

PSYCHOLOGY REVIVALS

Sensation Seeking

Beyond the optimal level of
arousal

Marvin Zuckerman



Psychology Press

Sensation Seeking

Originally published in 1979, this title represents a summary of 17 years of research centring around the *Sensation Seeking Scale* (SSS) and the theory from which the test was derived. Now an integral part of personality testing, including adaptations for use with children, this reissue is a chance to see where it all began.

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University of Delaware



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To the memory of **Eli Zuckerman**

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Preface

This volume represents a summary of 17 years of research centering around the *Sensation Seeking Scale* (SSS) and the theory from which the test was derived. The first form of this test was devised in 1961 as an incidental part of my experimental research in sensory deprivation. The idea was to develop a measure of individual differences in what is an “optimal level of stimulation.” I had hoped that such a measure would predict responses to the sensory deprivation situation. Since that time, the test and the theory behind it have become the central part of my interest and research efforts. One might say that my goal shifted from predictive validity to construct validity.

The SSS has generated a large amount of interest in the idea of stable individual differences in the need for varied sensations, arousal levels, and experience. The research has extended into practically every area of psychology, as can be seen from a reading of the chapter titles of this book. Previous summaries of this body of research have appeared in book chapters and an unpublished manual and research report, but much has been published since these earlier summaries were written. I have attempted to include all the research in this volume, published and unpublished, and positive or negative results. The attempt at inclusiveness may make the book somewhat less “sensational” than might be desired by the reader who wants conclusions without being burdened with the findings. My goal in this book is to enable the reader who wants to know what the state of knowledge is in any particular areas to have access to the total body of work in these areas in this volume. But even more important is the attempt to present a theory and the results that support or refute the theory and the validity of the central operational measure on which it is based. The many positive, replicated

findings assume more significance in the context of the inclusiveness of the volume. Another book is being planned to discuss the topic on a less technical level.

This book should be of interest to graduate students, teachers, and researchers in many fields, including personality, abnormal psychology, sensation, perception and cognition, vocational interests, social psychology (attitudes and values), psychophysiology, and psychopharmacology. Although most of the cited research involves studies of the human species, there is enough attention to studies of exploration and sensory deprivation in primates to interest many comparative psychologists. Few personality constructs have this broad a relevance across the diverse areas of psychology.

The book begins and ends with theory. In a time of pragmatic empiricism, dominated by the atheoretical stance of Skinner and the behavior modification movement in clinical psychology, it may be untimely to emphasize theory. However, it is my view that this is the main point of the scientific endeavor: not to control behavior but to explain it in as rational and elegant a manner as is possible given the data. A primarily biological theory of the type developed here will probably be more useful for prediction than for control, although some implications for treatment will be discernible to the reader.

The theory developed in the final chapter is new. The optimal level of arousal theory, from which the test was developed, has not proven efficient, and a new theory, resting on the psychopharmacology of the limbic systems, has been evolved. The book also contains the first published version of the SSS Form V, with its scoring keys and norms. Earlier versions of the SSS trait measure and a state measure of sensation seeking are also included.

I believe that many readers, even those who do not contemplate research using the SSS, will find valuable insights for their work in other areas. Many may want to reexamine their social-environmental assumptions of causation to allow for the interactive influences of biological systems. Graduate students and others may find some relevance to their areas of study and may find that the SSS will account for some sizable portion of their between-subject "error" term. I await the verdict of their empirical studies.

Clinicians may also find something of value in this work. Although the theory does not suggest a new form of therapy, it does suggest that the goals and techniques for therapy should take the sensation-seeking temperament of clients into consideration. One of the sad consequences of the atheoretical approach to therapy is the assumption that all disturbed people are more or less alike in potentialities and differ only because of social influences. Diagnosis is thought to be an unnecessary, and even pernicious, process, since all can benefit from a single type of therapy that will bring everyone to the same optimal level of functioning. But the client who might benefit from encounter groups is not necessarily the same client who would benefit from

relaxation methods. The Sensation Seeking Scale may help therapists or vocational counselors to formulate realistic goals for their clients.

ACKNOWLEDGMENTS

Many persons have contributed in different ways to the writing of this work and the research that went into it. Many years ago, during my first postdoctoral years, Arnold Buss rekindled my interest in research and helped clarify my career goals in psychology. He was my first model as a clinical-researcher and has recently contributed to the shaping and organization of this volume. Charles Spielberger helped me immeasurably by bringing my latest work to the attention of the international community of psychologists during the critical year of 1975, when I started my sabbatical with a series of presentations at international meetings in Europe. Prior and subsequent to that year, we have been friends and collaborators on the development of the trait and state approach to anxiety.

Hans Eysenck was the inspiration to my biological approach to personality long before the sabbatical year spent with him and Sybil Eysenck at the Maudsley Institute in London. I will always be indebted to him for the inspiration of his work on the "biological basis of personality" and the opportunity he gave me to work with David Fulker and Sybil Eysenck on the genetics of sensation seeking at the Maudsley. During my year in Europe, I also became acquainted with Jeffrey Gray and his work, which has extended Eysenck's theories into new realms of neurophysiology and suggested the possible neurological basis of sensation seeking. I hope this volume will familiarize readers in the United States with his ideas and writings, which are more widely known by psychological scientists in Europe. The interest in the motivational structures of the limbic system, generated by Gray's work, led me to seek out Larry Stein and read his work on the psychopharmacology of the reward and punishment systems. It is from the theories of these three, Eysenck, Gray, and Stein, that I have constructed my new conception of the biological basis of sensation seeking. There are not many giants in our field like these three scientists who can stand astride the fields of personality, motivation, emotions, genetics, and the neurosciences.

Another debt is owed to my former students, who conducted crucial studies on sensation seeking during my years at the University of Delaware. Foremost among these are Edward Carrol, Reid Daitzman, Richard Neary, and Thomas Murtaugh. Every university professor knows that without the help of such dedicated students, his work would not advance far, and he would be buried in the teaching and administrative work of a university.

A third area of acknowledgment should be given to scientists who have made extensive use of the Sensation Seeking Scale (SSS) in their own areas of

study. Ronald Bone has contributed an enormous amount of data, much of it unpublished, that went into this volume. Thomas Myers used the SSS in his studies of sensory deprivation and in later studies of meditation. Frank Farley has made extensive use of the SSS and has also made major contributions to the optimal level of arousal theory. George Kish wrote one of the classical reviews of stimulation seeking in other species and has used the SSS in his work with humans. Monte Buchsbaum and Dennis Murphy at the National Institute of Mental Health have used the SSS in their extensive research programs on evoked potentials and brain biochemistry. It is their findings that enabled me to develop the sensation-seeking theory "beyond the optimal level of arousal" into these new areas.

The University of Delaware has helped me conduct the intensive studies in sensation seeking that started after my arrival here in 1969. Small grants from the University of Delaware Research Foundation and the General Faculty Research Fund supported several of these studies, and fellowships supported some of the students who worked on them. Other grants from the university helped defray most of the expenses of preparing this manuscript. Ralph Exline, the chairman of our department, has encouraged and helped me along the way to this volume.

Gudrun Sartory translated some of Wundt's writing on the optimal level of stimulation discussed in Chapter 2.

The items for the first form of the SSS were written in collaboration with an undergraduate student at Brooklyn College, Eileen Brockman, who worked with me on the first factor analyses. I lost touch with her after leaving Brooklyn College and hope that somewhere she will see this and receive her long overdue thanks. Ideas for many of the items, and some of the general construct as well, came from observations of former friends, colleagues, and lovers. I wish them all well and trust that they will find their optimal levels of stimulation in life.

My own children, Steven Zuckerman and April Schanoes, have indirectly contributed to my life work by introducing me to the exciting spirit of the college students during the 1960s and early 1970s. They and their friends explored new paths of personal, social, and political experience that I only dreamed of during my own youth. They continue to challenge my values and opinions, as do some of my better students.

My last and most important acknowledgment goes to Mary Hazard, whose quiet love and care have enabled me to find the peace and time that is so necessary for the prolonged work of writing a book. She has helped me appreciate the aesthetic mode of sensation seeking in the arts and generally opened my senses to the world. She flourishes in beauty and is sickened by ugliness in all things.

1 Introduction

Nothing is constant but change.
—Slogan on the wall of
a drug rehabilitation center,
author unknown.

MODELS OF PERSONALITY AND THEIR SOURCES

Change is indeed a fact of life, whether we resist it or accept it. Even if we choose to remain the same, the people and situations we encounter and the world around us will change. But some creatures seek change rather than merely adapting to it. A moderate amount of change or sensation seeking has an obvious adaptive value for organisms with a capacity to acquire and retain information. New sources of food supply and general familiarization with, and even expansion of, one's territory are an advantage to the more adventurous, exploratory type. Sexual, aggressive, and much normal social behavior require some tolerance for the relatively novel and arousing situation. However, it is also likely that organisms that are too adventurous and sensation seeking will take risks that may reduce their survival chances. As with most other traits, evolution has probably produced variations about an optimal level of the trait.

