# Anxiety, Reality and Schizophrenia

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**Abstract**

*A theory of anxiety, inductively arrived at from, a series of investigations on the experience and mastery of anxiety in sport parachuting, and consistent with diverse findings by others, was presented. Major assumptions are that anxiety is mastered through inhibition, and that the gradient of inhibition is steeper than the gradient of anxiety. It was shown that the interaction of the expanding gradients can account for a systematic expansion of awareness of threat-relevant cues at tolerable levels of anxiety. Further evidence suggested that the anxiety system is a sub-system of a larger system for the modulation of excitation from all sources of stimulation. If it is assumed that the basic defect in schizophrenia is an inability to adequately modulate excitation, the major symptoms of the disorder can be accounted for, some otherwise anomalous findings can be explained, and some interesting implications for research are suggested.*

The theory to be presented here has its roots in a series of studies on the experience and mastery of anxiety in sport parachut-ing.[1,2,3,4,5,6,7,8] Findings emerged that were of a high order of reliability, and that could not readily be explained by current theories. It became apparent that anxiety was not merely a negative affect that contributed to problems in living, but that it was intimately associated with expansion of awareness of threat-relevant cues and with mastery of the environment. It could be compared to fire in that in proper degree, and under control, it served a highly useful function, but could also become extremely destructive. The findings suggested that control is achieved through the organization of inhibition at several levels, and that there is a unifying principle which governs the manner in which inhibition interacts with anxiety.[1,2] It was observed that the principles uncovered with respect to anxiety could be extended to a broader psychophysiological system for modulating the excitatory component of all sources of stimulation, with interesting implications for the development of reality awareness and emotional control.

The plan of this paper is first to present the anxiety theory, including a brief review of the empirical findings upon which it is based; second, to present the theory of excitatory modulation; and third, to consider the implications of the latter theory for the symptomatology and etiology of schizophrenia. Space, as well as the current state of research, does not allow for a thorough defense of all the arguments that will be presented. Rather, at this point, the validity of the theory must rest mainly upon its integrative power and cohesive-ness, and its value is largely heuristic.

## The Anxiety Theory

### *The Empirical Findings*

In several studies of sport parachuting the same effect was exhibited as a function of experience. Initially, it had been expected that as a parachutist gained experience and mastery, he would show a gradual decrease in the steepness of gradients of physiological arousal along dimensions of parachuting-relevant cues. The findings were as reliable as they were unexpected, holding for each individual tested longitudinally, as well as for groups arranged by experience level. With experience, the monotonic gradient of the novice became inverted V-shaped, and the peak progressively advanced to more remote cues. Fig. I presents the GSRs of novice and highly experienced parachutists produced during a word association test containing stimuli dimensionalized according to their relevance for parachuting. While the two groups produce similar

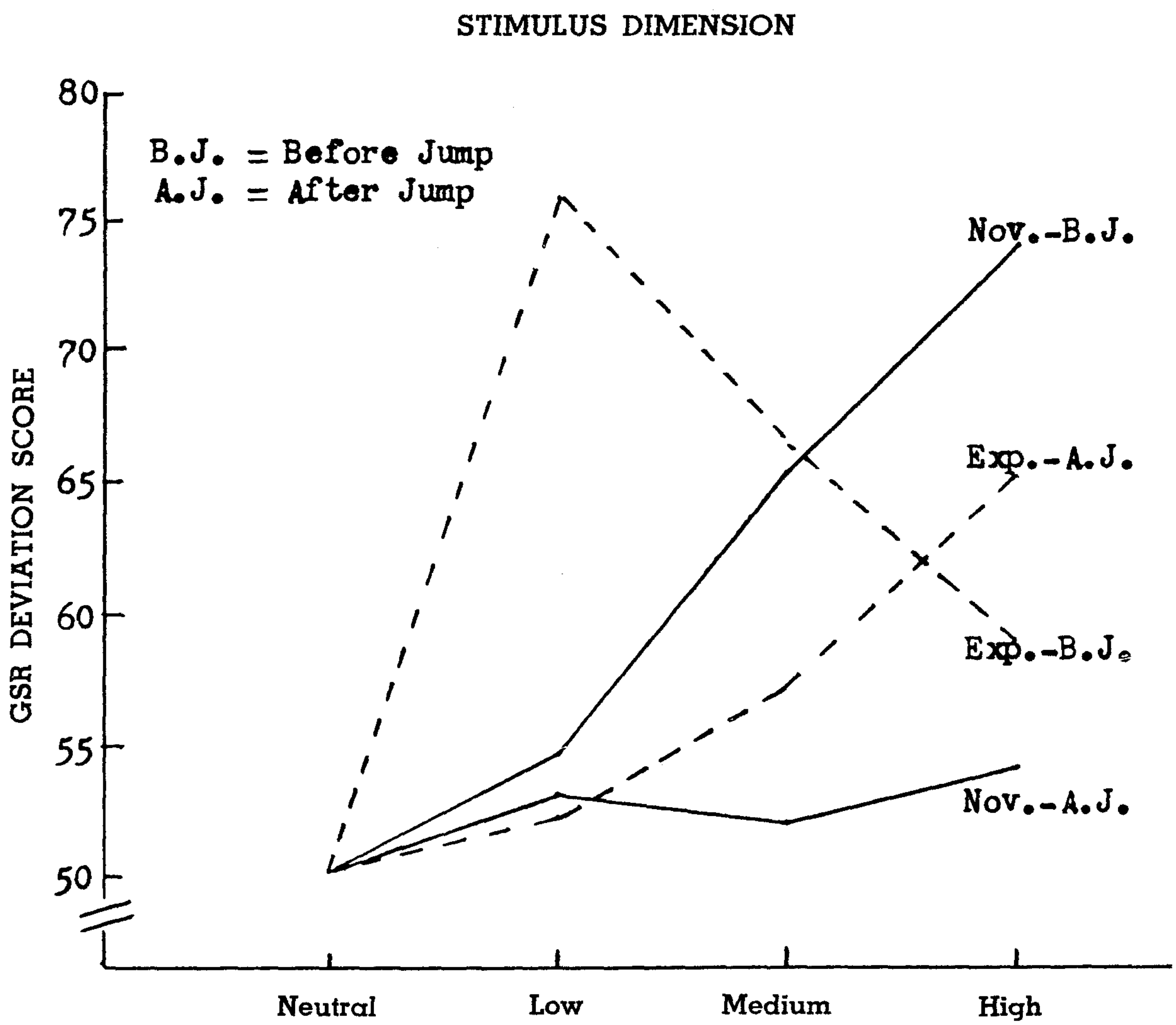


Fig. 1. GSR curves for reactions to a stimulus dimension in a word association test by novice and experienced parachutists tested before (BJ) and after (AJ) a jump. Deviation score refers to a correction for both individual differences in GSR lability and mean reaction to neutral stimuli.[1] In the overall study there were 4 experience levels, each containing 7 Ss tested twice. The data here are for the least and most experienced groups in Table 1.

monotonic gradients after a jump, before a jump the curve for the novices increases in steepness, while that for the experienced parachutists becomes inverted V-shaped. Table 1 presents results for the same study for parachutists grouped according to four levels of experience. With increasing experience, there is a progressive shift from monotonic gradients to inverted V-shaped curves, the peaks of which are increasingly displaced along the stimulus dimension. Fig. 2 presents the results for a single S tested longitudinally. Before the second jump he produces a monotonic gradient, before the fifth an inverted V-shaped curve that peaks back one step, and before the nineteenth jump one that peaks back two steps. While all Ss tested longitudinaly exhibited the same developmental pattern,

they did not all do so at the same rate.

The development of the inverted V Cannot be attributed simply to an increased familiarity with parachuting-relevant words. It is exhibited only shortly before

**TABLE 1**

FORM OF GSR CURVE AS A FUNCTION OF EXPERIENCE[1]

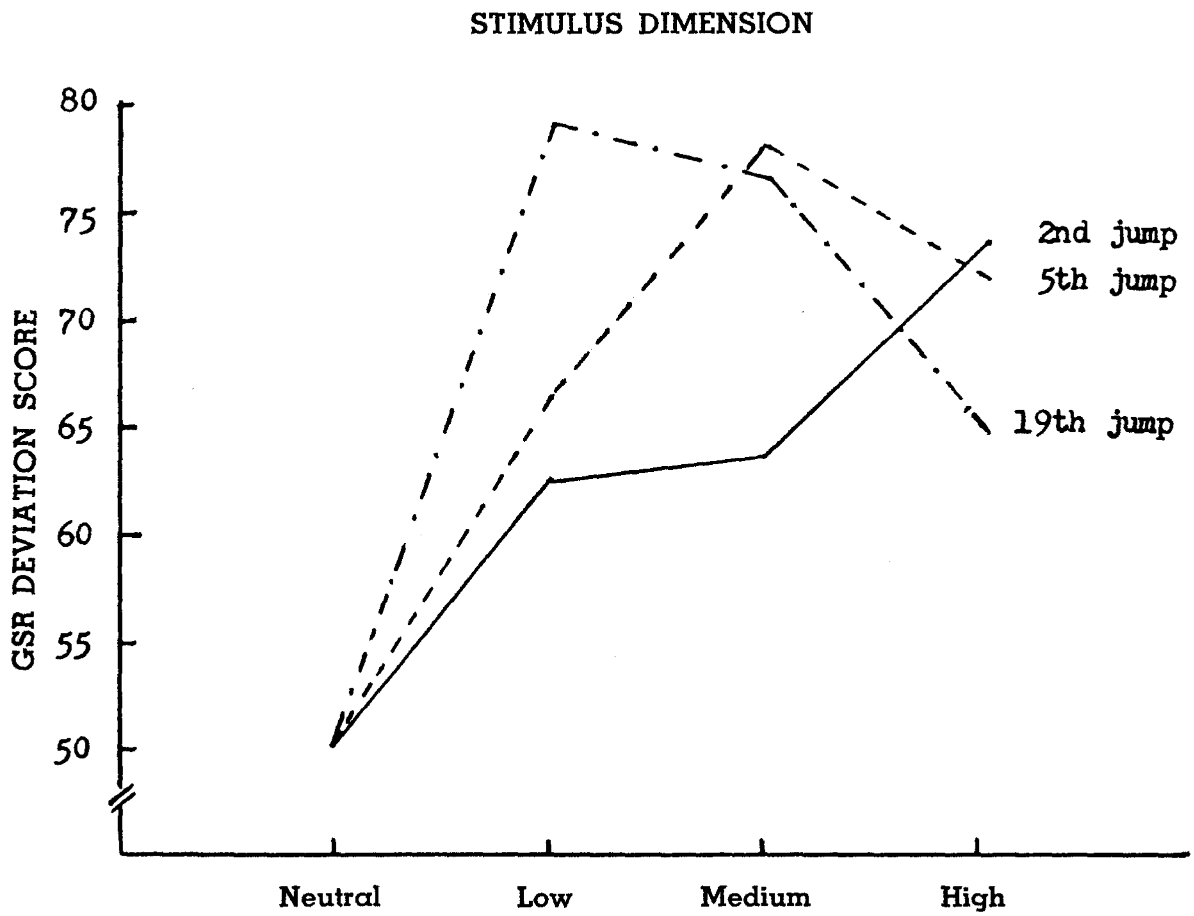


Fig. 2. GSR curves produced to a stimulus dimension in a word association test by a single parachutist tested after 2, 5, and 19 jumps. Deviation score refers to a correction for differences in GSR lability and mean reaction to neutral stimuli on the three occasions.[1]

a jump, and does not appear as a function of repeated testing in the absence of experience. General observation suggests that it is related to the mastery of anxiety. On a few occasions, the developmental pattern has been observed to reverse itself after a mishap. Moreover, the more promising jumpers, who are rated as exhibiting greater emotional control when jumping, exhibit an accelerated pattern.

