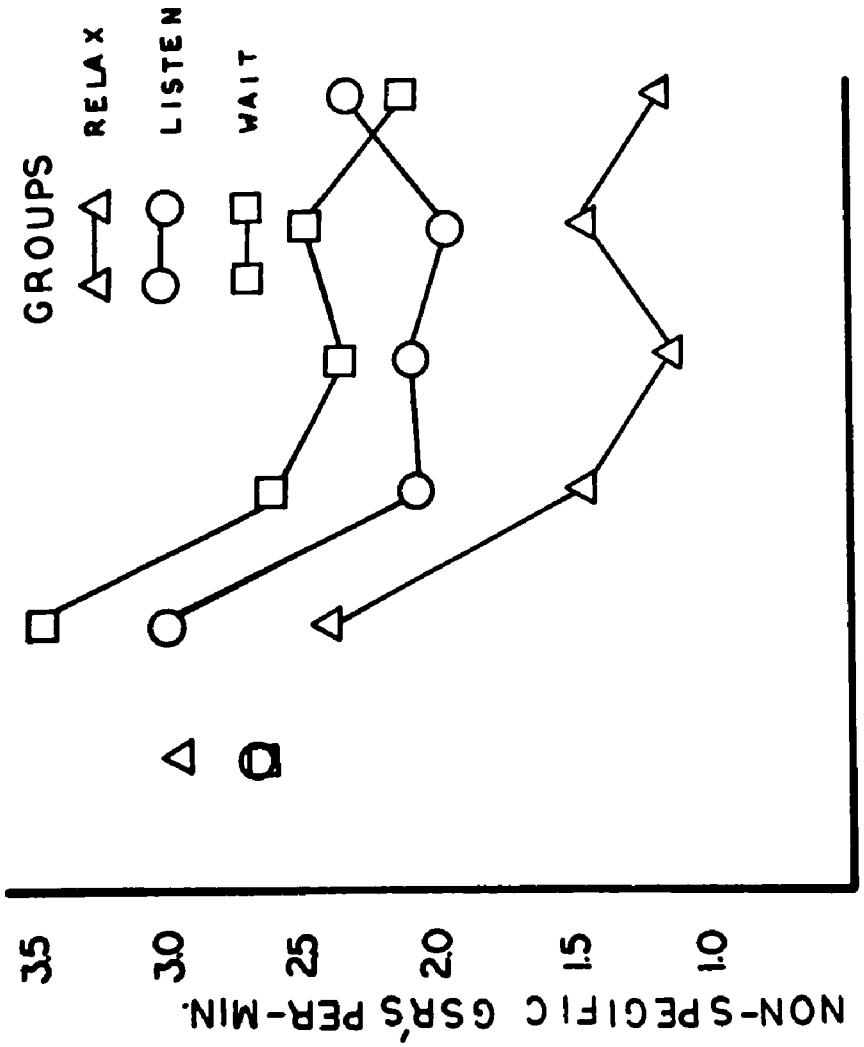


Figure 5. Mean non-specific G.S.R. scores for recovery periods.

A comparison of differences between means with Duncan's Multiple Range Test, indicated that the mean scores for the Relaxation group were significantly ($P < .05$) lower than the scores for the Waiting and Listening groups, which did not differ from each other (Table 18 --Appendix B).

The results of partitioning individual non-specific G.S.R. scores are summarized in Table 8.

TABLE 8

PARTITION OF INDIVIDUAL NON-SPECIFIC G.S.R. SCORES FOR RECOVERY PERIODS

Non-Specific G.S.R.'s	Groups		
	Relaxation	Listening	Waiting
$> B_1$	5	19	31
$\leq B_1$	45	31	19

Separate Chi-square analyses (df = 1) of the distribution of non-specific G.S.R. scores during recovery periods indicate that the Relaxation group had a significantly greater number of scores $\leq$ to initial baseline scores than did the Listening group ($P < .05$) or the Waiting group ($P < .001$). The analyses also show that the Listening group had a significantly ($P < .05$) greater number of scores $\leq$ to

initial baseline scores than did the Waiting group.

Mental Arithmetic Periods--Figure 6 illustrates the mean non-specific G.S.R. scores for mental arithmetic periods. A two way analysis of variance of non-specific G.S.R. scores for mental arithmetic periods indicated a significant effect due to groups. The data are summarized in Table 9.