My dog Babar spends a lot of time running around and sniffing at various objects, dogs, and persons. His "voyeurism" knows no limits. He peers in neighbors' picture windows and climbs up on automobiles to stare at the

2 1. INTRODUCTION



FIG. 1.1. Dog approaching a novel object.

drivers. The picture in Fig. 1.1 shows an incident that happened one day while he was excitedly exploring a beach. He came across a novel object, one that he had never smelled or seen before, a horseshoe crab. The picture shows the ensuing investigation, resembling an eager researcher poring over his or her data. A moment later he seized the shell, tossed it in the air, and ultimately demolished it. Fortunately the crab no longer inhabited it. Play can be a destructive activity. The sequence of orienting, investigation, play, and eventually habituation and ignoring is a common one in most mammals reacting to novel stimuli. Most behavioral theories discuss the effects of previous reinforcements, but have little to say about reactions to novel stimuli or play.

Why do dogs and people (Fig. 1.2) explore the novel and seek new experiences? Why do we risk upsetting our stable, comfortable, and predictable social arrangements to make personal and collective revolutions? Why do we ski and race our cars at excessive speeds, fully aware of the risks in these unnecessary activities? Why do we disturb the healthy, homeostatic balances in our bodies with the drinking of alcohol, ingestion of drugs, jogging, and other potentially addictive and physically stressful activities? Why can't subjects be content and happy lying for a few hours or days in a comfortable, dark, soundproof room? But all these questions should be rephrased as: Why do some persons engage in these activities whereas others behave like "normal" tension-reducing, fear-avoidant persons should? Is

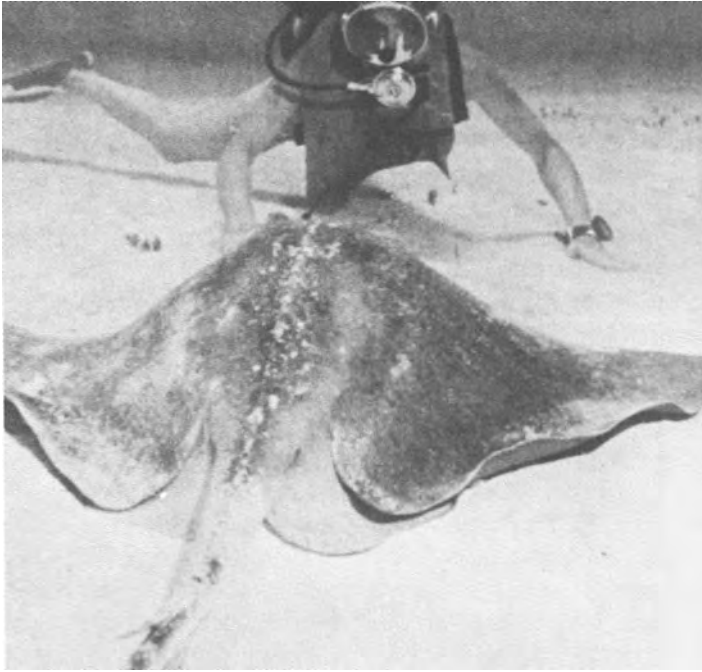


FIG. 1.2. Scuba diver approaching a novel object. (Courtesy Jack McKenney Film Enterprises. Reprinted with permission.)

there a generalized trait that can subsume various kinds of risk taking, sensation seeking, and intolerance of constancy? These are the kinds of questions that led me to define the construct of sensation seeking, to devise measures of it, and to examine the relations of these measures to the kinds of variables described in this book.

The idea of a sensation-seeking trait emerged from my attempts to provide a framework for the data on individual differences coming out of experiments on sensory deprivation. The first definition of the trait was based on factor analyses of a broad range of rationally constructed items, but the original construct and items were also influenced by less scientific observations of patients, friends, children, pets, and even myself. There was a need to give a definition to a range of behavioral phenomena that defied classification and explanation within existent theories.

The ultimate models that we construct do not need to have a simple, common-sensical relation to folk concepts or to provide a phenomenological feeling of truth. The physicist's model of the physical world bears little resemblance to our perceptual impressions of reality. A biological model for human behavior may have little "face validity," since it deals with another

level of phenomena. The psychoanalyst's idea of an unconscious mind does not seem reasonable or even rational to the average man or woman but was Freud's attempt to explain certain significant lapses in the memories of his patients. But the constructs that we devise are eventually limited by the sources of our observations. A mentalistic psychology such as that evolved by the structural school of Wundt and Titchner could not be applied to the data of animal behavior without producing a strained anthropomorphism. Conversely, the radical behaviorism of Watson and Skinner, developed from animal data, was strained by attempts to accommodate cognitive phenomena. Most theories have a limited "range of convenience," to use Kelly's expression. Freud's construct of repression applied nicely to a range of neurotic behavior, particularly that which included hysterical conversion and dissociative disorders, but the attempts to extend this idea to the broader range of normal human memory and cognition have not been successful.

The neobehaviorism of the 1930s and 1940s produced a model of humans that portrayed them as governed by a small number of innate drives and a larger number of acquired drives and described learning as governed by the satisfaction or reduction of these drives. The limited range of convenience of this model was apparent to all but the more involved scientists of that time. I can remember the heat generated by the "latent learning" controversy as to whether or not anything could be learned without making a reinforced response. The argument was barely plausible when applied to rats but somewhat absurd when applied to humans. Tolman's attempt to develop a cognitive theory, applicable to humans as well as rats, could not sway the Hull-Spence adherents who, under the banner of parsimony, insisted on working from rats to man rather than vice versa. It was not until the 1960s that Bandura and Walters (1963) provided us with a learning theory based on observations of children rather than rats and a theory that asserted that social learning is based on observation and modelling. Like most of the older learning theories, Bandura's deliberately avoids dealing with the biological substrate of learning and motivation. The emphasis on cognition, and the de-emphasis of biology, provides little possibility for a broad, comparative theory of behavior.

Another curious feature of the earlier behavioristic theory was the restriction of primary motivation to the "gut drives" of hunger, thirst, and sex. Harlow and others had long ridiculed this limitation of drive theory, pointing out that one could observe extended sequences of goal-directed behavior in the absence of deprivation of these needs. Harlow's broader view of motivation was undoubtedly influenced by the fact that his subjects were species higher on the phylogenetic scale, monkeys and apes. Still there was ample evidence from lower species that the primary drive explanation had little relevance for most of their behavior outside of a Skinner box or T-maze.

The theories had a particularly difficult time in explaining animal activity, exploration, investigation, and play in the absence of high levels of primary drives.

The reaction of most clinical and personality psychologists of the time was to reject the general behavioral theories of motivation, developed from animal laboratories, and to embrace human models, particularly the psychoanalytic ones with their limited range of convenience and even more limited empirical base of knowledge. Despite the efforts of Dollard and Miller to build conceptual bridges between behavioral and clinical theories, it was not until the advent of behavioral methods of treatment that clinical psychologists returned for a new look at the theories from which the new treatment models arose. But by now, these models are largely of historical interest. The field of learning has moved from the rat and the pigeon to the human and the computer. The area of "information processing," as it is now called, is largely addressed at cognitive problems that reflect the functioning of the human brain with its unique capacities for symbolic transformation and organization. The area of motivation is also changing. Researchers are moving away from "gut physiology" to the study of central motivational mechanisms. This closer amalgamation of behavioral psychology and neurophysiology has been made possible by the advances in the latter field in the last quarter of a century. But despite the impact of these developments in our understanding of the brain on learning, memory, motivation, and psychopathology, most clinical and personality psychologists remain remarkably steadfast in the exclusion of biological theory from their models of the human. The final chapters of this book represent an attempt to apply these biological models to the area of sensation seeking. Although this may be regarded as an aberrant approach, and a "reaction formation" to the prevalent environmentalism of social learning theory and clinical theories, it represents the position I have arrived at after a long journey through the theoretical realms of psychology. I am somewhat surprised to find myself there.

THE USE OF TESTS TO DEFINE PERSONALITY

The psychometric approach has developed almost independently of the laboratory-experimental approach, which led Cronbach (1957) to speak of the "two disciplines of scientific psychology" and Eysenck (1967) of the "two faces of psychology." Despite Cronbach's hope for a rapprochement between the disciplines of individual differences and experimental psychology, it has

not taken place for various reasons that I cannot go into here (see Zuckerman, 1976a).

The study of individual differences via tests has been dominated by the rational-clinical approach and the inductive-factor analytic approach. The first attempts to measure personality in tests were Jung's (1910) use of the word-association technique to discover "complexes" in patients and Woodworth's Personal Data Sheet, an objective method used for screening neurotics from the armed forces in World War I. Clinical dimensions of neuroticism and anxiety continue to dominate interest in the field of personality differences.

Normal dimensions of personality have been defined by the inductive-factor analytic approach as exemplified by Cattell and Guilford. The procedure of these two investigators has been to start with a broad range of trait terms or questionnaire items and to use the technique of factor analysis to isolate basic clusters of items that are intercorrelated with each other. These clusters are given tentative names and grouped in scales, and their psychological significance is further explored through validity studies relating the factor-derived scales to external criteria. Theory plays little role in the process until after the factor dimensions are developed into scales. Eysenck has taken more of a hypothetico-inductive approach, involving the theoretical definitions of the broad factor earlier in the process and deriving predictions of relationships between test scores and experimental observations from the theory itself.