Fig. 3 presents the subjective fear ratings of novice and experienced parachutists at 14 points in time, from a week before a jump to some time after landing. A rating of 1 was placed at the point of least fear, and a rating of 10 at the point of most fear. The other points were then rated accordingly. As all ratings necessarily vary over the same 10-point range, it is possible to evaluate the distribution of fear over time, but not absolute magnitude. In Fig. 3 it can be seen that the experienced parachutists have their peak of fear at a much earlier point in time than the novices.

Parenthetically, it is of interest to note that reported fear is not at its highest at the point of maximum danger, but at decision points, which shift forward with experience. Thus, the critical decision point for the novices is at the ready signal, when they can report that they are not ready, and delay or cancel the jump, and the critical decision point for the experienced jumpers is the morning, upon awakening, when, depending largely upon the weather, they decide if they will jump that day, and, having so decided, have no doubt that they will.

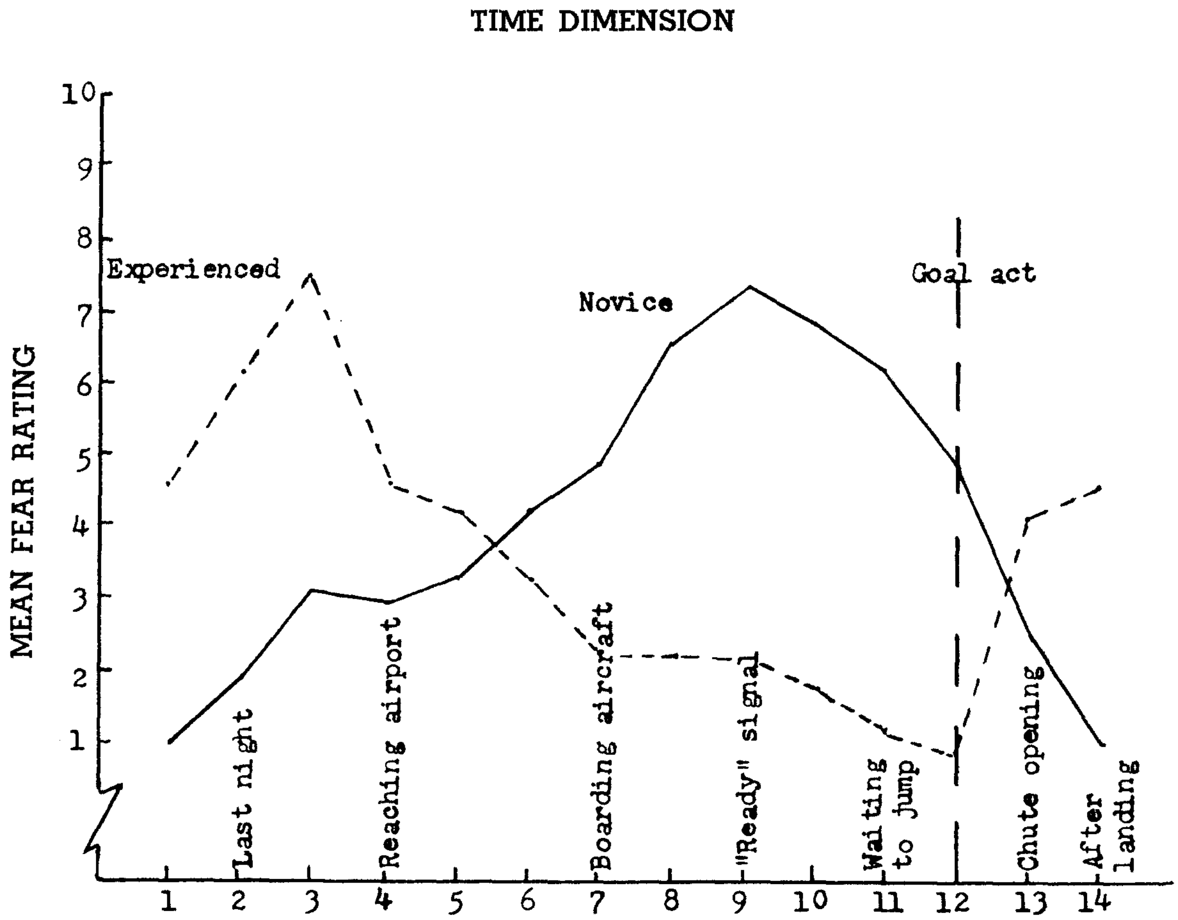


Fig. 3. Self-ratings of fear for novice and experienced parachutists along a dimension of events leading up to and following a parachute jump. N = 33 Ss per group.[7]

In the final study on parachuting to be reported, recordings of skin conductance, heart rate, and respiration rate were obtained continuously during ascent in the aircraft, and at selected periods before and -after. The results on skin conductance are presented in Fig. 4. On all measures, the curves of the novice and experienced parachutists were similar at first, but then diverged, with the novices demonstrating a sharp rise up to the moment before the jump, while the experienced parachutists manifested a drop. The peak of the inverted V-shaped curve for the experienced parachutists occurred earliest for skin conductance, next for heart rate, and last for respiration rate. This order indicates that the phenomenon cannot be attributed to the effect of the conscious control of breathing upon the other measures.

While both sets of data demonstrate the principle of displaced peaking as the result of experience, the curves of physiological arousal do not correspond to the ratings of fear, as the peaks of the fear ratings occur much earlier than the peaks of the physiological measures, which are relatively similar to each other. Thus, physiological arousal and subjective fear must be considered to be functionally distinctive variables.

Considering the overall findings, it is noteworthy that in three entirely different kinds of situations, using entirely different measures, the same principle was upheld. Namely, with repeated successful experience in facing a source of threat, monotonic gradients of fear and arousal were replaced by inverted V-shaped curves, the peaks of which became increasingly displaced away from the initial point of strongest reaction. The extensiveness of the finding, as well as its extremely high order of reliability, suggests the existence of a highly fundamental principle.

Why, then, it may be asked, has the principle not been observed previously in the many studies that have been reported

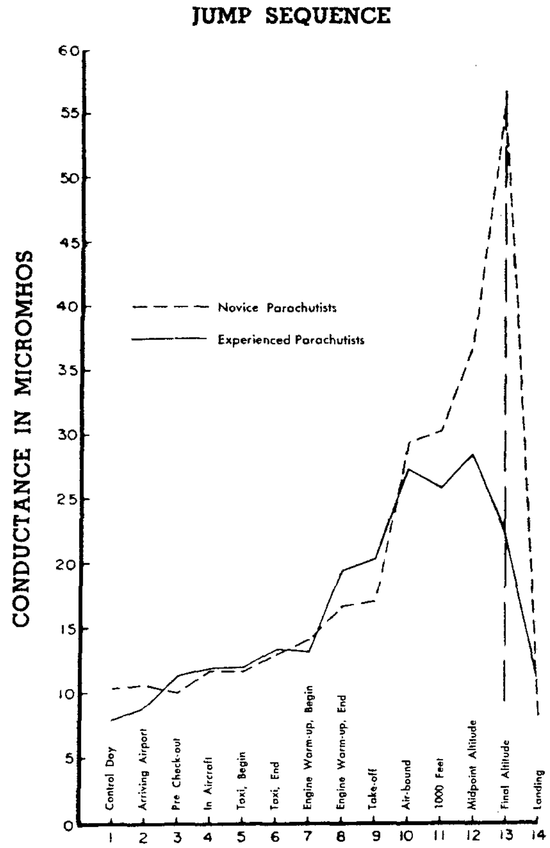


Fig. 4. Basal skin conductance of experienced and novice parachutists as a function of the sequence of events leading up to and following a jump. N = 10 Ss per group.[7]

on stress? The answer is that few studies have systematically investigated the effect of experience in a situation where active mastery of stress was possible, and in which measurements were made at several points along time- and cue-dimensions. Most experiments on stress have either ignored the variable of experience, pooling all experimental Ss into a single group, or have examined undifferentiated stress, without systematically varying the cues associated with it.

When stress-relevant cues have been varied, it has generally been at two levels, present and absent, making it impossible to establish curve forms, and fostering the erroneous impression that gradients simply decline in steepness with experience. As there are few enough experiments that meet one of the above conditions, let alone all, it is not surprising that the phenomenon of the inverted V-shaped curve has not been widely observed. Nevertheless, it has received some recognition.

Having observed fear and attempts to cope with it in combat flying, Bond makes the following observation:[9] "Every dangerous event, as it comes up, is broken off and isolated to become the subject of rumination and repetitive conversation. Every possibility is explored, every potential outcome considered, and all defensive action carefully rehearsed. Once mastered, the event drops into the preconscious, and attention is then turned to a new one. . . . The mastery of a situation through the repetition of it, lies at the core of the toughening process that takes place in the ego, particularly during training and the early stages of combat. ... Of particular importance is the timing of a trauma in relation to the toughening process. For instance, an event that may have a profound effect upon a cadet in his first flight will mean but little to a man in the basic phase and will scarcely be noticed by a seasoned flyer. This toughening process fulfills the function of pushing back the borders of the unknown, of replacing fantasy with reality, so that no longer is every event a blank screen on which inner fears are reflected but instead calls forth facts and certainties that limit the reflection and provide an outlet in the form of defensive action." The statement, "Once mastered, the event drops into the preconscious and attention is then turned to a new one," may well correspond to the advancing inverted-V in our parachuting studies.