TABLE 9

SUMMARY OF ANALYSIS OF VARIANCE OF NON-SPECIFIC G.S.R. SCORES FOR MENTAL ARITHMETIC PERIODS

Source	S.S.	df	M.S.	F
Groups (A)	206.7	2	103.4	8.7*
Mental Arithmetic Periods (B)	18.9	4	4.7	< 1
(A x B)	48.7	8	6.1	< 1
Error	1605.5	135	11.9	

* $P < .01$

A Duncan Multiple Range Test indicated that the overall mean non-specific G.S.R. score for the Waiting group was significantly ($P < .005$) higher than the mean scores for the Relaxation or the Listening groups; which did not differ from each other (Table 19--

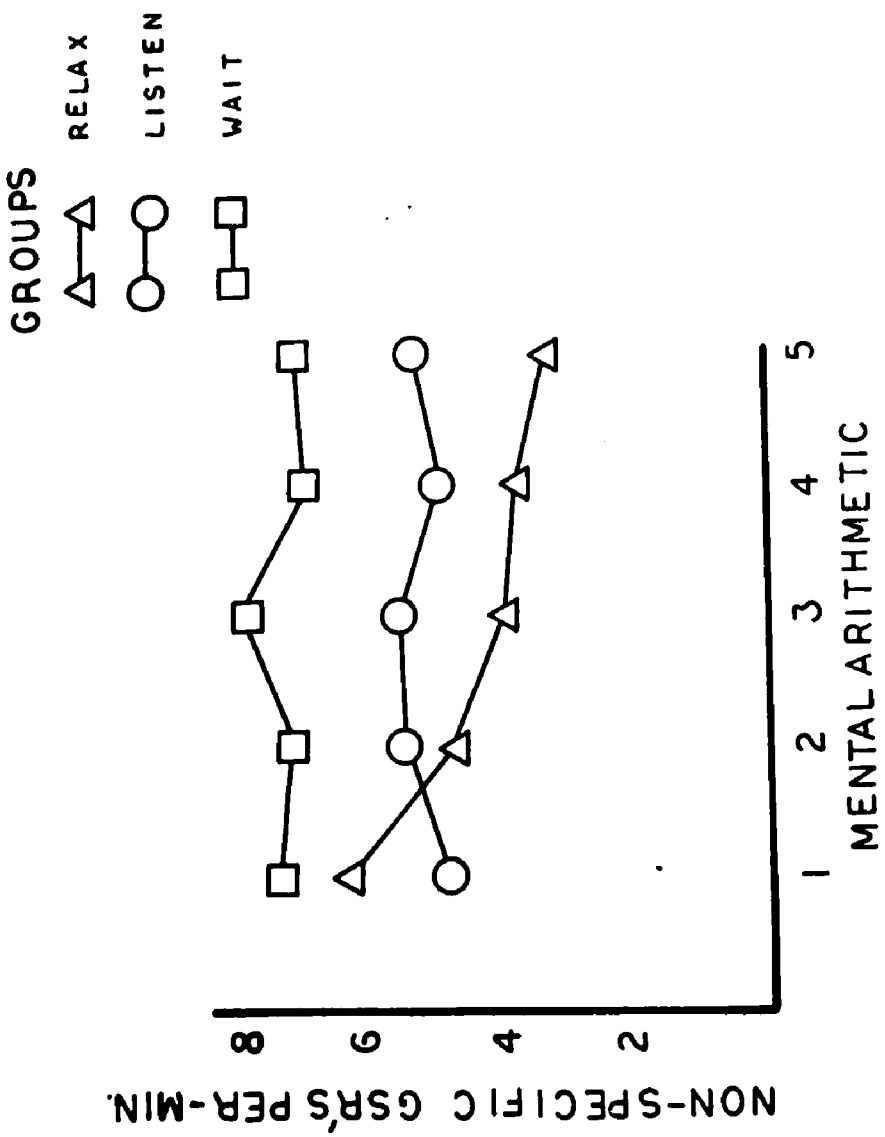


Figure 6. Mean non-specific G. S. R. scores for mental arithmetic periods.

Appendix B).

The results of partitioning individual non-specific G.S.R. scores for the last 4 mental arithmetic periods are summarized in Table 10.

TABLE 10

PARTITION OF INDIVIDUAL NON-SPECIFIC G.S.R. SCORES FOR THE LAST 4 MENTAL ARITHMETIC PERIODS

Non-Specific G.S.R.	Groups		
	Relaxation	Listening	Waiting
$> B_1$	23	27	40
$\leq B_1$	17	13	0

A Chi-square analysis (df = 1) of the differences in distribution of non-specific G.S.R. scores between Relaxation and Listening groups, for the last 4 mental arithmetic periods, did not yield significant differences. It was not possible to include the distribution for the Waiting group because of the "0" value for decreased rate of G.S.R.'s. .

V. DISCUSSION

Interpretation of the Data

The experimental design permitted observation of changes due to treatment conditions: a) for recovery periods; b) for mental arithmetic periods; and c) changes due to the repetition of stimulus conditions over time (adaptation). The data associated with each of these observations are subject to different interpretations and may be related to different aspects of the reciprocal inhibition paradigm.