Certain broad, normal factors, such as Introversion-Extraversion, have emerged from all factor analytic approaches when second-order (broader, or higher in hierarchy of factors) factors are considered, but the structure of these factors in terms of their subsidiary factors is still debated (Guilford, 1975).

In contrast to the inductive-factor analytic approaches, some investigators have attempted to define a limited construct and to develop a test measure of that particular construct. The "construct validity" (Cronbach & Meehl, 1955) of the test is assessed in terms of its relationships with other presumed measures of the hypothetical construct or by deriving predictions of behavior based on the role of the construct in a larger theory and testing these predictions using the test as the operational measure of the construct. The latter approach is only possible when the theory in which the construct is embedded is already well defined conceptually and by empirical investigations. Otherwise, a failure to verify a prediction would be ambiguous, since it might reflect either a failure of the test or a failure of the theory. In most cases of limited domain tests, the theory behind the construct and the test measure are developed simultaneously and interdependently; that is the way it happened for sensation seeking.

SENSATION SEEKING— OVERVIEW OF THE BOOK

The Sensation Seeking Scale (SSS) is an example of the use of construct validity in developing a limited domain theory around a test. *Chapter 2* provides the theoretical background that preceded the development of the SSS. The idea of a broad sensation-seeking motive, or the need to maintain an optimal level of stimulation or arousal, goes back at least a century.

The experimentation in sensory deprivation during the 1950s and 1960s revived interest in earlier theories and led to the development of new theories. It was from this area that my own interest in sensation seeking developed. The research in this area provided a “testing ground” for the theories, and the relevant data on arousal and stimulation seeking in sensory deprivation are provided in *Chapter 3*. This chapter concludes with my first theory of sensation seeking, which was an attempt to explain the results of sensory deprivation, particularly individual differences in reaction to the situation.

The theories described in *Chapter 2* provided little help in suggesting how the motive might express itself in stable individual differences. *Chapter 4* describes how the scales were developed. The items written for the first form of the SSS represented only guesses as to the phenotypical expressions of sensation seeking in activities, attitudes, and values. This is the phase in which one’s own unscientific observations of others and oneself play an important role. The results of the first factor analyses helped shape our preliminary definition of the trait. We had thought of the trait as a consistent preference for sheer quantity and intensity of simple, external stimulation. But most of the items describing a preference for simple, intense stimulation did not correlate highly with the general factor. The items with the highest loadings on this broad factor referred to the need for varied, novel, and complex stimulation rather than for simple, intense stimulation in one sensory modality or another. Subsequent factor analyses defined four subfactors; and on the basis of these, a new form (IV) was constructed. The four factors were conceived of as alternate expressions of the underlying common trait. Later studies in England confirmed the cross-cultural stability of the four factors, and the last form (V) of the test is a shortened version containing the most consistently loading items for the four factors and a total score weighting each factor equally. Reliabilities and interscale correlations for the various forms of the SSS are also reported in *Chapter 4*.

Chapter 5 discusses demographic differences on various forms of the SSS, including age, sex, national-cultural, regional college, racial, and educational differences. Age and sex differences are prominent; national and racial differences are also found, but education seems to be a less important demographic variable. Regional college differences and national-cultural

differences seem to be more marked in females. The implications of these findings for the question of biological vs. social determinants of sensation seeking are discussed throughout the chapter.

Although the SSS was designed to measure a specific trait, the question of its overlap with other trait measures and its place in the structural dimensions defined by Eysenck and Cattell had to be answered. Construct definition also suggested low to moderate relationships with other constructs measured by other tests. *Chapter 6* attempts to organize all these findings relating the SSS to self-report trait measures. In some areas, like the relationships between the SSS and Eysenck's dimensions, many replications provide a degree of certainty as to the "true" relationship between the measures. But the validity of the SSS rests on more than correlations with other trait measures.

Chapter 7 describes the relations between sensation-seeking traits and states and risk-taking activities. A model is presented that relates the trait to sensation-seeking and anxiety states, and relates the states to behavior in response to real and hypothetical situations. Also described in this chapter are the relationships between sensation-seeking trait and volunteering for unusual experiments and other novel activities such as encounter groups, responses to sensory deprivation, hypnosis and meditation, and the sensation-seeking characteristics of groups of persons who engage in physical-risk activities such as parachuting. The other end of the risk dimension, phobic and life stress responses, is also discussed in this chapter. The results of these last studies suggest that anxiety tendencies are not the only factor involved in phobias or negative reactions to life stresses. A different kind of risk is discussed in gambling behavior and attitudes toward travel.

Any important personality trait is likely to affect the styles as well as the selective nature of our sensations, perceptions, and cognitions. *Chapter 8* deals with these correlates of sensation seeking, including: sensory thresholds and tolerance for extremes of sensory stimulation, visual acuity, perceptual satiation, field dependence, augmenting or reducing of stimuli, preference for complexity, and color and musical preferences. The area of cognition includes the topics of general intelligence, specific aptitudes, academic achievement, originality and creativity, category breadth, cognitive complexity, rigidity-flexibility, and verbal learning. The relationship between sensation seeking and primary process thinking, as evidenced in daydreaming and imagery, is also treated in this chapter.

Chapter 9 deals with an important topic for counselors: the relation between sensation seeking and vocational interests as expressed in vocational preference inventories and the actual SSS scores of persons in various occupations that have risk elements. Social psychologists will be interested in the strong relationships found between sensation seeking and political, religious, sexual, and social attitudes. Styles of thinking that have been

identified with authoritarianism, such as dogmatism and intolerance for ambiguity, show a negative relationship with sensation seeking.

Some of the important implications of the SSS work for counselors who deal with habit problems are in *Chapter 10*, which describes the relationships between the SSS and sexual, drug, alcohol, smoking, and eating experiences. These studies confirm the original hypothesis of sensation seeking as a trait that is involved in a broad range of appetitive activities. It also provides a new view of sex that suggests that the sexual motive is secondary to a broader and perhaps earlier developing need for varied sensations. The chapter also places the sensation-seeking need as the primary one in drug experimentation. The idea that drugs are chosen for their effects on physiological arousal is examined in a preliminary test of the optimal level of arousal explanation for sensation seeking.

Although sensation seeking has been conceptualized as a normal trait, and has been shown to have no relationship with the broad trait of neuroticism or anxiety, various theories have linked the sensation-seeking tendency to impulse disturbances such as psychopathy and mania. Theories of schizophrenia also suggest an aversion to complex or intense stimulation in some forms of this disorder. Studies cited in *Chapter 11* tend to confirm these theories.

One of the most fruitful areas of investigation for an understanding of sensation seeking has come from the study of its relationship with biological variables. These studies and their implications are discussed in *Chapter 12*. Topics discussed in this chapter are the effects of stimulant and depressant drugs on high- and low-sensation seekers, diurnal variations in the sensation-seeking state, the strength and habituation of the orienting reflex, the cortical reactivity to different intensities of stimulation as measured by the average evoked potential, sleep efficiency and insomnia, hemispheric dominance, gonadal hormones, and the neuroregulator, monoamine oxidase (MAO). Genetic studies of sensation seeking and its biological substrates are also discussed.

Each of the biological correlates of sensation seeking is discussed in terms of its relationships with normal and abnormal behavior in humans and its behavioral correlates in animals. The biological correlates of sensation seeking are crucial in linking sensation-seeking behavior with similar behavior in other species and its expressions in human psychopathology. The drug treatments for certain psychiatric disorders also provide evidence of some common biological factors.

The data discussed in Chapter 12 provided the building material for a new theory of sensation seeking presented in the final chapter, *Chapter 13*. The 1969 theory, presented in Chapter 3, put a great deal of stress on the optimal level of arousal as mediated by the reticulo-cortical feedback system as the biological basis for sensation seeking. The new theory still retains the idea of

an optimal level of stimulation (defined in terms of a need for variety and complexity of stimulation) but suggests that the differences between high- and low-sensation seekers depend on the pharmacological characteristics of the limbic reward system. Although the new theory focuses on the biology of sensation seeking, some social theories are presented at the end of the chapter. These theories have little data base as yet, and it is hoped that family background factors will be investigated soon.

DEFINITION OF SENSATION SEEKING

The comedian Mort Sahl once described a situation where a psychology graduate student, working part-time as a teller in a bank, was approached by a man brandishing a gun who demanded, "Gimme your cash or your life." The graduate student looked up calmly and replied: "Let's begin by defining our terms." The story ends with the bank robber fleeing in utter confusion after a fruitless attempt to make his simple request clear to the student. I hope the following definition will be more successful.

Sensation seeking is a trait defined by the need for varied, novel, and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experience.