A second source of support is provided by Pavlov's observation of what he termed "paradoxical phases," following exposure to stress.[10,11,12] During the Leningrad flood, a number of Pavlov's dogs were nearly drowned while in their cages. Upon testing them at approximately weekly intervals, Pavlov noted a remarkable transformation

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in their conditioned response hierarchies. At first, they exhibited a total loss of response, which he attributed to a widespread state of protective, or "transmargin-al" inhibition. This was followed by an "ultraparadoxical phase" in which the normal hierarchy of responses to stimulus dimensions was reversed, so that stimuli that had previously elicited the strongest responses, elicited the weakest responses, and vice versa. The next stage consisted of "paradoxical responses" in which the greatest response magnitude occurred at intermediate points along the stimulus dimension, thereby producing inverted V-shaped curves.

In time, the peaks of these curves shifted toward what had initially been the upper end of the gradient, until the original gradient was restored. While the direction of the shift in peaks is opposite to that for our parachutists, Pavlov accounted for the phenomenon he observed by postulating the dissipation of protective inhibition following overwhelming stimulation, whereas we postulated the development of increasing inhibition in the service of proactive mastery of stress. Fig. 5 is a plot of data supplied by Pavlov on a single case in which an experimental neurosis was induced in the laboratory.[10] Pavlov later was able to demonstrate that he could drive the reaction in the opposite direction, i.e., the same one as for our parachutists, by establishing conditions designed to increase inhibition.

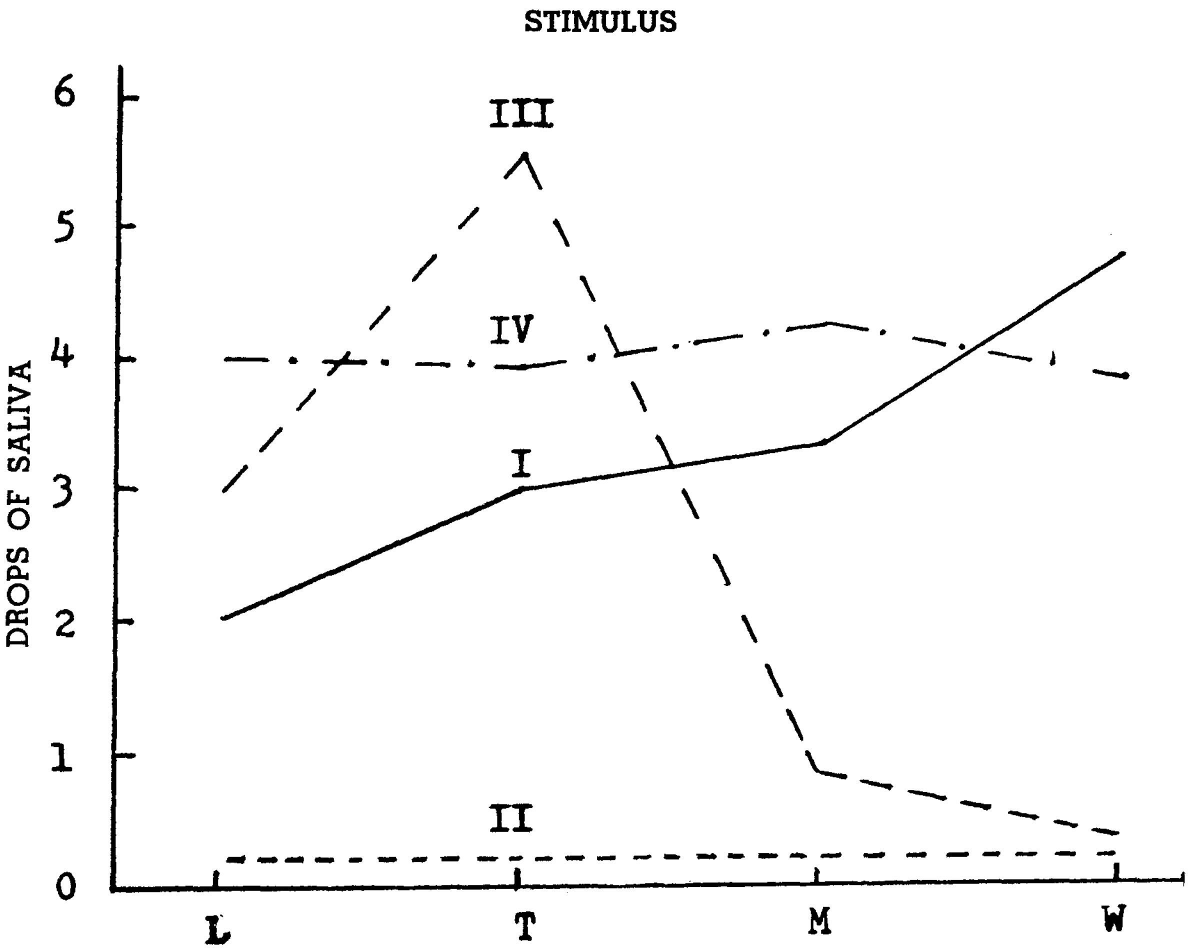


Fig. 5. The changing pattern of response hierarchies observed by Pavlov in animals exposed to extreme stress. Curve I corresponds to the original, pre-stress gradient, curve II to the phase of total inhibition, curve III to a paradoxical phase, and curve IV to the equivalence phase, which normally occurs between paradoxical phases. The curves were plotted from data supplied by Pavlov[10] on a single case.[2]

### *Postulation of Two Processes*

An explanation that not only accounts for the above data, but for a number of additional observations as well, follows from the assumption that the interaction of two fundamental processes is involved, namely the generalization and inhibition of anxiety. It is assumed that, as the result of repeated successful exposure to a source of threat, anxiety responses become increasingly conditioned to the extant cues, thereby raising the entire anxiety gradient. At the same time, a gradient of inhibition of anxiety (or of anxiety-producing responses) develops, which is steeper than the anxiety gradient. As can be seen in Fig. 6, these assumptions are sufficient to account for the development of inverted V-shaped curves, the peaks of which become increasingly displaced with experience.

Additional support for the control of anxiety by inhibition is provided by evidence of after-discharge effects for experienced jumpers, the group assumed to exercise the greatest inhibitory control. This can be observed for self rating of fear (see Fig. 3) and also occurred for heart rate and respiration rate recorded during and after the flight, but not for skin conductance. The same effect in parachutists has been reported by Basowitz, Persky, Korchin and Grinker.[13] We have also

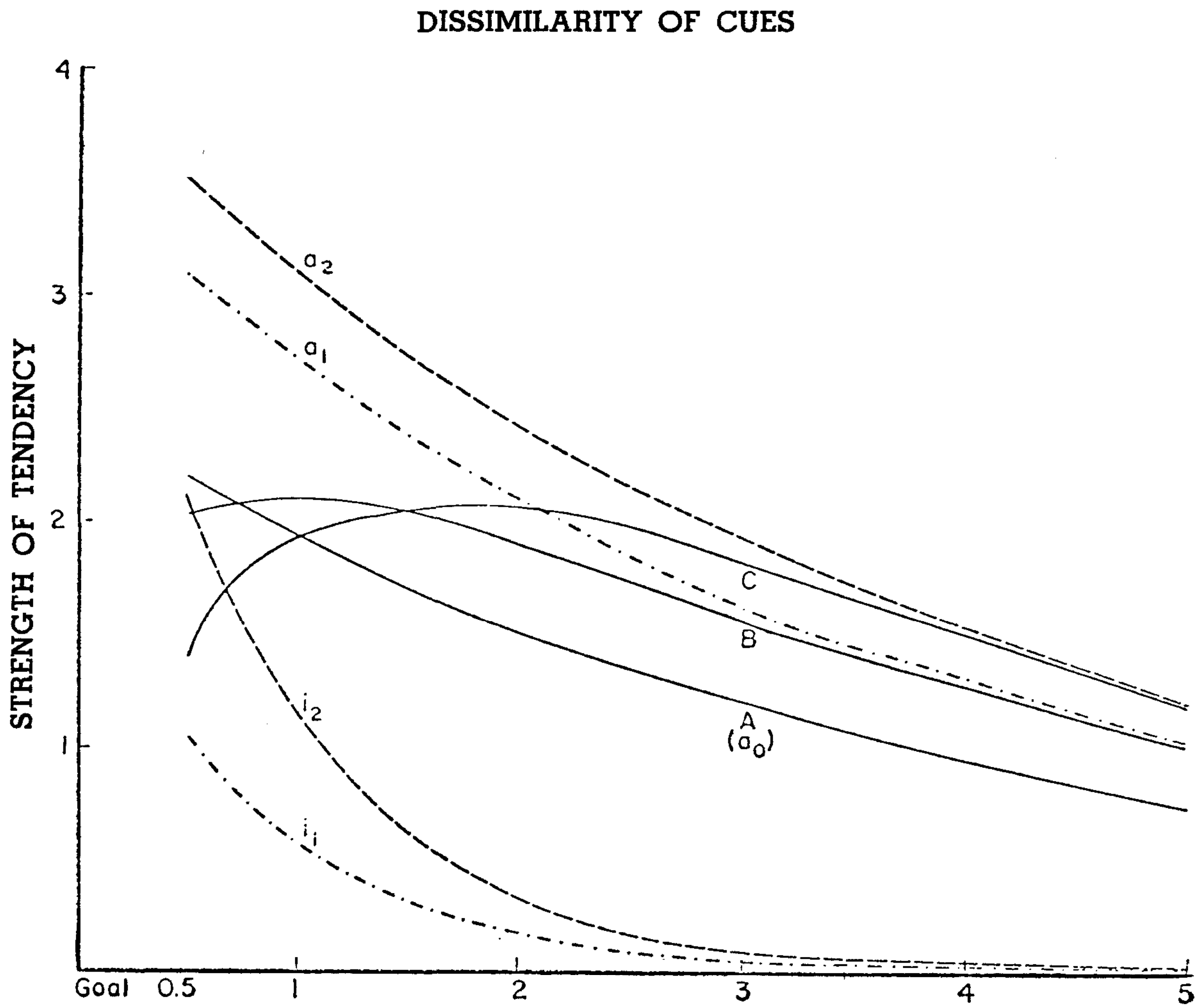


Fig. 6. Theoretical derivation of inverted V-shaped curves of anxiety, the peaks of which show increasing displacement with experience. Curve A represents the initial generalization gradient of anxiety. The upper two broken-line curves, $a_1$ and $a_2$, represent successive developmental levels in the generalization of conditioned anxiety. The lower two broken-line curves, $i_1$ and $i_2$, represent successive developmental levels of inhibition. Curve B represents net anxiety obtained by subtracting $i_1$ from $a_1$, and curve C a further developmental level at net anxiety obtained by subtracting $i_2$ from $a_2$. The curves are of the form $ae^{-kx}$. The curves for the three levels of conditioned anxiety, in order of increasing height, are represented by the formulas $2.5e^{-.25x}$, $3.5e^{-.25x}$, and $4e^{-.25x}$. The curves for the two levels of inhibition, in order of increasing height, are represented by the formulas $2e^{-1.25x}$ and $4e^{-1.25x}$.[2]

observed, on occasion, what we believe to be a breakdown in inhibitory control, i.e., experienced parachutists manifested levels of anxiety that surprised them following unexpected changes in the normal jumping routine that did not objectively justify the anxiety. Moreover, as novice parachutists exhibit desperate, crude attempts at inhibition of fear-producing responses, such as by perceptual distortion, it seemed reasonable to assume that what the novice does crudely in attempting to control his fear, the experienced parachutist accomplishes in a less extreme manner.[3,6]