Recovery Periods

Observations during recovery periods are directly related to the hypothesis which predicted that verbal suggestions of calmness, relaxation and tranquility would facilitate inhibition of arousal. For the purpose of this study, it was proposed that an inhibitory stimulus condition presented during the inter-stimulus intervals (recovery periods) between periodically presented excitatory stimuli would result in greater inhibition of arousal (recovery) than irrelevant stimulation or no stimulation. This hypothesis was strongly supported by the data. Both S.R. recovery ratio scores, based on point estimation at the end of each recovery period, and the absolute rate of non-specific G.S.R.'s observed throughout the entire recovery period, indicated significantly greater inhibitory effects for the Relaxation group and no differences between the two control groups. The hypothesis is further supported by Chi-square analyses

of the distribution of arousal scores between groups for recovery periods. When arousal scores were partitioned into those indicating higher than resting level (B_1) arousal and those indicating the same or lower arousal, it was determined that the Relaxation group had a significantly greater number of lowered arousal scores for both dependent variables.

The failure to find systematic differences between the two control conditions during recovery periods is consistent with the view that the inhibitory effects are attributable to the symbolic referents of the words used to suggest relaxation and not to their non-symbolic aspects (e.g. effect of human voice, discriminative properties as a time-out from work stimulus, distraction). These findings are in agreement with those of Matthews and Gelder (1968), who found that speech irrelevant to relaxation did not have a noticeable effect on levels of arousal in phobic Ss.

Mental Arithmetic Periods

The significantly higher recovery ratio scores found for the Relaxation group during the mental arithmetic periods may indicate that inhibitory stimulation during the recovery periods lowered the background level of arousal so that the same quantity of excitatory stimulation during mental arithmetic periods resulted in a lesser apparent degree of arousal. However, there are several reasons for questioning an interpretation that this result is due to a differential effect of treatment conditions on contiguous mental

arithmetic periods. For some reason which does not appear to be explicable in terms of treatment effects, the Relaxation group had higher recovery ratios for the first mental arithmetic period before the inhibitory instructions were introduced, which leaves the possible treatment effect unclear. Furthermore, results with the non-specific G.S.R. variable fail to indicate lower arousal scores for the Relaxation group, but instead indicate significantly higher arousal scores for the Waiting group. The overall interpretation of results for mental arithmetic periods remains equivocal.

Adaptation

There is no evidence of a significant interaction effect to support a conclusion that the Relaxation group showed progressively greater inhibition of arousal (adaptation) over trials than did the control groups. Failure to find a progressive reduction in arousal for the Relaxation group during recovery periods makes it doubtful that the inhibitory effect was increased to any great extent by learning during the experiment. One possible explanation for this finding (which will be discussed in greater detail in a later section) may be that the inhibitory stimulus was effective from the outset because of the individual's past learning and associations to the verbal suggestions.

A finding of significantly greater adaptation for the Relaxation group during the mental arithmetic periods would have lent support

to Wolpe's (1958) view that the repeated pairing of an inhibitory stimulus with a stressful stimulus would result in counter-conditioning the stressful stimulus. Although the graph of non-specific G.S.R. scores (Fig. 6) for the Relaxation group during mental arithmetic periods has the appearance of progressively diminishing, the interaction effect did not reach significance.

It is probably the case that a one-minute period of mental work following a two-minute period of suggestion-induced relaxation may not be adequate to produce a counter-conditioning effect. In the counter-conditioning treatment of fear, relaxation procedures may be performed at the patient's request along with the fearful stimulus with only a low level of arousing stimulation present. It is also the usual procedure to present the same arousing stimulus until complete adaptation occurs.

In summary, it has been demonstrated that at the time suggestions of relaxation, calmness and tranquility were presented, they facilitated inhibition of arousal, but there is little evidence that they enhanced adaptation over trials.

Experimental Implications

It has already been suggested that one probable source of difficulty encountered by earlier workers (Barber and Hahn, 1963; Grossberg, 1965), who could not demonstrate an inhibitory effect with relaxation procedures, was the use of these procedures with un-

aroused Ss. Paul (1969a, 1969b) proposed to deal with this problem by instructing his Ss to visualize a phobic situation prior to beginning relaxation procedures. His failure to find significant differences between treatment groups on skin conductance measures (although he did find differences in other physiological measures) may have been due to the use of a single pre-test arousal stimulus which was insufficient to discriminate the effects of specific relaxation procedures from the gradual recovery of all groups over a 25 minute test period. Matthews and Gelder (1969) were successful in the demonstration of inhibitory effects for a relaxation procedure, possibly because they chose to work with highly aroused phobic Ss.

The findings have shown that a modified adaptation paradigm, in which inhibitory stimuli are introduced during the recovery period immediately following the termination of an excitatory stimulus, provides an adequate condition for testing the effectiveness of inhibition of arousal. It is rather well established that an arousal recovery curve is negatively accelerated with largest change following shortly after cessation of an excitatory stimulus (Stern, 1970). Therefore it might reasonably be expected that the greatest differences due to treatment effects would occur at an early stage in the recovery period. As a recovery period grows longer and arousal diminishes, the effects of time and termination of excitation come to predominate, and initial differences are obscured. It would appear desirable therefore to measure differences in arousal for brief recovery periods.

