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AUTHOR Jenkins, W. O.
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ABSTRACT

This paper attempts to organize, systematize, elaborate, and elucidate a number of basic principles for behavioral change that have experimental foundation. The two major areas discussed concern procedures and principles for strengthening and weakening behavior. Matters of inducing behavior are considered. Principles for strengthening behavior are grouped around post-response events (including reward), characteristics of the environmental situation and the task, and aspects of the organism involved. Principles for weakening behavior are classified by the basic methodologies employed. Several basic methodological points are described. (Author)

MAKING AND BREAKING HABITS

A Summary Statement of Some Basic Facts and Principles of Behavioral Change

W.O. Jenkins

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The Institute for Child Development and Experimental Education

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This paper attempts to organize, systematize, elaborate and elucidate a number of basic principles for behavioral change that have experimental foundation. The two major sections of these notes involve procedures and principles for strengthening and weakening behavior. Matters of inducing behavior are considered. Principles for strengthening behavior are grouped around post-response events (including reward), characteristics of the environmental situation and the task and aspects of the organism involved. Principles for weakening behavior are classified by the basic methodologies employed. A few basic methodological points are treated.

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A Summary Statement of Some Basic Facts and Principles of Behavioral Change

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I. OVERVIEW

It is easy to pay lip service to the glib statement that "there's a lot we don't know in psychology". It is far more difficult to face up to what we do know. These notes attempt to spell out some experimentally established principles of behavioral change. The latter phrase includes methods and principles for increasing, maintaining and decreasing response strength.

Before getting on with the business at hand, a couple of core matters need treatment. First, the basic postulate inherent in this presentation is that behavior is lawful. If this were not the case, there would be no science, behavioral or otherwise. The problem, of course, is to tease out the laws by experimental means. Related to this point is the fact that all science is behavioral at heart, i.e., the reactions of organisms are involved be they subject or experimenter. This point plus the fact that all science reduces to some form of discrimination, makes psychology the propaedeutic science as Stevens has indicated (1939).

The next point concerns the basic orientation of this presentation. An attempt has been made to stick to empirical, non-theoretical descriptive statements. The basic bias of the writer peeks through on occasion and should be pointed up. It is descriptive behaviorism based

on a contiguity, associationistic viewpoint dealing with stimulus and response events external to the organism. No theoretical or empirical consideration is given to the inner workings of organisms.

The principles selected for presentation deal with the gross behavior of organisms. They focus on the reactions of individual, intact animals, human and infra-human. The basic concern is with behavioral laws that hold across species for individuals whose functioning has not been subjected to any sort of physical intervention. It follows that the principles are based on variables having large effects on behavior. The principles while presented in isolation, clearly do not stand alone; they interact, interlock, overlap and dovetail.

Definition of terms. Certain common elements require definition. The central ones are stimulus, response, response strength, association, reinforcing stimulus, and learning or conditioning. Their definitions follow.

A. Stimulus. A stimulus (or cue) is any part of the environment or change in part of it that produces an alteration in the behavior of an organism. What is a stimulus for one organism may not be a stimulus for another. The criterion is entirely behavioral and quite circular. The stimulus can be and usually is measured directly by the investigator, but the ultimate criterion is the behavior of the organism or subject exposed to it. Since stimuli constitute classes and are rarely simple and unitary, the phrases "stimulus compound", "stimulus complex", "stimulus situation", "stimulus class", and the like will be used.

B. Response. A measurable part or property of the behavior of an organism that changes with environmental alteration. The basic properties or dimensions of behavior along which measurement occurs are: frequency, rate, latency, magnitude, duration, amount, variety, conditions, direction and quality, appropriateness or correctness. Responses can be measured and recorded independently of stimulation, but always occur in some sort of stimulus context, that must be specified (conditions). Responses, like stimuli, form equivalent classes. A response occurs only if it is measured or observed, i.e., constitutes a stimulus for the behavior of another organism. Only if E does something about S's behavior does the latter become a response.