The adaptive implications of the two-process theory of anxiety is of considerable interest. For one, the theory can resolve the enigma of anxiety as an adaptive as well as a destructive process, or as the riddle has been stated ". . . why should the alarm burn down the house?"[14] The heightening of the anxiety gradient provides the organism with earlier and earlier warning signals, and the steeper inhibitory gradient prevents the anxiety from becoming excessive. Thus, given appropriate inhibitory controls, the alarm does not burn the house down, but instead provides the individual with a highly effective early-warning system. Another adaptive consequence of the interaction of the anxiety and inhibitory gradients is that the advancing peak of anxiety forces the organism's attention to be successively focused on an ever-widening range of threat-relevant cues. The inhibitory gradient permits this expansion of awareness to occur at a rate that does not overwhelm the organism with the addition of new to old anxiety.

### *Distinctions Among Anxiety, Fear and Arousal*

Up to now, the term anxiety has been used loosely to imply a negative affect associated with threat or stress, and as no different from fear. It will be helpful, at this point, to make finer distinctions with respect to anxiety, fear, and arousal.

Fear is viewed as an avoidance motive. Like other motives, it includes a state of arousal, a tendency to approach or avoid, and a class of objects which elicit the arousal and toward which the approach or avoidance tendencies are directed. Fear is not recognized as a motive as often as are some other motives, such as sex and hunger, only because the class of objects to which it is directed is more varied and less directly manifested. This is because fear is readily conditioned to a variety of unrelated stimuli that are not stereotyped within a culture, and the objects of fear may be repressed.

Arousal is more fundamental than fear, as it is the non-directional component of all states of motivation and stimulation. It can be defined as the sum total of all stimulation, inner and outer. Thus, while all fear involves arousal, not all arousal involves fear. In considering the relationship between fear and arousal, it is important to consider that a person may express strong avoidance reactions, motorically or verbally, and experience relatively little arousal, or he may exhibit relatively weak avoidance reactions and experience much arousal.

Normally, fear is conditioned to those situations which have produced excessive arousal in the past. However, fear can also be based upon the anticipation of high levels of arousal in the absence of direct experience. A person who states that he has, and behaviorally exhibits, strong avoidance reactions, but shows relatively little arousal in the presence of a threatening object, has, in effect, made a poor estimation of what his reaction would be. Such a person, of course, will not normally face the threatening object and find out that this is so. The defenses here are completely cognitive, or psychological.

This is not the situation for the person who experiences high arousal in the face of a threatening object. Such an individual will ultimately respond on a reflexive biological level to keep his level of arousal within nondestructive limits. He will clearly have fewer degrees of cognitive freedom. Arousal and the defenses against it are thus considered to constitute far more fundamental systems than fear and the defenses against it. It can be anticipated that disorders that involve the former will be more profound than disorders that involve the latter.

A fundamental assumption for the development that follows is that the organism must maintain its level(s) of arousal, no less than other aspects of its internal environment, within homeostatic limits in order to survive. This assumption is consistent with Freud's view that, in the course of evolution, organisms had to develop ways to protect themselves from excessive stimulation as well as to respond to appropriate levels of stimulation, and that excessive stimulation constitutes the most fundamental source of anxiety.[15,16] It is also consistent with Pavlov's concept of transmarginal, or protective, inhibition, invoked when the cortex is subjected to excessive excitation, which can presumably destroy the "weak cortical cells."[10,11,12] It should be noted that it is actually immaterial to the position that follows whether there is an integrative arousal system (which we suspect there is) and its inhibitory control in addition to sub-systems, or whether there are only the sub-systems, as it is assumed that the same basic relationship between excitation and inhibition holds for all systems. Parenthetically, it might be noted that it would seem that an integrative system for controlling total excitation could be tapped by measures that reflect receptivity and dampening of stimulation, such as absolute and differential thresholds, critical flicker fusion, and other measures of perceptual acuity. Autonomic measures have to be treated with caution, as they are influenced by localized controls. This will vary with the particular system, of course. Heart rate cannot possibly vary on a one to one basis with external stimulation, since if it did, the organism would soon be destroyed. Skin conductance appears to be a particularly promising measure for within, but not between, subject differences. It has an advantage over heart rate in that it does not show the same rebound effects,[17] and there is some evidence that it is directly correlated with stimulation of the reticular activating system.[18]

Having discussed fear and arousal, we are now in a position to consider anxiety, which *is* viewed as lying somewhere between the two. Like fear, anxiety follows perception of danger. It differs from fear in that it is subjectively experienced as a more diffuse state and contains an element of helplessness. A man running from a lion is frightened. A man threatened by a danger to which he does not know how to respond is anxious. Thus, anxiety is defined as undirected arousal following the perception of danger, or, alternatively, as unresolved fear.

## The Theory of Excitatory Modulation

I venture to submit that the principles postulated with respect to the inhibitory modulation of anxiety and the simultaneous expansion of reality awareness hold with respect to lesser sources of excitation than those normally identified with anxiety. More specifically, it is postulated that there is a fundamental law of behavior, the Law of Excitatory Modulation (LEM), which describes the manner in which the organism regulates excitation at several levels of organization, permitting it to function efficiently without being excessively stimulated.[2] In simplified form, the law states that the gradient of inhibition is steeper than the gradient of excitation.* The law is presumed to hold for variations in excitation associated with the magnitude of the stimulus, its duration or number of repetitions, and the decay interval following stimulus offset. The LEM can account for the transient paradoxical responses observed by Pavlov in normal animals with relatively low *levels* of stimulation, as well as for the prolonged, extensive paradoxical effects produced by overwhelming stimulation. An example of the latter was provided in the account of Pavlov's dogs during the Leningrad flood.

As an example of the former, Pavlov noted that there is a direct relationship between the magnitude of the CR and the CS up to a point, after which the relationship reverses itself.[12] The stronger the motivation, the earlier the point at which the reversal occurs. Pavlov explained this by assuming that when the excitation produced by the stimulus is high enough, it induces inhibitory effects that more than

*For a more thorough statement and development of the LEM, see Epstein, 1967.

compensate for the increase in excitation. The LEM is consistent with Wilder's Law of Initial Values,[19] and with Sokolov's observation that alerting reactions, which are associated with increased receptivity to stimulation, increase in magnitude with increasing stimulus intensity only up to a point, after which defensive reactions occur, which reduce receptivity.[20] Moreover, repetition of a moderately strong stimulus can cause alerting reactions to be superseded by defensive reactions through a cumulative effect. The LEM can account for the course of habituation of both phasic and tonic autonomic reactions. It can also account for the recovery of habituated responses, and for after-discharge effects of anxiety.[2]

## The Process of Habituation

From the above perspective, the process of habituation is of fundamental significance, having implications for the development of excitatory modulation and the expansion of reality awareness. The simplest explanation for the decrease in the magnitude of response that constitutes habituation might appear to be that fatigue is involved. That this is incorrect, and that it is an inhibitory effect, is readily demonstrated by experimental disinhibition of the habituated response. The insertion of an extraneous stimulus between habituation trials immediately reinstates the response, whereas if a fatigue effect were involved it would reduce it yet further. The inhibition is apparently highly selective and discriminating, and intimately related to the development of expectancies, or a cognitive model of the stimulus situation.[20]

Within our own laboratory, direct support for this view is provided by research in which we are investigating the magnitude of an autonomic response as a function of previously established probabilities of occurrence of stimuli. Not surprisingly, the more the stimulus is expected, the less the reaction to it. The experimental condition of 100% expectancy corresponds exactly to the condition for habituation. It is rather interesting to note that, operationally, 100% expectancy and habituation in this situation are equivalent concepts.

While it may seem reasonable enough to assume that habituation, which involves a reduction in response, is a consequence of inhibition, it is less evident that habituation is also associated with the generation of new sources of excitation and thereby an expansion of reality awareness. There are two ways in which habituation can contribute to a broadening of the range of reactivity. One follows from the assumption that living organisms are inherently responsive to stimulation, and will seek to maintain stimulation above some lower limit. Thus, as they become less reactive to one source of stimulation, they tend to become more reactive to other sources. The other involves a more directed increase in reactivity, and includes a systematic working through of stimulus dimensions and the development of integrative schemata.

The answer as to how a directed increase in reactivity can be produced by a process associated with a reduction in reactivity lies in the consideration that the stimulus acquires cue value through the process of habituation. Originally the stimulus could be responded to only because of its energetic properties.* Through repeated presentations of the stimulus experienced at appropriate excitatory increments during the process of habituation, the stimulus becomes registered, so that it can from then on be responded to in terms of its cue properties. Thus, to the simple process of habituation is assigned the magical property

*The energetic properties of a stimulus are not limited to its absolute intensity value, but include factors such as movement and contrast effects within the total stimulus complex. I am thankful to Jerome Kagan, one of the symposium participants, for this observation. The important consideration with respect to the development presented here is that the stimulus initially has arousal value independent of learning with respect to its cue properties, and that the latter can be derived.

of being able to transmute stimulus energy into meaning.

Once the cue value of the stimulus is established, it produces gradients of perceptual-disparity for other cues along the same dimension or dimensions, and the perceptual-disparity gradients establish arousal gradients. Putting it otherwise, cues that are most similar to the habituated stimulus elicit minimal reactivity and cues further removed, at least up to a point, elicit maximal reactivity. We suspect that the curve rorm of increments in arousal along a dimension produced by habituation may be inverted V-shaped, as this is suggested by the LEM. However, such an assumption is not critical for the present development, as the only requirement is that a graded series of increments in arousal is produced along a dimension, with the maximum point being removed from the habituated stimulus.

Now, assuming that increments in arousal, up to a point, are pleasurable, it follows that habituation should produce approach responses to stimuli that differ to a degree from the habituated stimulus.[21] As the new stimulus becomes habituated, the point of arousal increment that is most pleasant should shift to a further point, and so on. As a result, dimensions are carefully worked over and expanded, and rudimentary integrative schemata developed.