Utilization of a recovery ratio score or similar method for estimating the degree to which an individual S approaches his initial resting level of arousal is helpful in overcoming some of the difficulties inherent in scores utilizing absolute values of skin resistance or skin conductance, concerning which Lykken (1968) has concluded, "The absolute value of ....S.C. is strongly determined by basic factors which are unrelated to the psychic or C.N.S. processes in which the psychophysiologist is interested." The use of a recovery ratio score, which is essentially a base-free measure of the degree to which an individual arousal index returns to pre-stimulation levels over an equated time interval, tends to avoid problems due to the Law of Initial Values, introduced by inter-subject differences in initial level of arousal (Steinschneider and Lipton, 1965).

Electro-dermal measures used in this experiment, particularly the skin resistance measures, do not discriminate between arousal due to different stimulus conditions or inferred emotional states. This limitation (which is a strength as well as a weakness) has been interpreted as arising from the connection between S.R. measures and an "intensive" dimension common to all conditions effecting arousal. This interpretation suggests that findings based on skin resistance indicators may be widely generalizable.

Methodological Limitations

The tape recorded messages heard by the Relaxation group and the Listening group were dissimilar not only in the symbolic

referents of the language, but also in the degree of suggestion which they embodied. While an S in the Relaxation group heard a message suggesting he felt calm, tranquil and relaxed, an S in the Listening group heard excerpts from a medical journal article with only one initial suggestion that paying attention to the communication would serve to divert him and help him relax. It may be objected that the effects ascribed to the meaning of the suggestions may be attributable in some fashion to the S's receiving a more personal kind of communication, rather than listening to impersonal reading. One method of controlling for this possibility might involve a control group receiving a message containing suggestions which are neutral or irrelevant to relaxation (if such is possible). For the purposes of this study, it was considered more important to control for the possible inhibitory effects due to non-symbolic aspects of hearing spoken language. It must be recognized however, that the dimension of personal involvement elicited by the message was essentially uncontrolled.

Another objection may be raised concerning the possibility of somatic mediation in the Relaxation group through spontaneous muscle relaxation. Previously reviewed reports (Rachman, 1968; Davison, 1966) cast doubt on the necessity of such mediation, and animal research recently reviewed by Miller (1969) suggests that arousal indicators can be manipulated upward or downward under curarization with no perceptible change in muscle tonus. Monitoring E.M.G. responses would not clarify the matter unless it were

demonstrable that individual Ss showed changes in E. M. G. significantly earlier than they showed autonomic changes. So far as is known to this writer, no such evidence exists. In its absence it could be argued with equal conviction that suggestion results in arousal reduction which mediates muscle relaxation, against the view that muscle relaxation mediates arousal reduction.

Theoretical Implications

On the whole, the study results support the view that symbolic aspects of instructions verbally representing a state of calmness, tranquility and relaxation can in themselves exert an inhibitory influence on arousal. These findings have implications both for the limited theory of reciprocal inhibition of fear (Wolpe, 1958), and for the development of a more general theory of inhibitory stimulation.

The finding that muscle relaxation induced by progressive relaxation training or by hypnosis is not necessary to produce an inhibitory effect on arousal argues against a strict peripheralist (Jacobson, 1938) interpretation that inhibition of arousal is necessarily mediated by decreased afferent feedback from the musculature. This in no way discounts the possibility that muscle relaxation may operate synergistically to facilitate inhibition of arousal, either by physiological means, as a discriminative stimulus for a subjective feeling of relaxation, or as a response reinforced by the therapist. It is quite possible that a cyclical sequence of events is involved in lowering the level of arousal through muscle relaxation training, beginning

with lowering arousal through the symbolism of relaxing instructions, which then facilitates the lowering of muscle tonus, which may in turn exert a feedback effect promoting still lower arousal. Lader and Matthews (1968) have recently suggested a similar explanation.

The finding that elements of the reciprocal inhibition treatment (suggestions) inhibit an arousal state presumably not related to fear, but to mental effort, raises some interesting issues.

This effect is consistent with the view that a common "intensive" dimension may be found in arousal which accompanies manifestly different psychological states, and suggests that conditions which inhibit arousal may directly affect this intensive dimension irrespective of the source of arousal.

It is well known that a wide variety of stimulus conditions resulting in diverse specific behaviors also elicit increases in sympathetic-adrenal arousal. Extension of the reciprocal inhibition principle to the larger set of arousal states implies that there may be another class of stimulus conditions which, in addition to evoking specific behaviors, also have a general tendency to inhibit arousal. Following this line of reasoning, one may speculate that the reciprocal inhibition treatment of fear recommended by Wolpe is a subclass of treatments which act directly to reduce an intensive dimension of arousal.

Implicit in the formulations of most activation theorists is the assumption that arousal reflects in some fashion the mobilization

of energy preparatory to an act of behavior anticipated from salient stimulus conditions. The relationship between arousal and what may be termed the behavioral requirements of a stimulus condition may be conceptualized in terms of a systems theory approach as follows: an input or stimulus condition which moves an organism out of its equilibrium or "zone of stability" invites a correction (Miller, 1965). The behavioral requirements of a stimulus condition are related to the range of potential corrective responses, while arousal is related primarily to an intensive dimension of both the stimulus condition and the behavioral requirements. Germana (1969) reviewed the literature relating activational and behavioral responses and concluded that there is considerable evidence for a correlation between the required intensity of a behavioral response and the activational level it elicits.