C. Response Strength. Any descriptive measure of single responses such as latency or magnitude, or groups of responses, e.g., percentages or frequency or rate of responding, which expressed quantatively the occurrence of a response under specified conditions. "Response strength" is a generalized rubric for the individual measures cited above. Alterations in it are the basis for inferring behavioral change.

D. Association. Association refers to the temporal and/or spatial contiguous occurrence of two sets of events, usually a stimulus and a response class. The repeated contiguous occurrence of the two events forms the basis for the inference that if one occurs, the other has occurred or will occur.

E. Reinforcing Stimulus (Reward). A stimulus that, when applied following a response, increases the strength of the response class.

Reinforcement is the process whereby response strength is increased under these conditions. Reinforcing stimuli, like other stimulus events, constitute classes.

F. Learning or Conditioning. A set of inducing stimuli is presented for bringing about a specified class of response some property of which is recorded. The occurrence of some member of the specified response class is followed immediately in time by presentation of a reinforcing stimulus. The result is an increase in response strength on some later presentation of the original stimulus situation. The behavior is not weakened or eliminated by the sheer passage of time.

There are certain classes of events that impinge on the life cycle of organisms that are not amenable to the specific form of statement given for the classes of variables and their associated principles that are elaborated later in the presentation. These include in gross terms the relatively amorphous influences going under the headings of genetic factors, the cultural and social milieu, early experience and individual differences. These are higher-order categories subsuming, in part, some of the behavioral rules and regulations enumerated in later paragraphs. These broad groupings of events are not, however, to be simply indicated. On the contrary, they constitute major sources of behavioral variation. Genetic features, for instance, although they cannot be pinpointed for individual organisms, have a great deal to do with behavior. Frequently we have a dearth of information about the early environment and behavior of our Ss, matters that contribute greatly to

the catch-all known as individual differences. These several factors may contribute to chance error, but there is a very real possibility that they are major sources of constant error slanting experimental findings in a particular, unknown direction.

There is one overall point contributing to the stage setting for a statement of basic behavioral principles. It may be stated as follows: When a wide range of most variables is employed, a parabolic function usually emerges. Values of variables below or near absolute threshold do not produce behavioral change. As the value of the variable is increased more and more of its behavioral impact emerges. Next there follows a plateau on which changes in the variable do not generate further increments or decrements in the reaction. Finally, extreme values of the variable do not produce the original class of behavior, but rather some new class replaces it. Across the board a U-shaped function results. In this presentation we shall be concerned with all phases of the parabolic relationships.

A Heuristic Model. A guideline is needed to pin down the statement of principles in the later sections of this paper. Fig. 1 shows, in stylized form, such a paradigm. It depicts the stages in the learning process or the chronological progression of learning. It points up one major matter, namely, that the terms "learning" and "learning theory" are misnomers. We are dealing here with not only the incremental effects classified as acquisition, but also the maintenance of behavior in post-learning performance and principles and procedures for weakening

or eliminating established behavior. It is an interesting commentary that to call these processes "learning", as most writers do - implies a contiguity position that all behavioral change whether incremental or decremental involves acquisition. So it may, but that is not our concern in the present context.

A number of items are noteworthy in the highly smoothed functions shown in Fig. 1. First, in operant level or unconditioned or preconditioning determinations, the overall low level of responding under constant cue conditions and the absence of reward presentation tends to decline over time.

In acquisition, a reinforcing stimulus is introduced under constant stimulus conditions with an associated marked increase in response strength to an asymptote.

During post-learning performance reinforcement is continued under constant circumstances and the level of responding is high, asymptotic and in a relatively steady state. Quotidian variability and local response variations have been ignored here since, under the conditions cited, they are small-scale effects relative to gross response stability.

In the first phase of weakening behavior, the typical operations are to omit reinforcement (experimental extinction) or to apply it to some incompatible response class (counter conditioning) with other aspects of the stimulus situation held constant. The associated behavioral change is progressive decrement with the ultimate attainment of an asymptotic value.