The term *sensation* is used rather than *stimulation* because it is the sensory effects of external stimulation that are most important in defining their value as primary reinforcement. A television addict might be called a stimulation seeker, but television provides little in the way of novel sensation. Drugs and sensory deprivation provide little external stimulation but sometimes produce unusual sensations and images. The high-sensation seeker is sensitive to his or her internal sensations and chooses external stimuli that maximize them. Unusual sensations may be produced by emotions, drugs, and physical activities such as free-fall skydiving, scuba diving, or other activities involving speed and movement beyond the ordinary range. Tastes in art and music, clothes, and friends may also depend on the capacity of sensory and social stimuli to produce novel sensations and experience.

The term *sensation* is also used in contrast to *cognition*. The evidence suggests that we cannot equate sensation seeking with cognitive curiosity. Although sensation seeking is not incompatible with intellectual curiosity, the latter is not a typical expression of the trait defined by the SSS.

The term *seeking* is used because the trait is expressed in an active mode. The sensation seeker is rarely the victim of a lack of opportunity or restriction of environment, although the environment may restrict the forms of the sensation-seeking activity. Sensation seekers observed in the very restricted condition of sensory deprivation stimulated themselves by moving around on the bed, whistling, feeling the walls of their cubicle, or simply relaxing and

enjoying the rich fantasies of their primary process thinking. Young children do not have to be stimulated to sensation seeking. Left to their own devices, they improvise games and are sometimes capable of rather dangerous ones, producing terror in their parents.

Sensation seeking may be described as a "trait" or a "state." A trait can be defined as the tendency to experience the relevant state and behave in a specific manner on many occasions in many (but certainly not all) situations. The trait of sensation seeking refers to the tendency to seek relatively novel and stimulating situations and to explore them. The state of sensation seeking is one defined by a predominance of characteristic types of strong, positive affect feelings in situations of great novelty and risk.

The phrase "varied, novel, and complex sensations and experiences" describes the qualities of stimulation that are valued by a sensation seeker. "Varied" reflects the need for change. Just as rats will vary the paths they take to a goal, high-sensation seekers will vary their routines to avoid boredom, in contrast to the lows who are less distressed by an unvarying routine. "Novel" means something unlike previous experiences in some respects, if not all. Novelty means maximal unpredictability in a sequence of events as opposed to the other extreme of perfect predictability. "Complexity" refers to the number of stimulus elements and their arrangement. It may also refer to immediate comprehensibility or perceptual closure as opposed to cognitive or perceptual ambiguity requiring more information processing.

Finally, "risk" may be defined as the appraised likelihood of a negative outcome. One of the characteristics of high-sensation seekers is their tendency to do things that lower-sensation seekers regard as too risky. The behavioral difference could be due to their different appraisals of risk or to their different reactions to similarly appraised risk. This is a question explored in Chapter 7. "Physical risk" pertains to the appraised chances of being physically hurt or killed. "Social risk" means the estimated likelihood of being embarrassed, shamed, or humiliated or of experiencing guilt or loss of valued affection or respect of others.

2

Theoretical Background

A collection of disconnected facts does not constitute a science any more than a mob of men constitutes a college, or a heap of bricks a building. The sciences are not concerned with facts as such but with ordered facts.

—H. J. Eysenck (1952)

Three lines of theoretical development converged in the 1950s to produce a challenge to the drive reduction theories prevalent in behavioristic psychology and psychoanalysis. The first of these was the view that curiosity and exploration represented a primary instinct or drive rather than one in the service of other drives such as hunger or sex. In contrast to the visceral or hormonal sources of other drives, the source of a curiosity or exploration drive was conceived of as novel stimuli or internal brain tensions rather than cyclically arising tissue deficits.

The second line was one suggesting that the primary motivating powers of stimuli depended on their quantitative or qualitative deviation from an *optimal level of stimulation*—smaller deviations producing pleasure and approach behavior and larger deviations toward the higher end of the range producing pain, fear, and avoidance. A development of optimal level of stimulation theory attributed the seeking or avoidance of stimulation to its effect on central physiological mechanisms of arousal. Some of these *optimal level of arousal* theories, such as those of Hebb, Leuba, and Berlyne, were an extension of the theorists' earlier optimal level of stimulation theories. Another variant of these theories described the motivating power of stimuli in

terms of their change from the prevailing level of stimulation and the arousal produced in terms of its relation to the prevailing level of tonic arousal. These might be described as *stimulus change or arousability theories*.

The theories in the first two lines were unidimensional, dealing only with the continuum of stimulus intensity excitation in the brain and suggesting that a homeostatic level existed that was optimal for positive feelings or performance efficiency. A third line of theories, including those of Pavlov, Hull, Cattell, Eysenck, and Gray, considered behavioral tendencies, and individual differences in them, as arising from the *balance between excitation and inhibition* characteristics of brain systems.

INSTINCT AND DRIVE APPROACHES

Most general theories have recognized the fact that humans and other species spend a significant part of their waking time in exploration and sensation-seeking activities, but some theories have regarded such behavior as stemming from primary motives such as hunger or sex, whereas others have seen the behavior as independent of these motives.

Freud

Freud's (1915/1957b) concept of "trieb" (translated as "instinct") was closer to the modern concept of drive than instinct, since it referred to the tensions generated by internal physiochemical processes but did not regard the objects, or instrumental behavior leading to tension reduction, as innately patterned. In the last version of his *instinct* theory, Freud subdivided them into life (eros) and death (thanatos) instincts. The life instincts included sexual and life-sustaining instincts (hunger, thirst, and pain avoidance). The sexual instinct was further subdivided into part instincts (oral, anal, genital, voyeuristic, and so forth), which in the course of normal sexual development become amalgamated under the supremacy of the genital. Aggression represents a reversal of the object of the death instinct, which is a state of nirvana or death itself, into outward-directed destructiveness.

This classification of instincts does not include curiosity, exploration, activity, sensation seeking, or any tendency to increase or vary stimulation. The reason for this omission is the tension reduction nature of Freud's motivational theory. The sexual instincts, like hunger and thirst, are internally generated, and their aim—like that of all instincts—is the reduction of tension. The ego, adhering to the reality principle, searches for objects in the real world, but the seeking is only in the service of the id and its pleasure principle. Pleasure is the reduction of stimulation (Freud, 1920/1955): orgasm in the case of genital sex, satiation in the case of hunger, and pain

reduction in the sense of any prolonged intense stimulus. Thus, life and death instincts have the same aim—reduction of tension; but the life instincts maintain the tension inherent in living matter, dealing only with unavoidable surges of tension. The death instinct represents the ultimate aim and works more constantly and quietly toward the “final solution.”

According to this somewhat depressing theory, the search for new sensations or experiences is a search for sexual or destructive gratifications, sometimes displaced or sublimated into other forms. As Fenichel (1945) stated: “the longing for objects thus began as a detour on the way to the goal of being rid of objects (of stimulus) [p. 35].”

Freud’s stimulus reduction view of motivation stemmed in part from his conception (1915/1957b) of the nervous system as: “an apparatus which has the function of getting rid of the stimuli that reach it, or of reducing them to the lowest possible level; or which, if it were feasible, would maintain itself in an altogether unstimulated condition [p. 120].”

Today we know that this conception of the nervous system is inaccurate. The CNS maintains a constant level of activity and is constructed with feedback systems designed to activate itself when external stimulation drops off.

Prior to this conception of the nervous system, Breuer and Freud (1895/1937) postulated a model more compatible with an optimal level of arousal theory and the real functions of the CNS as we know them today, but I discuss that model later in connection with the second line of theoretical development.

Further Developments of Analytic Theory

Although the newer analytic theories of the 1930s and 1940s challenged many of Freud’s assumptions, most accepted the idea of tension reduction as the basis of pleasure. Sullivan (1953), for instance, defined a state of euphoria in the following curious manner: “The nearest approach to anything like it . . . might occur when a very young infant is in a state of deep sleep Now it is a peculiarity of life that the level of euphoria and the level of tension are in reciprocal relation. That is, the level of euphoria varies inversely with the level of tension [pp. 34–35].”

Positive affect is seen as either a low tonic state of arousal (Sullivan) or a sudden reduction in arousal (Freud). Conversely, both theorists agreed that higher levels of sensation or arousal are undesirable and are felt as displeasure.

Since sensation seeking is a conscious ego function, it would have to be regarded as a secondary or derived motive in Freudian theory, because the ego only functions to gratify the instinctual id needs within the limits set by social reality and the superego. However, a later analytic development (Hartmann, 1964; Rapaport, 1960) viewed the ego as partially autonomous,

having its own innate functions, such as perception. Although such functions might be used in the service of the id, they might also function in a “conflict-free sphere” (Hartmann, 1958). Activities like play and creative activity may actually use materials from the id “in the service of the ego.” As we will see in a later chapter, the concept “regression in the service of the ego” has proven a fruitful one in sensory deprivation research (Chapter 3), and the capacity for such nonthreatening regression seems to be a characteristic of sensation seekers (Chapter 8).

Instinct, Drive, and Need Conceptions

The idea of instincts governing behavior in man as well as other species was popularized by McDougall (1923). Instincts were seen as internal forces that lead to mating, nest building, protection of the young, and other such activities whose expression can be seen in man as well as other species. In retrospect, we see here an important antecedent of sociobiology (Wilson, 1975).