Support for such a process in everyday life is indicated by the pattern of changes in the world of fashion and art, and, very likely, by the pattern of quests for new experiences and cognitions in other spheres. A new music style, art form, automobile or clothes design that at first is different to the point of being too arousing, and therefore discordant, after a while becomes a pleasant innovation, and finally boring, after which a new innovation is introduced, and so on. Within our laboratory, we have recently demonstrated a systematic shift in preference for the other tones in a dimension as a function of habituation to one of them.

In addition to supporting an expansion of awareness, a cognitive concept, the process of habituation is fundamental with respect to the development of excitatory modulation, an energetic, or emotional concept. There is reason to suspect that the expansion of cognition and the development of excitatory modulation are very likely two aspects of a more fundamental process, namely, the development of selective inhibition. At this point, it will be useful to more carefully examine the process of habituation. Upon the first presentation of a sufficiently intense stimulus, a strong involuntary response occurs. With successive presentations, response strength rapidly falls off and approaches an asymptote. Not only does the organism experience the stimulus followed by a range of increments in arousal, almost certain to include the levels most conducive to registering and retaining it (i.e., to forming an enduring cognitive model of it), but, at the same time, the organism receives experience in modulating the excitation produced by the stimulus. We have elsewhere referred to this process as "intensity learning," since it clearly conforms to the definition of learning as a change in performance based upon experience and not attributable to fatigue or maturation.[2] As in the studies of stress in parachuting, the stimulus can be said to be mastered in the sense that there is both an increase in awareness and a reduction in stimulus-induced arousal.

Although habituation is one of the most reliable phenomena known to psychology, it does not occur under all circumstances. The stimulus must be neither too strong nor so weak as to fail to elicit an alerting reaction. It is noteworthy that specifying the conditions for habituation requires statements on both the stimulus and the state of the organism. (In referring to the strength of the stimulus, what is meant is its strength before it acquired cue value, which is to be derived.) If the stimulus *is* too weak, it will, of course, not constitute a stimulus at all, except, perhaps, in the eyes of the experimenter. If it is too strong, it will continue to evoke strong responses, or will produce defensive reactions, which involve a state of diffuse inhibition that reduces receptivity to stimulation in general, rather than the fine-tuned, selective inhibitory controls associated with habituation.

The overall state of arousal of the organism (i.e., its total state of stimulation, as can be operationally manipulated through variations in inner and outer stimulation) must also fall within limits if habituation is to proceed normally.[22] Up to relatively high resting levels of arousal it is reasonable to assume that the Weber-Fechner ratio holds, such that the experienced intensity of a stimulus is inversely proportionate to the resting *level* of arousal of the individual. Thus, a stimulus of moderate intensity will be experienced as excessive if arousal level is sufficiently low. This phenomenon is exhibited in the exaggerated startle response of an awake, but drowsy, person. At relatively high levels of resting arousal, the "law of defense," i.e., the need of the organism to protect itself against excessive stimulation, can be expected to become dominant.[2,10,11,12,15,16]

It follows that individuals with abnormally *low* or high arousal levels, for whatever reason, should be most prone to find stimulation as excessive, and therefore noxious, and should tend to avoid new sources of stimulation, and, as a result, they should obtain limited experience in the development of excitatory modulation and expansion of awareness. Should they be exposed to moderately strong stimuli that cannot be avoided, such stimuli, experienced as excessive, will not habituate, and again there will be no experience in excitatory modulation. In short, such individuals are apt to be defective at an extremely fundamental *level* with respect to the control of excitation and the development of an adequate cognitive map of the world in which they live.

It should be noted that extremely high arousal levels are apt to produce more severe effects than extremely low arousal levels, as a limit with respect to biological tolerance, and consequent extreme compensatory defenses, is involved in the former case.

## The Theory of Schizophrenia

The implications of the above theory for the etiology of schizophrenia are self-evident. Presumably, the schizophrenic was over-aroused during a formative, early period, and had to rely upon emergency, unmodulated inhibitory controls to keep excitation within limits. As a result, he failed to adequately develop excitatory modulation and an adequately extensive and integrated model of the world.

The question remains as to how an extended state of over-arousal arose in the first place. If there is one behavioral quality that individuals differ reliably on from birth, it is excitability, or reactivity to stimulation. Thus, it can be anticipated that some individuals will come into the world more susceptible to over-stimulation than others. It is also evident that certain environmental circumstances are more apt to induce a sustained level of high arousal than others.

As was noted earlier, the concept of excitatory modulation itself involves an interaction of environmental variables and state of the organism. Thus, it would appear that defects in excitatory modulation must involve an interaction of environmental and organismic variables, and that the same state can be produced by different combinations. Not only should there be some cases of schizophrenia where individuals were so susceptible to over-stimulation that no *normal* environment could have averted the disorder, but there should be other cases in which individuals who, despite a relative lack of susceptibility to over-stimulation, were placed in environments that over-taxed their considerable capacity.

On the organic side, in addition to genetic factors, conditions conducive to schizophrenia should include not only certain diseases of the central nervous system, but also disorders of the sensory receptors that cause stimulation to be experienced as painful, particularly at certain formative periods.

At the psychological level, a condition that we suspect has particular significance for the development of schizophrenia is one in which the mother experiences strong unconscious hostility toward the infant or young child, resulting in an approach-avoidance conflict, allowing her neither to reject her offspring nor consistently love it. As a result, the relationship from the child's view becomes positive enough for the child to seek more of it and negative enough so that strong needs remain unfulfilled. In short, such a situation would be extremely effective in producing a prolonged state of high overall arousal.

Space does not permit consideration of the differences in etiology between a severe defect from the very early years on, as in "process schizophrenia" and a later breakdown in adulthood, as in "reactive schizophrenia." It will have to suffice to note that different magnitudes of the defect in excitatory modulation, among related factors, such as the collapse of a weakly organized self-system versus a failure to develop one in the first place, are considered to be involved.

Let us now turn to a consideration of the symptoms of schizophrenia as accounted for by the theory. The explanations that follow all proceed from the assumption that schizophrenia, at its most fundamental level, is the result of an excessively crude system for modulating excitation. Putting it otherwise, the schizophrenic's inhibitory control system is viewed as a poor servo-mechanism, which over-reacts in one direction, and over-compensates in the other. The schizophrenic is thus considered to be lacking in the refined inhibitory controls that are required for effective functioning with respect to emotional and motivational control, cognition, attention, and sensory and perceptual discrimination. Given a tendency toward all-or-none reactions to stimulus-induced excitation, it can be expected that, in order to be protected from over-stimulation, the schizophrenic will ultimately seek an adjustment characterized by avoidance of stimulation and by exaggerated inhibitory reactions to stimulation that cannot be avoided. Over-reactivity is apt to be observed only in the acute state, and, later on, in situations where avoidance is not possible and inhibitions fail.

Assuming that schizophrenia involves an excessively crude system for modulating excitation, the following symptoms can readily be accounted for: a tendency to over- or under-respond, sensory and emotional anomalies, poor contact with reality, anhedonia, inadequate impulse control, hallucinations, attention deficit and cognitive deficit.

A tendency to over- or under-react, the most direct manifestation of an inadequately modulated inhibitory system, is among the most prevalent symptoms of schizophrenia. Russian, as well as Western investigators have noted at least two groups of schizophrenics, one excessively reactive and one excessively unreactive.[23,24,25] We would add a third, characterized by marked shifts in reactivity, as exhibited in catatonic schizophrenia.

Sensory and emotional experiences in schizophrenia often exhibit an "all-or-none" quality. Schizophrenics complain of living in a world devoid of emotion and stimulation, in which everyone appears to be dead, as well as of experiencing stimuli and emotions so intensely that colors appear too bright, sounds and odors too strong, and feelings, even pleasurable ones, so strong as to be difficult to bear.[2627]

Poor contact with reality follows directly from the assumption that the schizophrenic learned early to avoid and defend himself against stimulation. As a result, failed to obtain experience in developing the expectancies and integrative schemata which would have reduced the impact of new stimuli. This forced increased reliance upon crude inhibitory controls in order to keep from being over-stimulated. Thus, a mutually reinforcing cycle was established between avoiding stimulation and failing to develop excitatory modulation that would allow the range of stimuli that could be dealt with at non-threatening levels of arousal to be expanded. Moreover, high levels of excitation induced by new stimuli are apt to generally disrupt performance, including perceptual discrimination and reality contact.

According to Meehl, ". . . anhedonia, a marked, widespread, and refractory defect in pleasure capacity ... is one of the most consistent and dramatic behavioral signs of the disease."[28] The pre-schizophrenic child, presumed to be over-aroused, would tend to find increments in stimulation aver-sive, and could, therefore, be expected to exhibit deficit in deriving pleasure from the small changes and increments in stimulation that normally elicit pleasurable reactions. Put otherwise, the schizophrenic is motivated to avoid pain, rather than to seek pleasure from stimulation.

As the result of unmodulated impulses and their unmodulated expression, impulses tend to be experienced in uncomfortable intensity and as dangerous. It is thus not surprising that schizophrenics become emotionally flat as a way of protecting themselves from emotions and impulses they cannot otherwise handle. Opler[29] notes that the symptomatology of Irish schizophrenics is indicative of excessive inhibition while that of Italian schizophrenics reveals insufficient inhibition. It is noteworthy that both groups exhibit one thing in common, namely, an inadequately modulated inhibitory system.

Assuming that there is a need for living organisms to seek excitation beyond a certain minimum, hallucinations can be explained as excessive reactivity to inner or extraneous external stimuli following inhibition of reactivity to more salient, or intense stimuli.

Attention requires the operation of a fine-tuned inhibitory system that allows relevant stimuli to be reacted to, while irrelevant stimuli are screened out. Given a crude inhibitory system, the schizophrenic must either screen out too much and, therefore, exhibit broad inattention, or narrow attention, as in paranoia, or be flooded with stimulation, as in acute schizophrenia.

Cognitive deficit can be deduced from an attention deficit and, at a more fundamental level, from the inability to modulate excitation, which forces the schizophrenic to either have to ignore significant cues or to experience cognitive disruption as the result of excessive excitation.