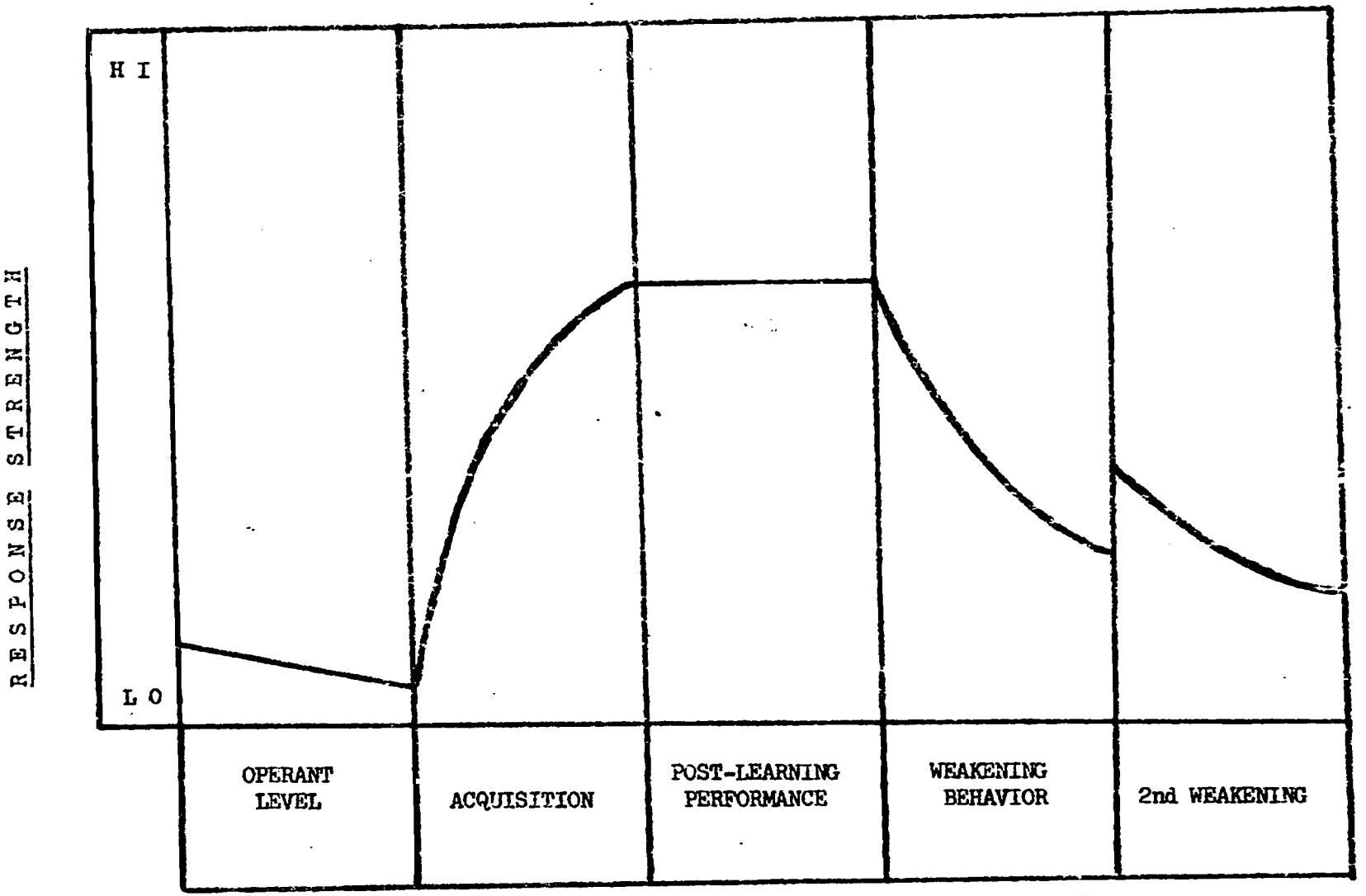

Figure 1. PHASES OF THE "LEARNING" PROCESS

If the weakening operations are repeated after a period of non-exposure to the experimental situation, an initial increment in responding appears over the terminal level of the first session ("spontaneous" recovery) followed by a foreshortened decremental function reaching an asymptote.