“Curiosity” was listed by McDougall as a basic instinct. Whereas other instincts were elicited by objects of a particular sort, such as the scent of a female rat in estrous eliciting sexual behavior in the male rat, curiosity was aroused by indistinct perception or identification of an object. The objects eliciting maximal curiosity would be those of some resemblance to the objects exciting other instincts but with enough difference to excite the other instincts. In this view, curiosity was simply an instinct necessary for the operation of other instincts in allowing for some stimulus generalization.

Woodworth (1918) first offered the construct of “drive” as an alternative to instinct. The older idea of instinct regarded the entire sequence from internal arousal to instrumental behavior and object selection as under the control of innate mechanisms. Drive, in contrast, was regarded as a mechanism that activates other mechanisms, such as habits. Curiosity was conceived of as a general drive whose expressions were determined by inborn or acquired abilities, skills, and interests. Curiosity was blended with the sex drive and added to its strength but was not an expression of that drive as Freud had maintained.

Tolman (1922) also argued against the instinct conception of innate connections between objects and the internal conditions characterizing drives; however, he did feel that the range of potential objects was somewhat limited by the nature of the drive mechanisms. Certain acts were more likely to reduce the drive and more likely to be learned than others. This is similar to Freud’s view of the sex drive.

Among first-order drives, Tolman (1926) included sensory needs or “sensitive zone demands.” Though similar to Freud’s specific erogenous zone sex “instincts,” Tolman did not interpret these as components of a general sex drive. Thumb sucking is given as an example of a sensory drive.

Curiosity was conceptualized as a second-order drive with no physiological basis. Like McDougall, Tolman conceived of curiosity as a drive in the service of primary drives. The inborn mechanism was an impulse to “get more of,” or “more stimulation from,” objects.

In a later volume, Tolman (1932) expanded the idea of primary sensory needs to “sensory-motor-hungers” to include aesthetic and play needs. As with other primary appetites, the goal of these hungers was tension reduction. The tensions of these sensory-motor drives were thought to be inherent in the sensory-motor neurons themselves. This was an attempt to reconcile stimulation-increasing activities with the idea of tension reduction as the aim of the drive, a theme carried into later theories.

Hull (1943) made drive a primary construct in his theory. Like Tolman, he argued that primary drives were expressions of cyclical physiological needs or internal stimuli arising from such needs, but Hull was more definite about separating behavioral mechanisms from the drive stimuli. His list of primary drives did not include general sensory-motor needs or curiosity. Exploration was interpreted as generalized activity produced by other primary drives such as hunger or sex. Exploration should be absent or minimal when such primary drives were satiated, and its strength should vary directly with the strength of these drives. Tolman (1926) had left this last assertion as an open question. Hull introduced the concept of reactive inhibition as a negative drive that might act to increase the variability of behavior. This idea is further elaborated in the discussion of optimal level of arousal theories, which postulate a balance between central excitation and inhibition states.

Applications in Personality Theories

In the late 1930s personality theories began to incorporate ideas from the existent general behavioral theories as well as the psychoanalytic theories. The concept of “need,” elaborated by Henry Murray (1938), resembled that of “drive” with certain important differences. A need, as defined by Murray, has a directional or qualitative aspect as well as an energetic one (i.e., it is defined primarily by its goals rather than its physiological origins). Its direct source is not visceral tensions but the hypothetical activities in the brain that underlie desire and purpose. Some of these brain tensions are classified as “viscerogenic” and are acknowledged to be expressions of more peripheral body tensions, whereas others are psychogenic, or currently independent of viscerogenic needs (although they may have been subsidiary to them at one time). This classification follows the traditional one of dividing drives into primary and secondary, although it also incorporates Allport’s (1937) idea of “functional autonomy of motives.” This construct states that motives that may have originated from primary biological drives may become autonomous and govern behavior even when the behavior no longer serves to

reduce the primary drives. According to Hullian theory, secondary drives should extinguish when they no longer are connected through association with primary drives.

Murray's inventory of needs has been a fruitful source to constructors of personality tests, which have been related to the Sensation Seeking Scale (Chapter 6). One grouping of needs by Murray includes those that are directed toward the enjoyment of sensations. Two of these, *sex* and *sentience*, are classified as viscerogenic, and the other two, *exhibition* and *play*, are called psychogenic. The needs are defined by their behavioral expressions rather than by their hypothetical origins.

Sex is defined as the need "to form and further an erotic relationship," Sentience is the need "to seek and enjoy sensuous impressions." Exhibition is the need "To make an impression. To be seen or heard. To excite, amaze, fascinate, entertain, shock, intrigue, amuse or entice us [p. 170]." Play is defined as the need "to act for 'fun' without further purpose... random, whimsical, fantasy-driven behavior which releases internal tensions, but achieves no exterior effects [pp. 172-173]." As will be seen in Chapter 6, all these needs, measured by personality trait tests, do show correlations with sensation seeking.

Another grouping of needs concerns the degree of organization, stability, or rigidity of personality and broad styles of responding. Need for *sameness* versus need for *change* represents the relative preference for fixation in location, tastes, and social attachment versus the desire for new experiences. Need for *impulsion* versus a need for *deliberation* represents a tempo factor in response ranging from quick, nondeliberate responding to slow, cautious reactivity. *Conjunctivity* versus *disconjunctivity* refers to the expression patterns of organized vs. disorganized response. *Placidity* is opposed to *emotionality*, and they are estimated in terms of the frequency, intensity, and duration of manifest emotional expression and felt or reported emotion. This grouping is also pertinent to the sensation-seeking construct, as will be seen in Chapter 6.

Murray's contribution to psychology has been a delineation of traits that personality researchers have drawn upon to construct tests. The theory tells us little about how such traits are organized or their actual mechanisms. It remained for later researchers, using factor analytic procedures, to organize such traits under the broader factors such as extraversion or to show how they operate in behavior (e.g., McClelland and the need for achievement). The grouping of some of these needs as components or expressions of a sensation-seeking trait was suggested from a rational and intuitive framework and has been confirmed in empirical correlative studies.

Gardner Murphy (1947) described his approach to personality as a "bio-social" one. Criticizing the peripheral or "gut" motivational psychologists, he suggested that all activity stems from biological tensions and that these

tensions are inherent in all nerve cells, not just those of muscles and glands. Receptors and higher brain centers could also generate tensions that activate behavior.

“There is a prima-facie case, then, for sensory drives cognate in importance with activity and visceral drives, and there is evidence that from the very beginning the intensity of such needs shows a highly individual character” (Murphy, 1947, p. 113).

The foregoing quote from Murphy suggests individual differences in the strength of sensory drives. He felt that these drives furnished the impetus for aesthetic and play behavior and disputed the Freudian view that such behavior used redirected energies from more basic sex and aggression instincts.

Allport (1937) regarded “drive” as a rather crude biological conception somewhat useful for explaining the behavior of animals and human infants but inadequate for describing adult human motivation. He formulated the doctrine of “functional autonomy of motives” which said that the link of adult motives with the biologically rooted motives in infancy “is historical, not functional.” This early manifesto of independence from the drive construct was important because the construct required a tension reduction aim for all behavior. Most theories have either postulated that sensation-seeking activities are attempts to reduce other basic drives or primary sensory drives. The solution of postulating a new kind of drive, exploratory or sensory, is clearly circular and adds little to our understanding of the behavior unless we can specify the conditions or biological changes that cause such drives to increase or decrease in strength.

Maslow (1954), building on Allport’s doctrine of functional autonomy, described a typical development sequence of motivation with the characteristic “needs” changing with maturation. The sequence starts with physiological needs and proceeds through safety, belongingness and love, esteem, and finally *self-actualization*. The self-actualization need does not fit easily into a drive (or need) reduction scheme of motivation, since it involves the need to realize one’s innate capacities and potentials in work, love, and play. It involves constant growth, change, and openness to new experience.

Implicit in the construct of self-actualization is the idea that humans often seek novel sensations and experiences. Maslow (1968) describes self-actualizers as seeking “peak experiences,” which are novel experiences producing feelings of aliveness and fascination, with some characteristic disorientation in space and time. They can be sexual, love, aesthetic, religious, creative, or other types of experience. In the 1960s many young persons used psychedelic drugs in an attempt to produce such experiences. The self-actualizer experiences such novel subjective states as euphoric rather than threatening.

Maslow’s theory suggests that infants and young children are mostly under the control of physiological and security needs and that only more mature

persons, who have had these earlier needs gratified, seek actively to extend their experience. The concept of *competence* described by White (1960) is similar to the construct of self-actualization. "The competence of an organism means its fitness or ability to carry on those transactions with the environment which result in its maintaining itself, growing and flourishing [p. 100]."

In contrast to Maslow, White feels that this motive is present at birth and exists alongside deficit motives at all stages of development. Competence is actually the goal of the biological motive of *effectance*. *Effectance* is equated with exploratory behavior in animals, and its reinforcement is said to be "changes in sensory input that follow upon activity or exertion [p. 103]." Effectance is conceived of as a neurogenic motive rather than a viscerogenic one. "It can be informally described as what the sensori-neuro-muscular system wants to do when it is not occupied with the homeostatic business [p. 103]."