Having conceptualized arousal level in terms of the intensity of behavioral requirements associated with a stimulus condition, it may be justifiable to speculate that at least two potential methods exist for altering the stimulus conditions to lower the level of arousal. One method may involve the removal of excitatory stimulus conditions so that a behavioral requirement and its associated arousal is reduced or eliminated. A second method may involve adding an inhibitory stimulus condition to the stimulus set which will directly inhibit the arousal associated with a behavioral requirement. The second method of approach assumes that stimulus conditions exist

which directly inhibit arousal, but need not be related to the source of the behavioral requirement. By way of example, one may reduce a fearful student's arousal level prior to an examination by cancelling the examination, by teaching him techniques of relaxation, or offering him a tranquilizer.

By hypothesizing a class of stimulus conditions which directly inhibit arousal, and by further assuming that they follow the general laws of Pavlovian inhibition (e.g. algebraic summation with arousing stimulus conditions), it is possible to create a framework for the study and comparison of alternative methods of inhibition. Following this assumption it would be reasonable to expect that psychological methods of arousal reduction may be open to evaluation in the same fashion as psychopharmacological agents which inhibit arousal.

The nature and action of inhibitory stimulus conditions on distress are not well known. Some conditions may be innately inhibitory, functioning in a symmetrically opposite fashion to the Pavlovian unconditional stimulus (U.C.S.) and may be termed unconditioned inhibitory stimuli (U.C.S.$^-$). Kessen and Mandler (1961) suggest that sucking and fondling may serve as an innate inhibitor of distress in infants.

It is more likely that most stress inhibitors are learned rather than innate. Mowrer (1960) hypothesized that stimuli conditioned to relief from aversiveness may produce "anticipatory hope" and "...that the mere prospect of relief would be somewhat relieving"

(p. 135). It is quite possible that words synonymous with calmness, tranquility, relaxation have in the past been conditioned to relief states or states of low behavioral requirement, and may tend to reelicit them thus resulting in an inhibitory effect on arousal. Lazarus and his co-workers (cf. Lazarus, 1965) have reported that what Ss say to themselves under stress significantly affects the degree of physiological arousal associated with the stimulus conditions. Lazarus holds the view that appraisal of threat is essentially a cognitive function which may be countered by other symbolic inputs.

The action of arousal-inhibiting conditions in reducing distress requires a further assumption that inhibiting arousal will lead to decreased subjective discomfort. If one conceptualizes arousal as the intensive dimension of the behavioral requirement associated with a stimulus condition, inhibiting arousal should result in a decreased urgency to behave in such a manner as will reduce the effect of a distressing stimulus condition and restore equilibrium. In cases where the requirement to behave is intense, but the range of corrective behavioral options is limited, it is particularly important to develop techniques for inhibiting states of arousal. This problem is especially relevant, but not limited to, arousal states accompanying strong emotion. It may be conjectured that much of the distress associated with strong emotion may be due to prolonged states of arousal, or intense behavioral requirement, with no range of adaptive behavior available to reduce the arousal

level, or where it is unfeasible to alter the stimulus conditions which have elicited the arousal.

The "placebo" effect may be one instance of the operation of symbolically-mediated inhibition of arousal. It is assumed that illness is accompanied not only by discomfort due to tissue pathology but also by a high degree of emotional arousal and a limited range of behavioral options with which to decrease discomfort. If stimulus conditions are introduced which are associated with relief, comfort, tranquility, etc., they can result in an inhibition of arousal which may be interpreted by a patient as lowered distress or relief.

Schachter (1964) summarized the findings of several of his experiments dealing with cognition and the alteration of arousal states by drugs as follows: "...given a state of physiological arousal for which the individual has no immediate explanation, he will describe his feeling in terms of the cognitions available to him." One may speculate that the converse may also be likely. Given a state of lowered arousal, an individual will label his mood as calm, which in turn may result in facilitating further inhibition of arousal.

The action of an inhibitory stimulus in counter-conditioning a noxious stimulus (i.e., phobic stimulus) is far from clear. Wolpe (1958) proposed the explanation that muscle relaxation (as an anxiety inhibiting response) favors conditioning of reactive inhibition to anxiety eliciting stimuli, leading to the permanent inhibition of their potency as anxiety elicitors.

Lader and Matthews (1968) suggested that conditions which lower the general level of arousal favor habituation of A. N. S. responses to unreinforced stimuli. They hypothesized that conditions of low arousal provided optimal conditions for the extinction of phobic responses.