One of the most consistent findings in research on schizophrenia is that schizophrenic groups generally have higher variances than unselected control groups. This is a most embarrassing result, as for any classification system to have significance, it must be able to demonstrate homogeneity among members within a class relative to variation among classes. This observation has led some to conclude that there is no such entity as schizophrenia, but only different disorders that have been loosely grouped together because of a lack of information about their etiology. From the viewpoint of the theoretical position advanced in this paper, there is homogeneity in schizophrenia, but it must be looked for appropriately within the context of the nature of the disorder. Assuming that the basic defect, as postulated here, *is* a crude inhibitory system for modulating excitation, the heterogeneity reported in studies which have examined mean differences in directional responses can be understood. Depending upon the particular sample selected, it should be possible to obtain schizophrenic groups that have means that are greater, lesser, or no different from the means of control groups. In the likely event that the schizophrenic sample includes under- and over-responders, higher variances can be anticipated. To test the hypothesis that schizophrenics suffer from a defect in excitatory modulation, it is necessary to examine absolute magnitude of deviation from adaptive or normative responses, independent of direction. This is discussed in the next section.

## Research Considerations

The aims of this section are to consider some of the research implications of the proposed theory, to present the major findings of two recently completed studies designed within the framework of the theory, and to offer some suggestions for research on physiological reactivity in schizophrenia. It is beyond the scope of this paper to review all the relevant literature, which would require a lengthy paper in itself.

From the preceding discussion, it follows that the schizophrenic is defective in reacting to stimulation in three basic ways: (1) he has a crude inhibitory system for modulating the intensity component of stimulation and, therefore, should exhibit increasingly deviant responses as stimulus intensity increases; (2) he is defective in ability to attend to, establish expectancies for and assign meaning to cues; (3) he is defective in capacity to derive pleasure from increments and variations in stimulation.

### Modulating the Excitatory Component of Stimulation

The hypothesis of a crude inhibitory system can be investigated by varying the parameters of stimulus input and observing the degree to which response magnitude varies accordingly. Unless it is found that deviations vary uniformly in the same direction, such as when a schizophrenic group consistently under-responds, it is important to consider absolute deviations, as the hypothesis of a crude inhibitory system requires that responses be excessive or insufficient, and deviations in one direction can cancel out ones in the opposite direction.

Among the parameters of stimulus input that require investigation are intensity of stimulation, amount of stimulation in terms of both duration and number of trials, rate of stimulation, time interval between stimulus and response and sensory mode of stimulation.

### Reduced Reactivity

Perhaps the most fundamental psycho-physiological relationship of all is the relationship of response magnitude to stimulus intensity. In a recent doctoral dissertation, Bergeron[30] varied intensity at three levels, once by varying the primary intensity value of pure tones, and again by varying the emotional intensity values of words in a word association test. He found that good and poor premorbid, chronic schizophrenics exhibited reduced reactivity at all levels of stimulation in both dimensions relative to normal controls. The schizophrenics also exhibited flatter gradients of response magnitude (see Figs. 7 and 8). As stimulus intensity increased, the discrepancy between schizophrenics and normals also increased.

In a doctoral dissertation concerned primarily with habituation, but in which stimulus intensity was also varied, Smith[31] replicated Bergeron's findings for chronic

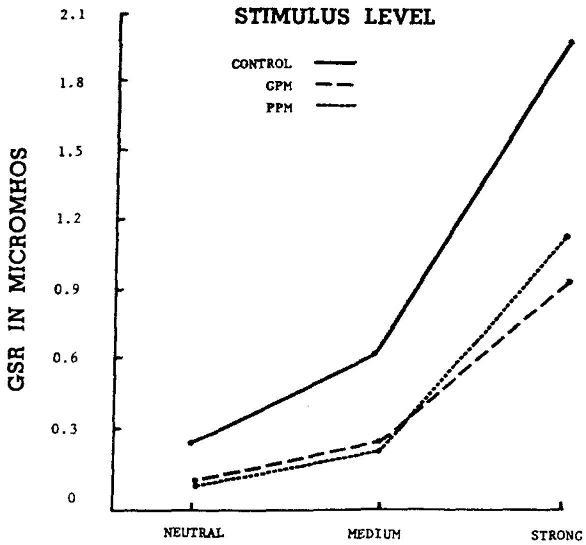


Fig. 7. Magnitude of GSR as a function of the intensity of pure tones for good premorbid schizophrenics (GPM), poor premorbid schizophrenics (PPM), and normal controls.[30]

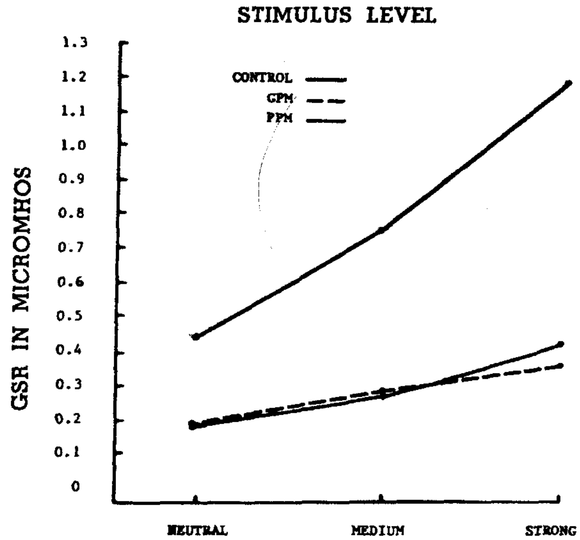


Fig. 8. Magnitude of GSR as a function of the rated socio-emotional disturbance value of words in a word association test for good premorbid schizophrenics (GPM), poor premorbid schizophrenics (PPM), and normal controls.[30]

schizophrenics, and found that degree of withdrawal was a significant factor, the more withdrawn patients producing the flatter gradients (see Fig. 9). The common finding of low reactivity in chronic schizophrenics is particularly impressive considering that Bergeron's schizophrenics had lower prestimulus basal conductance levels than his controls, while the opposite was true of Smith's schizophrenics.

It is noteworthy, considering the position of importance assigned to habituation in our theory of schizophrenia, that Sha-kow[32] states that one of the few stable findings in his extensive studies of chronic schizophrenics is that they fail to produce normal habituation curves. In the study referred to above by Smith, both low and high withdrawn schizophrenics produced significantly different GSR habituation curves from normals, with the high withdrawn schizophrenics exhibiting the greater deviance, and the greatest deviance occurring on the high-intensity stimuli (see Fig. 10).

## Paradoxical and Variable Reactivity

While the finding that a particular subgroup of schizophrenics uniformly under-responds, and does so increasingly at higher intensity levels relative to normal controls, is consistent with the theory, stronger support would be provided by evidence that the same schizophrenics over-respond, as well. Data to this effect are provided by the Smith and Bergeron studies. One of Smith's measures, which was aimed at representing the change in the rate of rise relative to the rate of fall in net excitation that occurs as a function of stimulation, consisted of the ratio of the slope of inclination to the slope of declination of the GSR.

This ratio increases as a function of increasing intensity of stimulation and decreases as a function of habituation trials. Reliable group differences were found for the change in this ratio over blocks of habituation trials. The normal group showed a sharp decrease in slope ratio from the first to the second block, the active schizophrenics showed little change, and the withdrawn schizophrenics showed a sharp increase in the ratio (see Fig. 11).

The paradoxical behavior of the withdrawn schizophrenics supports the existence of a crude inhibitory system rather than one that *is* uniformly excessive under all circumstances. In like manner, the less withdrawn schizophrenics exhibited a failure to differentially respond over blocks, and not simply a general reduction in reactivity. The results cannot be attributed to differences in magnitude of GSR responses, as magnitude of the GSR did not produce similar reliable group differences for changes in reactivity over blocks of habituation trials.

Smith also found a paradoxical effect exhibited by withdrawn schizophrenics for heart rate as a function of habituation trials. In one of the measures of habituation, the 15 stimuli in each habituation series were grouped into three clusters of five trials each, and standard deviations were computed on response magnitude *for each subject* for each of the five-trial clusters. Given normal habituation, relatively wide variation in responses can be expected within the first cluster, and relatively little variation within the next two clusters, where magnitude should be uniformly low. To the extent that this is not the case it indicates that response variation is not stimulus linked, but is determined by extraneous factors.

In Fig. 12 it can be seen that the normals and the active schizophrenics exhibited the expected reactivity pattern, particularly where stimuli of high intensity were concerned. This is understandable, as high intensity stimuli produce the greatest habituation range (see Fig. 10). The withdrawn schizophrenics, on the other hand, manifested a complete reversal of the expected gradient in their reactions to the high intensity stimuli.

The data suggest that the withdrawn schizophrenics are excessively inhibited in their heart rate reactivity to repeated strong stimulation up to a point, after which they exhibit a breakdown in inhibitory regulation, as indicated by an increase in random responsivity. The combined results suggest that while the withdrawn schizophrenics under most circumstances can be characterized as unreactive, or over-inhibited, under other circumstances, depending upon the response system and the strain put upon the individual's inhibitory capacities, variable reactivity occurs, suggesting a breakdown in inhibitory control. In investigating individual differences within groups, Bergeron[30] found that both his schizophrenic groups were consistent in their low reactivity as indicated by the standard deviations of their GSR responses

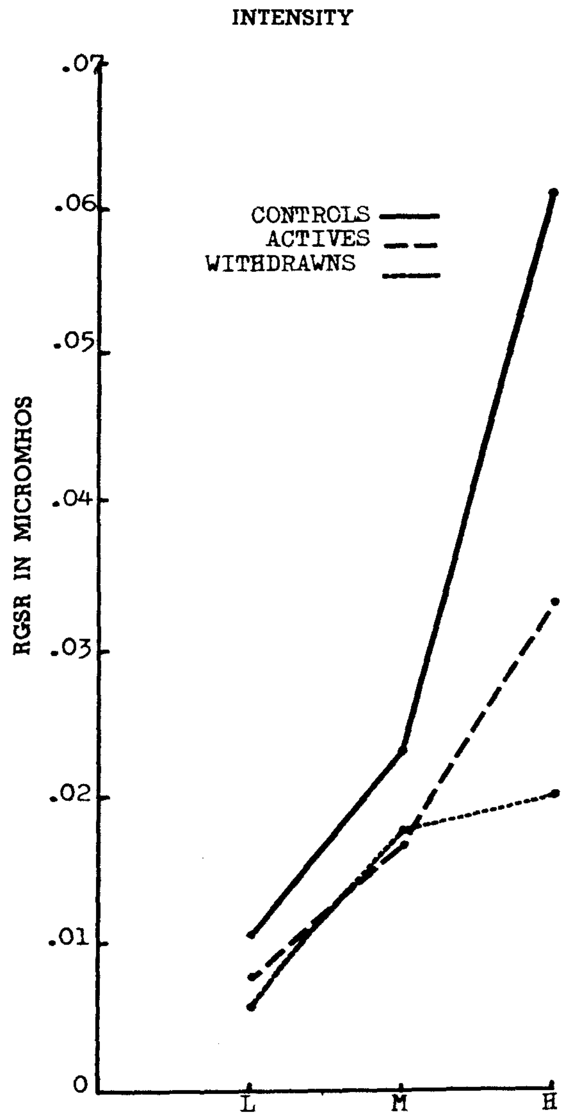


Fig. 9. Magnitude of GSR corrected for individual differences in range (RGSR) as a function of the intensity level of pure tones for active and withdrawn schizophrenics and normal controls.[31]

to tone and word stimuli. They were even significantly more homogeneous on this measure than normal controls. When a measure of respiratory rate was taken, however, exactly the opposite conclusion was suggested about the reactivity of good premorbid schizophrenics, as their standard deviation was significantly higher than that of controls and poor premorbid schizophrenics. Apparently the good premorbid schizophrenic group consisted of individuals who were uniformly low in GSR reactivity, but, with respect to respiratory reactivity, consisted of some individuals who were high, and others who were low in reactivity.