The term *effectance* is used to describe this motive because changes are only rewarding if they are intentionally produced. White reinterprets the classical Freudian view of development in terms of the strivings of the child to be independent: to feed and assert the self and to assume adult roles.

Challenges to Drive Theory

The personality theorists were not alone in their challenge to classical drive theory. Two comparative psychologists questioned the idea of primary drives governing all the organism's behavior. Both Young and Harlow emphasized the importance of external stimuli as motivators of behavior.

Young (1936, 1948) used "drive" in the singular sense only, defining it as released physical energy. Behavioral theories had moved away from hedonistic explanations of behavior as illustrated in the progression from a description of stimuli as "pleasurable," to "rewarding," to "positively reinforcing." Young proposed a doctrine of "factual hedonism" in which we may judge pleasantness or unpleasantness from behavior that is seeking or maintaining (of the stimulation) or avoidant.

The assumption of the necessity to introduce feelings back into psychology stemmed from his research on the palatability of different foodstuffs, apart from the state of hunger or past reinforcement history. Consistent human affective preferences were found for other kinds of stimuli: olfactory, visual, and auditory. Young suggested that pleasure was not simply a matter of tension or need reduction but was intrinsic to certain qualities and optimal intensities of stimulation.

Young (1936) regarded the "exploratory drive" as behavior elicited by a novel environment rather than internal tensions. He noted that there was no known tissue need that initiates exploration or play.

Harry Harlow was an even more devastating critic of drive reduction theories than Young. Based on his observations and experiments on “mice, monkeys and men,” he asserted (1953a): “It is my belief that the theory which describes learning as dependent upon drive reduction is false, that internal drive as such is a variable of little importance to learning, and that this small importance steadily decreases as we ascend the phyletic scale and as we investigate learning problems of progressive complexity [p. 23].”

Turning to man, Harlow (1953b) stated that: “Most, if not all, of man’s complex learning is motivated by nonemotional or mildly pleasurable stimuli and is disrupted or inhibited by intense affective states [p. 25].” As to the physiological basis of such motivation, Harlow said: “Learning efficiency is far better related to tensions in the brain than in the belly [p. 26].”

While Harlow entertained the ideas of optimal levels of stimulation and “brain tensions,” he did not pursue these lines of theory. Instead, his musings on sources of motivation imply that the “tropisms” and “instincts” seen in lower animals have some influence in primates as well. Having first rejected instinct and substituted the more restricted notion of drive, some psychologists have returned for a “new look” at instinct theory.

Summary

Behavioral psychologists of the 1920s rejected the biological construct of instinct for good reason: As a construct, it was tautological and mostly unverifiable in man. However, drive, which was substituted for instinct, posed a new problem. The concept of instinct presupposed an innate biological mechanism that predisposed the organism to react to certain kinds of stimuli with specific behaviors directed toward specific goals or objects. Instinctivists, such as McDougall, proceeded to classify human behavior into categories, such as reproduction and pugnacity, that could be identified in other species. Sensory curiosity was one of these categories. Drive theory restricted itself to a limited number of internal cyclical physiological conditions such as hunger and thirst and suggested that such conditions led only to a generalized activation of behavior rather than to specific behavioral sequences or a preference for one type of object rather than another. Freud’s definition of “trieb” placed it in this last category, although it was translated into English as “instinct.”

Although the specific central mechanisms of drives were not known, they could be defined independently of responses by deprivation operations and by other biological criteria such as weight loss in the case of hunger. However, the restriction of the construct to tissue deficit or excess conditions left a large realm of behavior, such as exploration and curiosity, without a motivational basis. The answer of Freud and behavioral drive theorists was the assumption that such behavior was actually in the service of these primary drives, an

assumption that strained credulity and—as Harlow and Young pointed out—could not be demonstrated in the laboratory.

To show a connection between a primary drive and a class of behavior, it must be demonstrated that the behavior results in a reduction of that drive. Both Freud and drive theorists assumed that pleasure or happiness (Freud) and reward or positive reinforcement (Tolman and Hull) consisted of reduction of the drive stimulus or internal tensions associated with that drive. As Young and Harlow pointed out, there are no cyclically occurring tissue deficits associated with exploration or play, and the behavior seems to be under the control of external rather than internal stimuli. Furthermore, the behavior itself increases the stimulation rather than reducing it. If novel stimuli or situations increase excitement, we should see only avoidance and withdrawal from such stimuli. Instead, both animals and people tend to approach and investigate novel stimuli if such stimuli are not too intense or threatening.

Tolman, Murphy, and White all suggested that the source of exploratory behavior might reside in sensori-motor tensions or tensions in the higher brain centers; of course, this attempt to preserve drive theory by transferring the biological site from the viscera to the receptors, cortex, or muscles is as tautological as the instinct theories with their hypothetical biological mechanisms. But there is an experimental operation in which receptors can be deprived of stimulation, analogous to food or water deprivation. This method is called *sensory deprivation*, and the research results discussed in the next chapter do suggest the plausibility of a drive for sensory information.

Most drive theories assume that the aim of motivated behavior is to reduce stimulation and internal tension to a minimum, but other theories suggest that the optimal range of stimulation or arousal is at some intermediate level. The pleasurable, rewarding, or positively reinforcing value of stimulation, according to these theories, would depend on the intensity of the stimulation and the level of tension in the organism prior to stimulation. The next group of theories describes this view of stimulus motivation.

OPTIMAL LEVEL OF STIMULATION AND AROUSAL THEORIES

Wilhelm Wundt: An Introspective Analysis From the Laboratory

Wundt (1893) carried some of these earlier formulations of philosophers, such as Bain, into the laboratory. Using the method of introspection to analyze the relationship between stimulation of pressure, temperature, taste, and olfactory senses and feelings of pleasure and pain, he formulated the optimal level of stimulation as a quantitative relationship shown in Fig. 2.1.

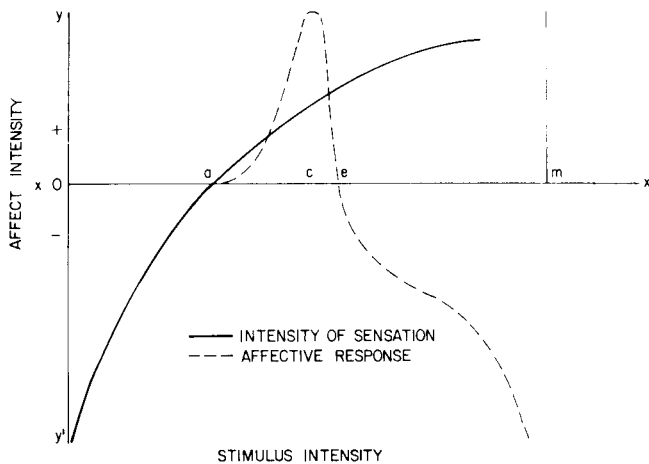


FIG. 2.1. The relationship between stimulus intensity and intensity of sensation and affective responses. (From Wundt, 1893.)

The x abscissa represents stimulus intensities, and the y ordinate shows internal reactions. The solid line represents the linear increase in intensity of sensations with increasing stimulation, and the broken line indicates the affective response. The affect curve starts at the stimulus threshold indicated by point a . The pleasurable quality of sensation increases with intensity of sensation to a maximum at point c . After this point, the pleasurable quality decreases rapidly, changes to displeasure at point e , and becomes increasingly displeasurable with further increases in stimulus and sensation intensities.

Wundt saw this as a restricted law that did not apply to the higher senses of visual and audition. Even within the taste senses, there were exceptions such as the taste of sweetness, which is always considered pleasant.

Wundt felt that the pleasure range occupied a very limited part of the total stimulus intensity range and concluded with a plea for moderation in pursuit of sensation. "Therefore, the experience of all time teaches that a moderate blessing creates the most favorable condition for happiness [translation, p. 53]."

Sigmund Freud: An Early Optimal Level Theory

In view of Freud's stimulus reduction views, cited previously, it is surprising to discover an optimal level of arousal theory in his first major work on psychoanalysis, *Studies in Hysteria* (Breuer & Freud, 1895/1937). Freud's first statement of the constancy principles was: "there is a tendency to preserve at a constant level the intracerebral excitement. An excess of it becomes burdensome and annoying, and there arises an urge to consume

it...I believe that we can also assume a level of the intracerebral tonic excitement, namely that it also has an optimum. On this level of tonic excitement, the brain is accessible to all external stimuli [p. 143].”

Freud states that “agitation” may be produced by excitement in excess of or below this optimal level. For instance, agitation may be produced by “lack of sensory impressions such as darkness and soundless quietude... and absences of perceptions, ideas and association activity [p. 142].” This lack example sounds like conditions of sensory deprivation, which, in fact, do produce a certain amount of anxiety and restless agitation (Chapter 3).

As Freud’s theory evolved, the definition of the constancy principle changed from an optimal level idea to a minimal level one as exemplified in the death instinct: “The goal of all life is death” (Freud, 1920/1955).”