The findings of the present study tend to fit more comfortably with the Lader and Matthews hypothesis. It is tentatively suggested that the habituation or extinction of a phobic response in reciprocal inhibition therapy may be facilitated by suggestions which directly inhibit the high levels of arousal associated with fear stimulation. The effective ingredient in reciprocal inhibition therapy may be the association of previously fear-eliciting stimuli with a new condition of lowered arousal.

While this study was concerned primarily with the inhibition of arousal by external suggestion, there is some evidence for the view that self-evoked suggestion may have similar effects. Recent reviews of the literature on instrumental conditioning of autonomic response systems (Kimmel, 1967; Katkin and Murray, 1968; Miller, 1969) indicate that Ss are somehow able to create conditions which inhibit arousal. Nowlis and Kamiya (1970) found that Ss who learned to increase their rate of alpha response instrumentally (an E. E. G. index of low arousal) reported using a range of self-evoked mental states (feelings of relaxation, pleasure, "letting go," etc.) to facilitate alpha responding. While the extent to which

symbolic mediation may be involved in the process of inhibiting arousal is still a matter of speculation, the study of self-suggestion as a technique for self-control of arousal would appear to be a logical extension of the reciprocal inhibition principle.

VI. CONCLUSIONS

1. The experimental findings strongly support the hypothesis that instructions suggestive of relaxation, calmness and tranquility are in themselves sufficient to elicit measurable inhibition of arousal under certain conditions.

2. There is little evidence to suggest that the inhibitory effect grows progressively stronger over trials. This finding supports a view that the inhibitory effect is due to past conditioning rather than new learning.

3. Suggestion-induced relaxation, rather than muscle relaxation training or hypnotic trance, may be an essential factor for the inhibition of fear related arousal in reciprocal inhibition therapy.

APPENDIX A

INSTRUCTIONS TO SUBJECTS

Initial Instructions for all Groups

We are going to measure some of your reactions while you are engaged in a series of rapid mental calculations. I am going to give you some numbers to multiply mentally. When you get an answer, please speak it into the microphone at your left. Continue working on a problem until you solve it, or until you hear the next problem. Work as rapidly as possible. There will be rest periods between each set of calculations.

You may notice that rapid mental calculations can result in fatigue and tension, which can impair your efficiency. I suggest that you try to relax as much as you can during the rest periods. Please pay close attention to any other instructions you may hear.

Now sit back and relax. The problems will not begin for several minutes while you become accustomed to the experimental room.

Relaxation Instructions

Period I.

I can help you to relax...listen closely to my voice and follow my instructions...close your eyes...sit back in your chair...let the palms of your hands rest gently on the arms of the chair...let your mind be

empty...the flow of your though be stopped...just listen to me. Think of your legs...feel all the tension and stiffness leave them... your muscles let go...all you feel of your legs is their weight on the floor...very comfortable...very heavy...very comfortable. Your arms are relaxing...they hardly seem to belong to you...your whole body is becoming relaxed...feel yourself sitting in the chair... sinking into the chair...feel the relaxation in your face...your face smooths, your lips part...relaxation is all through you...deeply... and deeply in your mind. You have no thought...only calmness... relaxation...deep...deep...relaxation.

Period II.

Let yourself sink back into the chair...relax your arms...relax your legs...feel your face relaxing...skin growing smooth...loose... so loose that your lips part...feel yourself relaxing all over...feel it...feel it all through you...think of the gentle feelings of relaxation... coolness...calmness...letting go...enjoying the feeling of complete calmness...complete relaxation...complete calmness...complete relaxation...relaxation is all through you...deeply...and deeply in your mind...you have no thought...only calmness...relaxation... deep...deep...relaxation...think of the gentle feelings of relaxation... calmness...coolness...peace.

Period III.

It is becoming easier to relax...it is becoming easier to turn off the feelings of stress and tension...think of your legs...feel the tension

drain out of them...feel their heaviness...they are so heavy...so comfortable...so relaxed...feel the calmness in your mind...feel the relaxation in your mind...your mind is like a still pool...calm... unrippled...perfectly tranquil...perfectly peaceful...nothing troubles you...you feel calmness...peace...perfectly calm...perfectly peaceful calm pervades you...drift with it...more...and more...think of how lovely it feels to let go...perfectly calm...perfectly peaceful...your mind is like a cloudless empty sky...no thought...only calm.

Period IV.

Repeat Period II.

Period V.

Repeat Period III.

Instruction to the "Listening" Group*

Period I.

Please pay attention to what I am going to read to you...it will help take your mind off the arithmetic problems. As human longevity increased...several decades ago...many more cases of malignancy... made their appearance...during the last few years...reports have appeared...of more than one malignancy...occurring in the same individual...the second ones...being entirely unrelated...to the first ones. The time interval between the appearance of the second tumor...varies in the literature from 0 to 14 years...a patient with

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cells...having malignant characteristics...a left lower lobectomy... was performed...and the pathologist reported...a poorly differentiated...squamus cell...carcinoma of the lung...six months later...the patient was readmitted...to the hospital...because of... night sweats, horseness...and weight loss...indirect laryngoscopy... revealed...a slight infection of the...left vocal vernical colis... with...a sharp line of demarcation...at the site of attachment.