The combined results of both studies support the view that schizophrenics suffer from a poorly modulated inhibitory system.

***Parameters of Excitation Requiring Investigation***

We know of no studies that have tested schizophrenics with stimuli varying in rate or duration of stimulation. We also know of no studies that have systematically examined the course of physiological activity as a function of the time following stimulus presentation. Investigation of this latter variable is particularly important since, in its absence, investigators may conclude that contradictory results exist where none in fact do. Elsewhere, we have demonstrated that opposite conclusions about arousal can be arrived at by measuring heart rate at slightly different post-stimulus times during a series of stressful events.[17]

There is a need for systematic investigation of the parameters of stimulus input

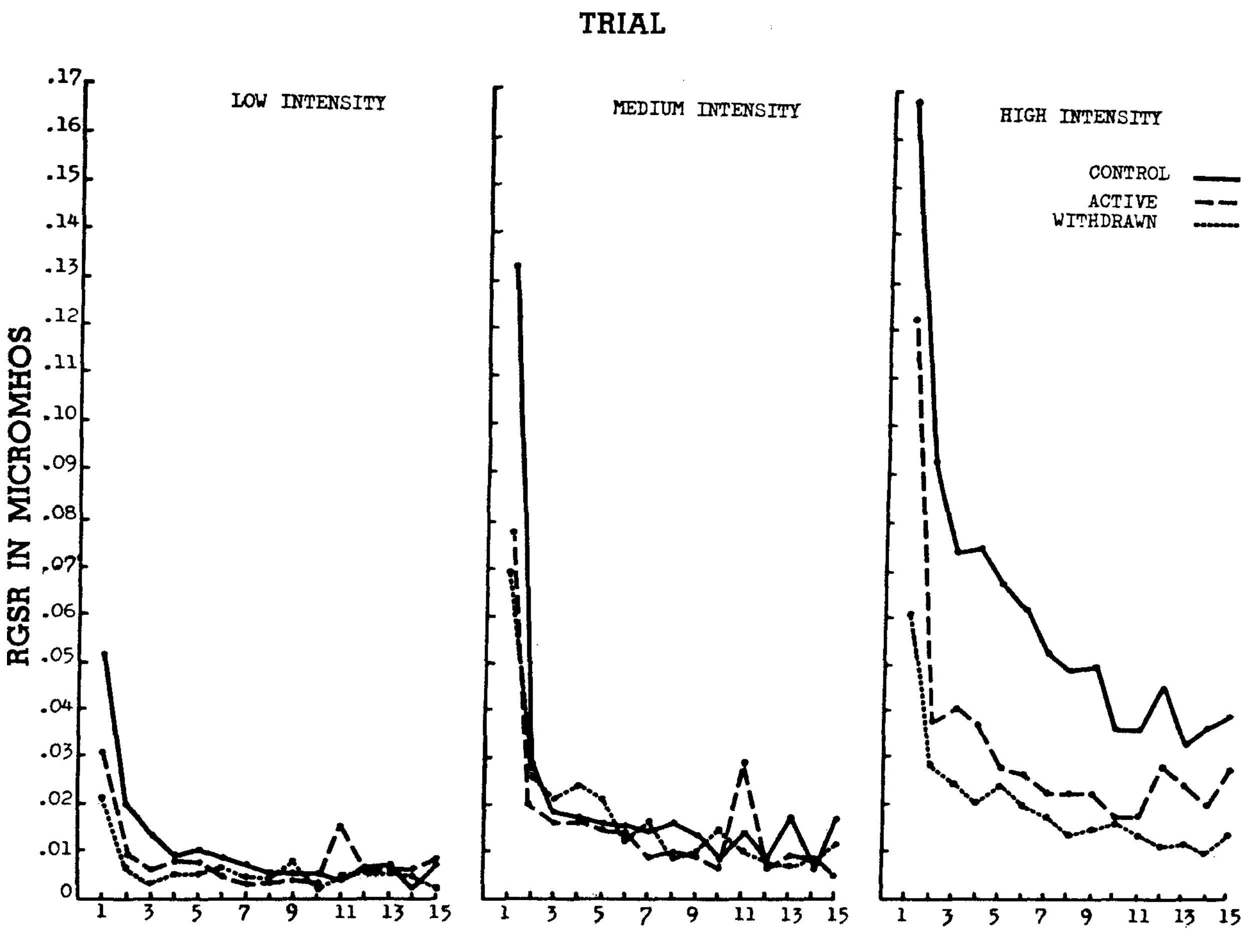


Fig. 10. Habituation of range-corrected GSR (RGSR) as a function of the intensity level of pure tones for active and withdrawn schizophrenics and normal controls.[31]

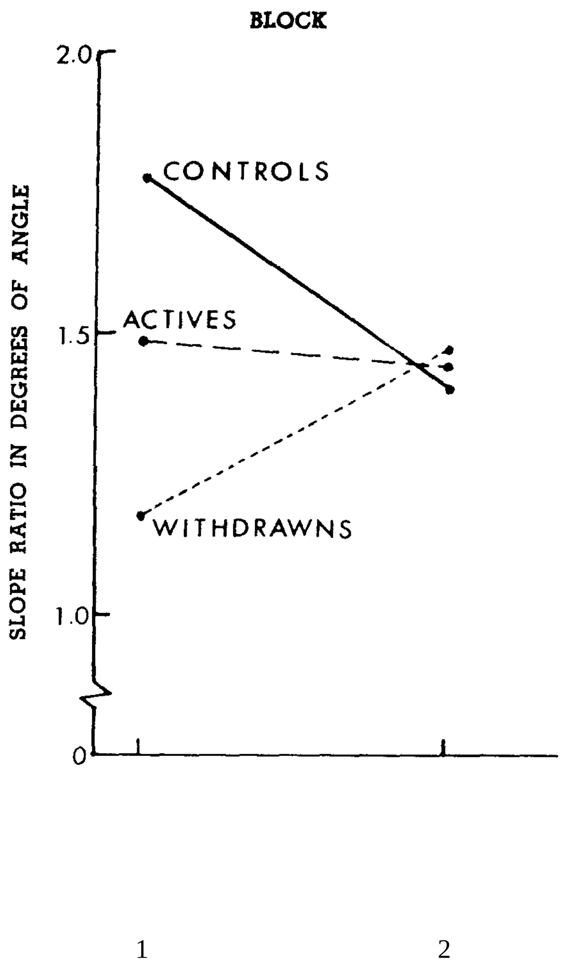


Fig. 11. Ratio of inclination to declination slope of the GSR in the two series of habituation trials for active and withdrawn schizophrenics and normal controls.[31]

with reference to different modes of stimulation. Venables[25] has suggested that schizophrenics are particularly prone to aberrant responses when stimulated in the auditory mode. Unfortunately, there are few investigations in which comparisons were made between different modes of stimulation within a single study. Venables had to arrive at his conclusion by contrasting findings in one study using one sensory mode with findings in another study using a different sensory mode. The studies differed in a number of factors other than mode of stimulation. If selective differences between schizophrenics and controls with regard to different sensory modes are established, it will be important to determine the reasons for the differences.

An important question is whether the differences are inherent within the specific characteristics of the modes, or are a result of other factors that happen to be correlated with them, such as the relatively greater ease with which one can fail to attend to visual stimuli than to auditory stimuli.

**Deficit in Assigning Meaning to Cues**

While it is self-evident that schizophrenics suffer from a defect in reality awareness, the level at which the defect occurs is less evident. The deficit appears to involve a highly general failure to respond adequately to the signal function of cues. Many schizophrenics function at a relatively primitive level by reacting predominantly to the immediate, primary aspects of stimulation, and ignoring the signal function of cues. Paintal[33] found that while the sample of schizophrenics he tested exhibited normal GSR reactions to a primary stimulus of electric shock, they failed to exhibit normal anticipatory reactions to the conditioned stimulus that served as the signal for the shock.

Sologub,[34] investigating the reactions of schizophrenics to personally significant verbal stimuli and varying intensities of lights, found that while the GSR reactions of the schizophrenics to the primary intensity dimension did not differ from that of normal controls, the schizophrenics exhibited smaller GSRs to the word dimension. While Bergeron[30] found that chronic schizophrenics exhibited deficient GSR reactivity to both a primary auditory stimulus dimension of increasing intensity and to a word dimension of increasing emotional significance, the deficit was more consistent for the word dimension. He interpreted this to indicate that while chronic schizophrenics attempt to insulate themselves from arousal from all sources of stimulation, they are better able to succeed with stimuli whose arousal effect depends upon meaning. This, of course, suggests that the defect in reactivity exhibited by many schizophrenics cannot be wholly attributed to a biologically inadequate response system.