In an earlier work, Freud also suggested that there might be a difference in temperament between “vivacious” and “indolently torpid” persons based upon “profound differences of their nervous systems; that is, on the amount of energy set free by the functionally resting cerebral elements” (Breuer & Freud, 1895/1937, p. 144). The implications of this quote are that persons who have highly arousable nervous systems are more likely to be active and sensation seeking than more hypoarousable types; i.e., a direct relationship between neurophysiological and behavioral reactivity. When Freud abandoned his preliminary attempts to formulate a neurological theory and moved to a more purely psychological one, this early idea of a biological basis for temperament was lost.

Yerkes–Dodson Law: A Behavioral Analysis

Wundt and Freud discussed the optimal level of stimulation, or internal excitation, in terms of the effect on subjective feelings of pleasure or displeasure. Comparative psychologists, such as Yerkes and Dodson (1908), cannot speculate far on internal feelings, for rats are notoriously poor at expressing emotional nuances except in the grossest terms such as defecation. Instead, these investigators were concerned with the effects of stimulus intensity of electric shock on maze learning in the “dancing mouse.” They varied two factors in their experiments: the level of the shock stimulus given for errors and the difficulty of the visual discrimination.

The results showed that the optimal level of stimulation for learning depended on the difficulty of the learning. For the easiest discrimination, the optimal level was the highest level of stimulation; for the most difficult discrimination, it was at an intermediate level but one relatively lower than that for the task of medium difficulty. Both the medium-difficulty and high-difficulty situations showed the inverted U-curve that Wundt formulated for affective reactions; learning was most effective at intermediate levels of stimulation.

The Yerkes–Dodson law simply states that learning involving easy discriminations or simple associations is facilitated by high levels of stimulation, whereas more difficult learning proceeds optimally at some intermediate level of stimulation. Harlow (1953a) cited the Yerkes–Dodson law to support his idea that intense stimulation is inimical to learning of moderate complexity and ironically observed that there was no reference to the Yerkes–Dodson law by drive reduction theorists (p. 27). Actually, at about the time Harlow made this accusation, Spence (1953) began a series of studies relating stimulus and arousal indices of drive to simple and complex learning. The result was an explanation of the detrimental effects of high drive on complex learning in terms of interfering responses produced by the drive. But between 1908 and the early 1950s there was a remarkable lack of interest in the theoretical development of the optimal level of stimulation construct.

Donald O. Hebb: Revival of the Optimal Level Theory

Hebb (1949) was one of the first psychologists (with the exception of Pavlov, who was after all a physiologist) to advocate physiological theorizing for behavioral psychology. He noted that most of the criticisms of physiological behavior theory were based on Pavlov’s “switchboard” model, which was no longer tenable in view of the discovery of recurrent circuits. The brain was now conceived of as continuously active with both general and autonomous processes determining attention and sets for particular stimuli. Motivation was conceived of in terms of organized central processes rather than peripheral tensions in the stomach or gonads. These brain processes resemble the hypothetical “brain tensions” suggested by earlier theorists; and in 1949 neurophysiological theory was still mostly hypothetical.

Hebb’s (1949) optimal level of stimulation theory first appears in a discussion of pain: “In most sensory modes there is an intensity limen at which avoidance appears. Below this point the stimulation may be sought out—that is, it is ‘pleasant’; above it, the same kind of stimulation produces avoidance and, if the avoidance is unsuccessful, behavioral disturbance [p. 182].” Pain is translated into an emotional dimension in the discussion of fear. People seek out “pleasant fears” in certain activities, like riding roller coasters, and fear becomes unpleasant at higher levels of arousal. However, at this time, Hebb felt that humans seek moderate fear arousal in order to experience the pleasure of reducing the fear, rather than because it is intrinsically more pleasant than lower levels of arousal.

A landmark discovery in neurophysiology in 1949 changed Hebb’s view of the optimal level problem, resulting in a shift from a narrow to a broad optimal level of arousal theory. Moruzzi and Magoun (1949) discovered that electrical stimulation of the reticular formation produces an activation of the cortex as shown in the EEG; Lindsley, Bowden, and Magoun (1949) further

demonstrated that lesioning the reticular formations produced an EEG characteristic of sleep, despite the fact that the specific sensory pathways to the thalamus and cortex were still open. These studies and those that followed showed the role of the reticular system in regulating central activation. The system is itself activated by sensory input as well as descending influences from the cortex in a regulative negative feedback system. As Lindsley (1961) has suggested, the reticular formation has a homeostatic function, regulating and adjusting the stimulation coming into the cortex from internal and external stimuli.

Hebb's former theory had assumed the autonomy of brain activity from sensory input. The recognition of the need for sensory stimulation to "charge" the cortex through the reticular formation, and the regulation of cortical activity by this structure, led to the new formulation centering around an *optimal level of arousal*.

Hebb (1955) now described two functions of sensory events as the *cue function*, which guides behavior, and the *arousal* or vigilance function, which activates the whole behavioral system. Both functions are necessary for organized behavior. Arousal is the physiological basis of the generalized drive state of purely behavioral theories.

Figure 2.2 is a reproduction of Hebb's (1955) showing the relation between the cue function and arousal function. The picture shows the inverted U-curve, which is the descendant of Wundt's and Yerkes and Dodson's curves. The curve shown in the figure would describe a cue function of moderate to

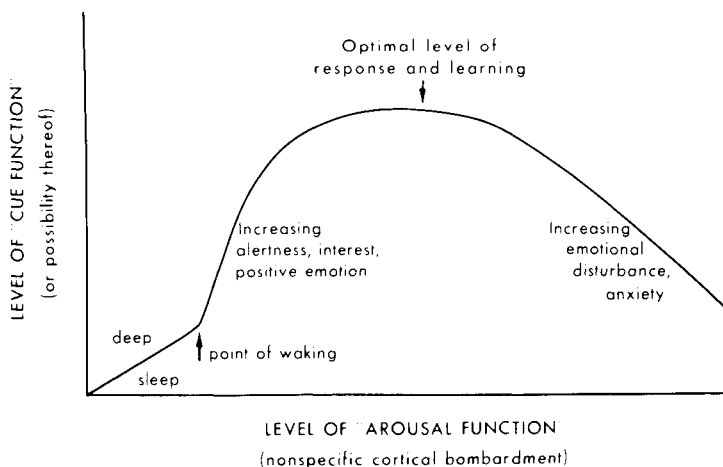


FIG. 2.2. The relationship between arousal and cue function (response and learning). (From: Hebb, D. O. Drives and the CNS (conceptual nervous system). *Psychological Review*, 1955, 62, 243-254. © 1955 by the American Psychological Association. Reprinted by permission.)

extreme complexity. The arousal is tonic level that extends from sleep to extreme emotional disturbance.

At low levels of arousal, an increase in arousal may be rewarding or pleasurable, but at much higher levels of arousal, a decrease is rewarding. Thus, a moderate level of arousal need not be pleasurable only in reduction but may be pleasurable as a change from a level that is too low. A drowsy state in the middle of the school day while sitting in a lecture may be felt as unpleasant, and anything in the lecture, such as a joke, that increases the level of arousal is felt as pleasant.

Other Optimal Level-of-Arousal Theories

Elizabeth Duffy (1932) was an exception to the general amnesia for the Yerkes–Dodson law that Harlow noted in behavioral theories. She had suggested that the inverted U-shaped function might describe the facilitative and disruptive effects of central tension, and years later (Duffy, 1957) she incorporated this function in her general arousal theory.

The concept of arousal used by Hebb pertained to cortical arousal. Duffy's is a more general one, which is defined as energy mobilization and is measurable by a variety of peripheral psychophysiological indices of autonomic activation and muscular tension as well as the cortical EEG index of activation. Duffy (1951) suggested that behavior may be described in two dimensions: direction and "energy mobilization," roughly equivalent to habit and drive in Hullian theory and to cue function and arousal function in Hebb's theory. However, in contrast to *drive*, which is often measured by the extent of overt behavioral response, arousal has no necessary relationship with overt behavior. A state of behavioral immobility in fear, or "freezing," may be associated with extremely high states of physiological arousal.

Duffy (1957) suggested that individuals may differ in arousal, for either genetic or environmental reasons, and such differences may affect their temperaments. Individuals with a fast alpha rhythm in the EEG (high arousal) are characterized as quick, impulsive, and variable in behavior, whereas those with slow alpha are rated as cautious and steady. This represents another suggestion that the optimal, or accustomed, level of arousal may be the basis for sensation-seeking-type behavior.

Donald Lindsley's (1951, 1957) motivational theory centers around the reticulo-cortical arousal system, which he himself has helped to define in neurophysiological studies. He conceived of the reticular formation as a homeostat (Lindsley, 1961) regulating the inflow of sensations to the cortex much as a thermostat regulates the inflow of heat into a house. When the cortex is underaroused, the reticular formation allows more stimulation to reach it, but when it is overloaded, there is a reduction in incoming stimulation. Lindsley's theory correctly predicts the cortical reactions to

prolonged sensory deprivation, which consist of an initial activation followed by progressive slowing of brain activity due to the loss of external stimulation (Chapter 3). The autonomic and muscular activation in sensory deprivation may represent compensatory attempts to activate the cortex through the limbic system or proprioceptive activation of the reticular system.