Period IV.

Repeat Period II.

Period V.

Repeated Period III.

---

*Excerpts from: Titche, L.L. Carcinoma of the larynx following carcinoma of the lung. Archives of Otolaryngology, 1966, 83, 108-111.

Mental Arithmetic Problems (All Groups)

Period I.	5x47,	2x93,	6x53,	7x38,	4x91,	9x62
Period II.	7x34,	3x65,	2x47,	6x75,	9x96,	8x85
Period III.	4x56,	5x79,	3x91,	7x13,	4x49,	2x69
Period IV.	4x18,	3x29,	7x63,	6x38,	7x74,	4x99
Period V.	7x19,	4x51,	6x35,	7x87,	9x39,	4x74

APPENDIX B

SUPPLEMENTARY TABLES

TABLE 11

SUMMARY OF ANALYSIS OF VARIANCE OF BASELINE NON-SPECIFIC G.S.R. SCORES

Source	S.S.	df	F
Between Groups	.01	2	<1
Error	325.30	27	

TABLE 12

INDIVIDUAL RECOVERY RATIO SCORES (X 10^{-3})
FOR RECOVERY PERIODS

	S#	1	2	3	4	5
Relaxation Group	1	1141	1100	1076	1016	1011
	2	1016	1135	1192	1349	1374
	3	1299	1286	1257	1223	1250
	4	1156	1506	1500	1648	1565
	5	1010	1143	1292	1213	1365
	6	882	939	1046	978	974
	7	1399	1496	1534	892	1053
	8	1053	1326	1580	1444	1847
	9	942	1142	1271	1246	1323
	10	709	804	913	984	1056
Listening Group	11	382	390	466	549	422
	12	512	577	547	601	547
	13	894	1034	885	734	757
	14	843	888	951	891	966
	15	900	767	900	1000	933
	16	341	947	848	466	508
	17	878	829	860	843	881
	18	853	798	734	695	638
	19	858	858	875	817	840
	20	887	875	879	910	848
Waiting Group	21	815	859	875	909	909
	22	939	886	851	825	791
	23	987	932	906	933	906
	24	753	758	782	647	1000
	25	683	669	954	919	808
	26	923	825	855	803	863
	27	392	503	714	386	540
	28	376	429	399	317	517
	29	820	809	855	1056	844
	30	879	866	951	971	972

TABLE 13

INDIVIDUAL RECOVERY RATIO SCORES (X 10^{-3})
FOR MENTAL ARITHMETIC PERIODS

	S#	1	2	3	4	5
Relaxation Group	1	932	956	1032	598	968
	2	827	1000	893	951	934
	3	848	1213	660	993	940
	4	695	563	563	544	534
	5	988	997	1028	1060	980
	6	750	821	908	980	790
	7	955	1053	1003	1066	1108
	8	591	566	841	853	697
	9	871	700	655	668	695
	10	696	737	784	869	905
Listening Group	11	291	339	344	323	358
	12	470	470	482	482	494
	13	839	793	1153	1055	1088
	14	835	929	929	1034	951
	15	900	933	900	900	933
	16	341	492	434	405	666
	17	841	532	630	703	742
	18	765	898	966	898	731
	19	492	586	728	489	629
	20	988	953	867	922	848
Waiting Group	21	600	580	728	768	825
	22	808	834	817	821	734
	23	946	892	919	906	892
	24	577	690	505	510	710
	25	558	631	628	709	1017
	26	885	818	810	833	788
	27	251	288	383	345	246
	28	263	302	300	281	334
	29	473	522	511	503	527
	30	786	830	869	898	877

TABLE 14

INDIVIDUAL NON-SPECIFIC G.S.R. SCORES
FOR RECOVERY PERIODS

	S#	Base-line	1	2	3	4	5
	1	3.5	1.0	0.5	1.0	1.0	0.5
	2	6.0	3.5	5.0	3.0	1.5	2.0
	3	2.0	1.5	1.5	0.5	1.5	0.5
Relaxation	4	3.0	2.0	1.0	1.5	1.5	2.0
Group	5	2.8	1.0	2.0	1.0	1.0	0.5
	6	2.0	2.0	1.0	1.5	1.5	2.0
	7	1.5	1.0	1.0	0.5	4.5	1.5
	8	1.0	0.5	0.0	1.0	0.0	0.5
	9	6.3	6.5	0.0	1.5	2.0	2.5
	10	1.0	5.5	3.0	0.0	0.5	0.0
	11	0.3	1.0	2.0	0.5	0.0	2.0
	12	2.5	2.0	1.5	2.0	1.5	2.5
	13	4.5	5.5	5.5	3.0	3.5	2.0
Listening	14	1.3	5.5	2.0	3.5	4.0	2.5
Group	15	4.0	5.0	2.5	3.0	2.5	3.5
	16	1.0	3.0	0.5	1.0	1.0	5.0
	17	0.0	0.5	0.0	1.0	0.0	0.0
	18	3.7	3.5	4.5	3.5	3.5	4.0
	19	5.0	1.5	0.5	0.5	1.0	0.0
	20	3.3	3.0	2.0	3.5	3.0	2.5
	21	1.0	1.0	2.0	2.5	1.0	2.5
	22	2.7	3.0	4.0	2.5	2.5	2.0
	23	2.7	4.0	1.5	2.5	1.0	1.5
	24	0.8	1.5	1.0	1.5	1.5	0.0
Waiting Group	25	1.3	3.5	3.0	0.5	5.0	2.5
	26	3.8	5.0	5.5	3.0	4.0	4.0
	27	0.3	1.0	0.5	0.5	3.0	0.5
	28	8.0	5.5	4.0	1.0	1.5	2.0
	29	0.8	2.0	1.0	1.0	0.5	2.0
	30	4.3	9.0	4.0	9.0	5.5	4.5