Across the board, the major sources of variation are reinforcement and its parameters, stimulus conditions and level and direction of change in response strength. These characteristics serve as major anchor points for experimental programs in the so-called learning field.

The outline of the statement of principles involves a section on Inducing Behavior; followed by principles of Strengthening Behavior broken into Reward Characteristics, Organism Characteristics and Situational Characteristics; and, Weakening Behavior, and finally, Methodological Principles. The principles will be given their common labels and be numbered consecutively from one on. Some spelling out of the statements along with examples will be presented. The qualifying phrase "all other things equal" is inherent throughout the presentation and will not be made explicit on each occasion.

II. BASIC COMMON THREADS

There are a number of core principles that serve as an umbrella function covering a wide variety of other principles. These include: learning per se, generalization, discrimination and repeated conditionings and extinctions and their corollaries. These will be treated in turn.

1. Learning, Conditioning, or Acquisition. To paraphrase the previously given definition, learning consists of the abrupt or gradual increase in response strength associated with the immediate post-response application of a reinforcing stimulus in the presence of specified stimuli. One interpretation is that all behavioral change is learning, be it by way of reinforcement or non-reinforcement operations. The same principles, for instance, seem to apply to conditioning and extinction, e.g., distribution of practice facilitates both acquisition and extinction or put the other way round, massed practice retards both learning and extinction. The overall point is that, in all instances, some classes of responding are replaced by others.

There seems to be another common element throughtout the learning situation. Initial learning appears to involve the dampening out or elimination of competing response, not simply the acquisition of new behavior classes. The rat does not simply proceed to learn to press the lever. He must first "get over" non-responding, immobility, or freezing, focus his behavior on the lever and not wander around, and so forth.

As an overview, the organism brings some particular behavior to the experimental situation. It may facilitate or impede the response class to be acquired. If it interferes, the competing behavior must be weakened before the new behavior can set in.

2. Generalization and Generalization Decrement. This pervasive thread to all behavioral change may actually be the most generic principle available, subsuming acquisition, elimination of behavior, re-

inforcement and many other behavioral items. A generalized statement of it reads as follows: Whenever stimulus change occurs, response variation follows, and, conversely, whenever response change occurs, stimulus alteration is involved.

Some writers separate out stimulus and response generalization. It seems, however, that the two go hand in glove and cannot be divorced. It appears more parsimonious to employ the overall term "generalization" for all instances since they covary isomorphically. It might be noted that this topic subsumes the voluminous literature on transfer of training and proactive and retroactive interference, e.g., McGeoch and Irion (1952).

A corollary of the generalization point is that behavioral decrement increases monotonically with increases in stimulus dissimilarity. The more the stimulus situation is changed, the greater the response or generalization decrement.

It might be noted in passing that reinforcement is a special case of stimulus change. The basic operation defining reinforcement consists of presentation of stimulus that changes the on-going behavior so that the organism is removed from the original stimulus context and placed in a new one. The rat faced with food stops bar-pressing and begins eating.