Besides the results of sensory deprivation, Lindsley (1957) suggests that the curiosity of animals and the hyperactivity, playfulness, and curiosity of children may be in part a function of the reticulo-cortical system, which gives a preference of passage to novel stimuli and is implicated in the blocking of response to repeated stimuli (habituation).

Schlosberg (1954) attempted to combine Duffy's and Lindsley's ideas into a three-dimensional theory of emotions. The dimensions include pleasantness-unpleasantness, attention-rejection, and activation (arousal). Unlike the optimal level of arousal theory, which relates pleasantness-unpleasantness in a curvilinear function to arousal, this theory suggests that affective reactions and arousal represent independent dimensions of emotion, and that both pleasant and unpleasant emotions may be found at all points on the arousal continuum from drowsiness to high activation.

Schlosberg also pointed out another parameter of the optimal level of arousal, which other theorists seem to have overlooked—the diurnal cycle. During the course of the day, the individual's optimal level of arousal must vary with his or her level of arousal, which is regulated by the intrinsic diurnal rhythms. Drowsiness that is below the optimal level during the day, with its demands for activity and alertness, is optimal at night before going to sleep. The optimal level of arousal must track the diurnal levels and also depends on the realities of task demands.

Malmo (1959) makes the point that activation (arousal) cannot be equated with drive, because internal conditions such as hunger or thirst interact with external cues to produce a given level of activation. Although activation increases linearly with drive, even simple kinds of performance such as bar pressing decrease at the high end of the activation-drive continuum, suggesting that the inverted-U-shaped function may hold even for these simple activities. Malmo hypothesized that deprivation of food or water increases activation effects of stimulation on the cortex by sensitizing the reticular formation through the release of a neurotransmitter such as epinephrine (more likely norepinephrine, in terms of current research).

Hebb, Duffy, Lindsley, Schlosberg, and Malmo were interested in the relation between levels of tonic arousal and emotion, learning or performance. The next group of theorists formulated their theories in terms of phasic arousal, or the arousal reaction to stimuli in relation to a tonic, or baseline, level of arousal. These might be called *stimulus change* or *arousability* theories: They emphasize that the impact of stimulation or whether it is felt as pleasant or unpleasant, or whether it facilitates or

interferes with learning and performance, depends on the degree of deviation from an adaptation level at the time of stimulation.

STIMULUS CHANGE OR AROUSABILITY THEORIES

Alexander Bain: Antecedent in Natural Philosophy

An early formulation of the stimulus change theory appears in Bain's (1875) volume *The Emotions and the Will* which was first published in 1859. Stimulation of the senses within certain limits of intensity was said to be pleasurable but beyond these limits became painful. This relationship between feeling tone and intensity of stimulation was said to be applicable to the senses of touch, hearing, and vision. Bain further stated that pleasure and pain have an effective value relative to a constant level of stimulation. His Law of Relativity is as follows: "Change is necessary to feeling; we are unconscious of unremitting impressions; the degree of feeling is proportional to the change; abruptness or suddenness of transition is one mode of enhancing the effect [p. 78]."

This law recalls Freud's (1930/1961) definition of pleasure as the "preferable sudden" reduction of internal tension: "We are so made that we can derive intense enjoyment only from a contrast and very little from a state of things [p. 23]." The difference is that Bain's law allows for pleasure in the sudden increase, as well as decrease, of stimulation.

Bain also formulated a "Law of Accommodation" describing the tendency for intensity of either negative or positive feelings to subside with repetition of the stimulus or situation eliciting them. From this, he deduced that variety must be important in maintaining pleasure in any activity. Though not focusing on individual differences, Bain described the peculiar tendency for the *sanguine* type of person to ignore past risks in the seeking of new adventures.

McClelland: Hedonic Theory

McClelland, Atkinson, Clark, and Lowell (1953) define the affective value qualities of stimuli in terms of their deviation from an adaptation level (AL). Their second postulate states: "Positive affect is the result of smaller discrepancies of a sensory or perceptual event from the adaptation level of the organism; negative affect is the result of larger discrepancies [p. 43]."

Affective states in man are defined by autonomic activation and verbal reports (which supply the positive vs. negative direction); in animals they are defined by approach and avoidance behavior in reaction to the stimulation.

The adaptation level is defined in terms of an expectancy. Like Wundt and Young, McClelland et al. suggest that there are “natural adaptation levels” for different sensory receptors, with slight deviations from threshold in some (i.e., bitterness) producing unpleasantness. Other kinds of simpler perceptual ALs are produced by experience. For instance, a young chimpanzee that has developed a stable expectation of what another chimpanzee looks like is terrified by the sight of a model chimpanzee head but only interested in a whole model chimpanzee (Hebb, 1946). The first stimulus represents a major deviation from AL, the second a small deviation. In this type of AL, the AL is a complex perceptual schema rather than a simple, discrete sensory trace. The deviation from AL seems to refer to the surprise or novelty of stimuli. A little bit of surprise or novelty is pleasant, but too much is unpleasant or even fear provoking.

The discrepancies from the AL may be in either direction. A person may inspire fear in another by either suddenly raising or lowering his voice considerably above or below the usual volume. Haber (1958) suggested that the McClelland theory may be described by an inverted W-curve, as shown in Fig. 2.3, instead of the classical inverted U-shaped curve of Wundt.

If the AL is zero or very low, as when there is no particular expectation, only an unidirectional discrepancy would be possible, and only the right half of the inverted W should apply. If you cover the left half, you will notice that what remains is the inverted U-curve. Since most discrepancies from expectation are qualitative (same vs. different) rather than quantitative, only the right half of the curve would apply in these cases. The curve would have more relevance to an optimal level of arousal theory where it might be argued that either moderate increases *or* decreases in arousal reaction from an arousal AL (tonic level) are pleasurable. This theory would be particularly applicable to the hedonics of drugs (Chapter 10), where it appears that both depressant and stimulant drugs are pleasurable to some drug abusers.

There is a problem with the assumption of this theory that all large discrepancies from AL are unpleasant. If I am expecting a \$300 raise and I get a \$1200 raise, it is unlikely that this would produce *less* pleasant affect than a

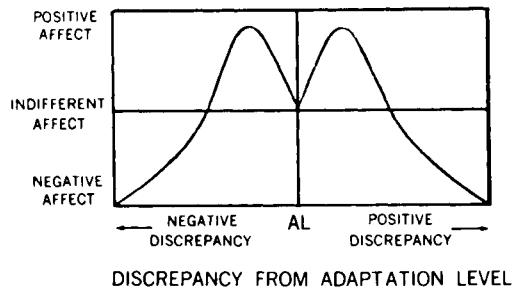


FIG. 2.3. The “butterfly curve” from theory of McClelland (1953). (From: Haber, R. N. Discrepancy from adaptation level as a source of affect. *Journal of Experimental Psychology*, 1958, 56, 370–375. © 1958 by the American Psychological Association. Reprinted by permission.)

\$600 raise (small discrepancy from AL). A literal interpretation of the theory would also lead to the conclusion that not getting any raise would be as pleasant as getting a \$600 raise. Of course, McClelland would argue that this continuum cannot be expressed in the decimal scale of dollars. But how are we to define ALs and discrepancies?

Leuba: Stimulation Change and Learning

Clarence Leuba (1955) has attempted to define reinforcement in terms of stimulus deviation relative to AL: "The organism tends to acquire those reactions which, when overall stimulation is low, are accompanied by increasing stimulation; and when overall stimulation is high those which are accompanied by decreasing stimulation [p. 29]."

Since Leuba includes internal stimulation, or general excitation, in "overall stimulation," this is also an optimal level of arousability theory. In his 1962 paper, Leuba shifted the emphasis to an "optimal innervation, arousal or activation within the central nervous system . . . a balance at an optimal level between input and output of innervation in the central nervous system [p. 64]."

Schneirla: A Comparative Approach

The idea that moderate deviations from the general level of stimulation elicit approach, whereas extreme and sudden deviations lead to withdrawal, was extended to a broad range of comparative behavior (from the army ant to the human) by T. C. Schneirla (1959). For lower organisms, he used the terms *approach* and *withdrawal* to describe reflexive, tropistic, and instinctive responses to stimulation. He used the terms *seeking* and *avoidance* for higher organisms to describe the purposive nature of their behaviors.

The basic postulate of the theory is "For all organisms in early ontogenetic stage, low intensities of stimulation tend to evoke approach reactions, high intensities withdrawal reactions, with reference to the source" (Schneirla, 1959, p. 3).

Schneirla suggested that two biological mechanisms mediated stimulation and behavior: the A-type (approach) governs activity directed at getting food, shelter, and mates; the W-type (withdrawal) is related to defensive adjustments such as huddling and flight. He hypothesized that the two mechanisms might be related to the two branches of the autonomic nervous system—the A-type activated by parasympathetic arousal and the W-type by sympathetic arousal. In the musculature, weak stimulation is associated with extensor activity and strong stimulation with flexor activity.

Schneirla also suggested that the pleasure or reward and pain or punishment areas of the limbic system discovered by Olds and Milner (1954)