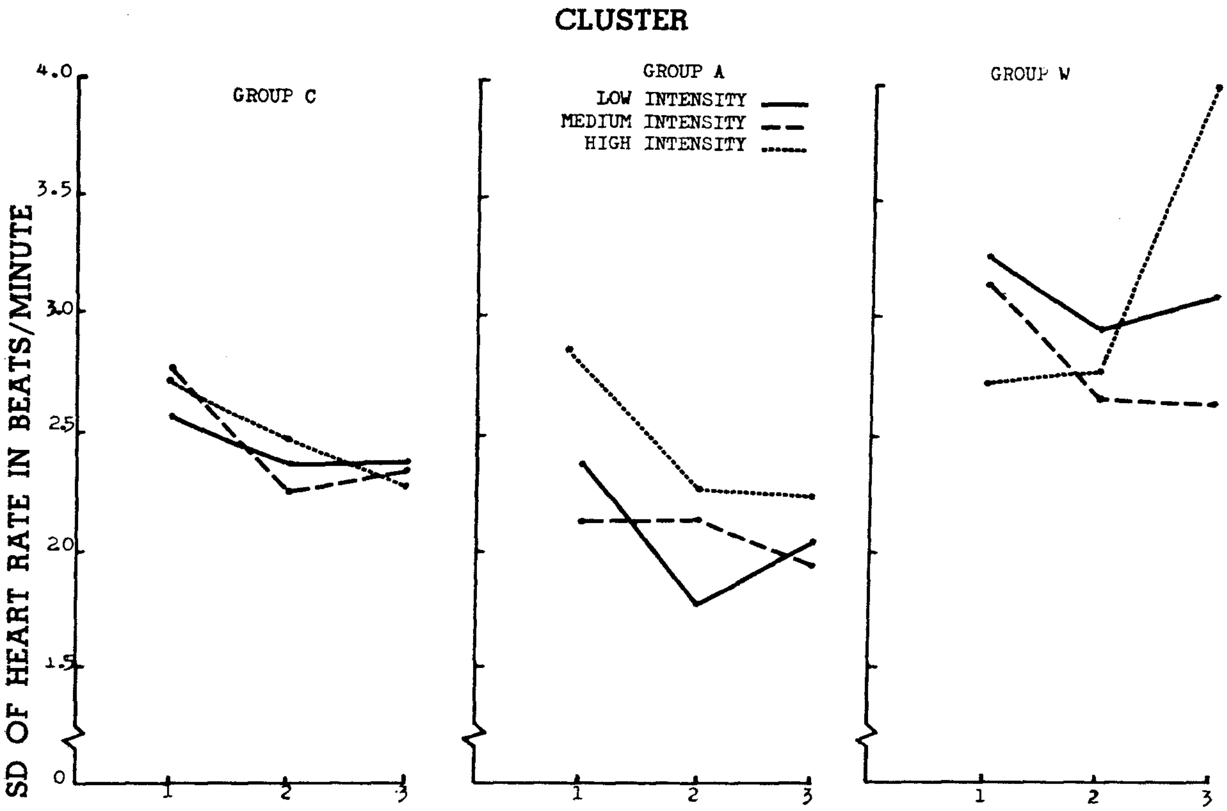


Fig. 12. Heart rate variability as a function of blocks of trials within habituation series, with stimulus intensity treated as a parameter, for active (Group A) and withdrawn (Group W) schizophrenics and normal controls (Group C).[31]

Research is necessary to determine the lowest common denominator of meaning to which the schizophrenic fails to respond. It very likely will be found to encompass all levels of meaning, including the establishment of the simplest levels of expectancy. In recently completed studies, we have demonstrated that by varying the probability of occurrence of a pure tone among other tones, it is possible to establish in normals highly reliable curves of magnitude of GSR as a function of the probability of occurrence of a stimulus. Such curves can be compared to curves of response magnitude as a function of stimulus intensity, and provide an effective demonstration of how expectancy serves to functionally reduce intensity. It is noteworthy in this context that habituation can be viewed as the establishment of a condition of 100% expectancy for the next stimulus. Experiments remain to be done comparing schizophrenics and normal controls on magnitude of autonomic response as a function of variations in stimulus probability. It is hypothesized that schizophrenics are relatively unreactive to variations in stimulus probabilities.

### Deficit in Deriving Pleasure from Stimulation

As to investigating capacity to derive pleasure from increments or variations in stimulation, experiments need to be done with both simple and complex levels of stimulation. A number of specific questions warrant investigation. Do schizophrenics differ from normal controls in positive affective reactions to variations in mild tactual stimulation, i.e., do they have different tickle thresholds for laughter? Intermodal comparisons can be made by substituting visual and auditory variations in stimulation for variations in tactual stimulation.

At what point is an increase in such stimulation experienced as pleasurable and at what point as unpleasurable? How are such relationships affected by variables such as the intensity of preceding stimulation and the resting level of arousal? Experiments need to be done on "cortical tickling," which would correspond to variations in stimulation from established expectancies. What degree of unexpectancy at what level of complexity is viewed as pleasurable, and what as annoying? It is hypothesized that the threshold for disturbing variation is lower for schizophrenics than controls.

To investigate positive affect related to social stimulation, tapes of "contagious laughter" can be used. Such experiments could help establish whether the schizophrenic suffers from a defect in pleasure capacity at an extremely fundamental level, as Meehl[28] has suggested, or whether it is a secondary consequence of cognitive or social functioning. It is hypothesized that the more complex the expectancy upon which a positive affective response is contingent, the greater will be the deficit exhibited by the schizophrenic, i.e., the schizophrenic will show minimal deficit in response to physical tickling and maximal deficit in pleasurable response to cognitive variation.

## Schizophrenic Subtype

Considering the high degree of within-group variance usually exhibited by undifferentiated schizophrenic groups, any serious program of investigation of schizophrenia must consider subdivisions of the disorder. The research cited in this paper was mainly with relatively stable, chronic schizophrenics. The findings generally indicated that such patients exhibit reduced reactivity to stimulation. The results on resting levels of arousal are less consistent, and require further investigation. There is a dearth of studies on acute schizophrenics with regard to both resting arousal level and reactivity to stimulation, undoubtedly because such patients are difficult to test. However, if an understanding of schizophrenia is to be arrived at, it is as important to obtain data on acute schizophrenics as on chronic schizophrenics.

### *Acute and Chronic Schizophrenia*

Acute and chronic schizophrenia should not be established solely by length of hospitalization, but should be based upon a consideration of the behavioral characteristics of the different stages of the disorder. Behaviorally, acute schizophrenics can be described as disorganized, bewildered, agitated, unable to concentrate and subject to distractibility by incidental stimulation.[35] Chronic schizophrenics are characterized by a relatively stable symptom picture, and an absence of agitation, confusion and other symptoms of the acute state. In addition to the acute and chronic stages of schizophrenia, it is important to consider the later stages, referred to by Arieti[36] as preterminal and terminal. Arieti notes that preterminal schizophrenics, who have generally carried a diagnosis of schizophrenia from 5 to 15 years, show marked impairment in thinking and exhibit strange habits, such as hoarding meaningless items and decorating themselves with scraps of paper. The terminal stage is characterized by marked sensory aberrations, extreme impulsive acting out, a broad failure in discrimination and an extremely concrete orientation. Such patients act as if they lack taste sensation and place non-edible objects into their mouths. They may show anesthesia for pain and temperature, but are relatively sensitive to olfactory stimulation. Thus, they exhibit an interesting pattern of excessive inhibition and disinhibition with respect to certain forms of stimulation which differs from that of acute and chronic schizophrenics. Studies of resting arousal level and reactivity remain to be conducted with such patients.

### *Behavioral Withdrawal*

In addition to stage of disorder, a promising subdivision of schizophrenics for studies of psychophysiological activity and reactivity is behavioral withdrawal. Ven-ables[25] has described a scale of withdrawal which he developed and found useful in his own research. Smith[31] found this scale to correlate highly with ratings of withdrawn behavior during testing. He also found that schizophrenics divided according to the scale differed significantly in the expected direction on reactivity to stimulation.

### *Basal Arousal*

In investigations of reactivity to stimulation, a subdivision worth considering is resting level of arousal. By dividing subjects on basal arousal level, information can be obtained on the relationship between arousal level and reactivity. It is possible that the relationship will be found to differ for schizophrenics and normals. Such a finding would have implications for a defect in schizophrenia with respect to the regulation of arousal. An approach which investigates the relationship between reactivity and basal arousal level is clearly to be preferred to one which simply statistically controls the effect of the latter upon the former.

### *Grouping Subjects by Dependent Variables*

Another approach that warrants consideration is to group subjects according to performance on what are usually dependent variables, such as measures of reactivity or arousal level, and to examine a wide variety of background and personality variables, treated as dependent variables. For example, high and low reactive schizophrenics, as indicated by GSR reactivity, could be examined for differences in age, withdrawal, premorbid adjustment, degree of disorganization, and other subject variables.

This, of course, is working backwards from the usual procedure. It has the advantage that it does not require the investigator to make an initial selection of subjects on subject variables which may turn out to have little importance for the other variables under investigation. For discussion of other subdivisions that appear promising the reader is referred to papers by Venables[25] and Silverman.[37]

## The Measurement of Arousal

Earlier we noted that it would only add to confusion to use "arousal" as a unitary concept that presumably could be measured equally well by a variety of physiological reactions. There is ample evidence that different physiological measures are differently related to stress, and that the differences cannot be attributed to errors of measurement, but are inherent in the homeostatic demands made upon the different systems.[17,38] Since heart rate serves a critical function, it is not surprising that it shows strong reversal reactions to previous rapid acceleration or deceleration. Skin conductance, on the other hand, which fulfills no vital function, exhibits a continuous increase to asymptote with increasing stress.

There is even evidence that the same system may exhibit different relationships to stress, depending upon a number of factors. Thus, an increment in stimulus-produced excitation can produce heart rate acceleration or deceleration, depending upon a subject's attentional set and preceding reaction.[1738] Magnitude of GSR varies directly with magnitude of stimulus input, but not with magnitude of response output.[26] It is thus clearly not justified to equate variations in "arousal" produced by dynamometer pressure with variations in arousal inferred from physiological reactions to sensory input, as some investigators have done.

Since most drive theorists appear to be primarily concerned with the relationship of cognitive performance to arousal, their concern should be predominantly with cortical excitation and its correlates. Particularly relevant measures, in addition to the electroencephalogram, include measures of sensory acuity, flicker fusion, perceptual discrimination and physiological reactions correlated with activity of the reticular system, such as skin conductance.[18]

## Summary

A theory of anxiety was presented that was inductively arrived at from a series of studies on the experience and mastery of anxiety in sport parachuting. It was assumed that with repeated successful exposure to a source of threat, two developments take place, the expansion of a gradient of anxiety, and the development of an inhibitory gradient that is steeper than the anxiety gradient. The interaction of the two gradients can account for an observed increasing displacement of the point of maximal anxiety to earlier and less prominent cues, thereby expanding the organism's range of awareness of threat-relevant cues and, at the same time, reducing anxiety to the more salient cues.

The relationships found for anxiety were found to apply to a broader system concerned with the modulation of excitation from all sources of stimulation. A general behavioral law, the Law of Excitatory Modulation (LEM) was postulated. This law holds that the gradient of inhibition is steeper than the gradient of excitation. As a result, the organism is able to function at efficient levels of excitation while expanding its range of awareness.

Finally, it was postulated that schizophrenia involves, at its most fundamental level, a defect in excitatory modulation. It was shown how such a defect could account for widely discrepant findings in the literature on schizophrenia, and could explain the major symptoms of the disorder. Implications for etiology were discussed, and it was noted that the formulation was essentially a psychophysiological one, involving the interaction of biological and experiential variables. Two studies conducted within the framework of the theory were described, and implications of the theory for further research were considered.

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