TABLE 15

INDIVIDUAL NON-SPECIFIC G S.R. SCORES
FOR MENTAL ARITHMETIC PERIODS

	S#	1	2	3	4	5
	1	3.0	3.0	1.0	2.0	1.0
	2	4.0	6.0	5.0	7.0	8.0
	3	12.0	2.0	4.0	4.0	2.0
Relaxation	4	6.0	8.0	3.0	2.0	2.0
Group	5	5.0	6.0	7.0	6.0	8.0
	6	6.0	3.0	4.0	3.0	3.0
	7	8.0	6.0	5.0	6.0	3.0
	8	1.0	2.0	1.0	0.0	2.0
	9	11.0	7.0	7.0	9.0	5.0
	10	8.0	9.0	3.0	0.0	0.0
	11	5.0	5.0	8.0	7.0	3.0
	12	4.0	10.0	9.0	8.0	7.0
	13	5.0	6.0	7.0	6.0	3.0
Listening	14	7.0	3.0	3.0	6.0	8.0
Group	15	0.0	1.0	3.0	3.0	6.0
	16	14.0	13.0	12.0	9.0	5.0
	17	0.0	2.0	3.0	2.0	4.0
	18	8.0	8.0	5.0	5.0	7.0
	19	5.0	3.0	3.0	2.0	6.0
	20	1.0	4.0	3.0	1.0	5.0
	21	8.0	8.0	8.0	6.0	2.0
	22	3.0	5.0	6.0	5.0	5.0
	23	10.0	7.0	8.0	8.0	9.0
Waiting	24	2.0	2.0	4.0	2.0	2.0
Group	25	4.0	4.0	6.0	6.0	6.0
	26	9.0	9.0	11.0	7.0	9.0
	27	6.0	5.0	1.0	1.0	5.0
	28	9.0	13.0	9.0	9.0	10.0
	29	5.0	7.0	10.0	10.0	8.0
	30	17.0	12.0	16.0	17.0	16.0

TABLE 16

DUNCAN'S NEW MULTIPLE RANGE TEST OF RECOVERY RATIO SCORES FOR RECOVERY PERIODS

Means	Listening	Waiting	Relaxation	Shortest Significant Range
	.7536	.7832	1.997	
.7536		.0246	.4461	R_2 = .1384
.7832			.4165	R_3 = .1391
M.S. Error = .043				
n = 50		Listening <	Relaxation	
S_x = .029				(p < .001)
df = 147		Waiting <	Relaxation	

TABLE 17

DUNCAN'S NEW MULTIPLE RANGE TEST OF RECOVERY RATIO SCORES FOR MENTAL ARITHMETIC PERIODS

Means	Waiting	Listening	Relaxation	Shortest Significant Range
	.6590	.7170	.8354	
.6590		.0580	.1764	R_2 = .1129
.7170			.1184	R_3 = .1176

M.S. Error = .049
n = 50
df = 147
S_x = .031

Waiting < Relaxation
Listening < Relaxation

(P < .01)

TABLE 18

DUNCAN'S NEW MULTIPLE RANGE TEST OF NON-SPECIFIC G.S.R. SCORES FOR RECOVERY PERIODS

Means	Relaxation	Listening	Waiting	Shortest Significant Range
	1.56	2.34	2.66	
1.56		.78	1.10	R_2 = .66
2.34			0.32	R_3 = .70
M.S. Error = 2.8				
n = 50		Relaxation < Listening		
S_x = .237				(P<.05)
df = 147				
		Relaxation < Waiting		

TABLE 19

DUNCAN'S NEW MULTIPLE RANGE TEST OF NON-SPECIFIC G.S.R. SCORES FOR MENTAL ARITHMETIC PERIODS

Means	Relaxation 4.58	Listening 5.26	Waiting 7.34	Shortest Significant Range
4.58		.68	2.76	R_2 = 1.99
5.26			2.08	R_3 = 2.05

M.S. Error = 11.9
n = 50
S_x = .489
df = 147

Relaxation < Waiting (P = .005)
Listening < Waiting

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