The matter of secondary reinforcement has received much hue and cry in the learning and behavior literature. Recently, for instance, Wike (1966) published a rather large volumne on the subject. In the pre-

sent context with the emphasis on parsimony, secondary reinforcement requires no special treatment. Experiments in this area are all variations of the basic theme of conditioning a particular set of stimuli to a specified response class and then demonstrating that presentation of this class of stimuli leads to increase response strength over its absence. But these are clearly matters of generalization and generalization decrement. The main parameter is the extent to which the particular stimulus set is taken out of context, i.e., the degree to which other portions of the total stimulus compound are altered. In an approach to the limiting case, rats might be trained in a T-unit with a buzz associated with the correct turn and presentation of the reinforcing stimulus. Then conditioning in a Skinner box might be conducted with one group receiving the buzz for bar-pressing and food, and the other group not. As an overview, it would seem that the concept of "secondary" reinforcement is redundant and reduces to cue change and cue constancy and their associated parameters. This same line of reasoning applies to "higher order" conditioning and motivation

Overall alterations in the stimulus situation and its concomitant response variation holds for environmental, reward, organismic and a variety of other categories of cue change. These several matters will be treated in detail in the appropriate individual contexts of later sections.

3. Discrimination. Where generalization involves the spread of behavior from old stimuli to new ones related along some dimension,

the other side of the coin is discrimination. In discrimination, response strength is increased in the presence of one set of cues and decreased in the presence of another (usually related) set by differential reinforcement. That is to say, a reinforcing stimulus is presented for a member of a particular response class when a given stimulus situation is presented and no reinforcement follows the occurrence of the same response when another, related set of stimuli are presented. It is a technique sometimes used to determine the smallest stimulus differences to which differential responding can be established, that is, to establish the differential limen. In casual terminology, discrimination procedures teach organisms "to tell the difference" between stimuli.

Discrimination is a complex process involving stimulus and response generalization as well as generalization of reinforcement and non-reinforcement effects. That is, when the response is reinforced in the presence of one stimulus, the subsequent increase in response strength carries over to increase responding in the presence of the other, negative stimulus. Conversely, non-reinforcement for the negative stimulus produces generalization of extinction effects that spread to behavior to the positive stimulus. The increments must add more than the decrements subtract or otherwise the discrimination would not be formed. The final stage of discrimination formation involves 100% responding to the positive stimulus and zero responding to the negative stimulus.

Practically all behavior is discriminative in its basic nature. We respond differentially, one way to a particular stimulus and in a

different manner to another, related cue. Furthermore, all science is founded on the discrimination process, the detection of differences, verbal, visual or otherwise.

4. Reconditioning and Re-extinction. The operations for this form of discrimination are quite straightforward. The organism is exposed to cycles of repeated conditionings and extinctions - repeated applications and removals of the reinforcing stimulus. This procedure yields more and more rapid conditioning and extinction up to the limit of one response and its outcome of reinforcement or absence of it determining the subsequent sequence of behavior. One lever press that produces reinforcement leads to continued pressing. One reaction not followed by presentation of the reinforcing stimulus leads to a cessation of responding.

There is one special characteristic of repeated extinction that calls for consideration. Under massed practice with conditioning followed by extinction with no intervening interval, there tends to be an increase in extinction responding in the sessions shortly after the first one. This phenomenon is quite independent of "spontaneous" recovery. The effect refers to overall increased resistance to extinction in, say, the second of a massed series of repeated conditionings and extinctions. Total responding is inflated in the later extinction over that in the first one with massing of sessions or trials. The effect seems to reflect the partial reinforcement principle in that across the board, massed blocks of conditioning and extinction sessions operate as

if less than 100% of the trials or responses are followed by presentation of the reinforcing stimulus. This phenomenon holds up particularly when a 100% reinforcement schedule is employed in conditioning, a further indication of the operation of partial reinforcement.

5. "Spontaneous" Recovery. This topic deserves special consideration because the recovery is not "spontaneous" and because it is a basic consequence of extinction and quite possibly other forms of weakening behavior. The behavioral facts of "spontaneous" recovery are clear: When a period of experimental activity is interpolated after extinction procedures have been applied, response strength appears at a higher level at the beginning of the next extinction session than it was at the end of the previous session.

As regards "spontaneity", this recovery phenomenon appears to be simply a case of the reinstatement of special cues. There are a variety of these associated with introduction of the organism into the experimental situation. These include tactual and kinesthetic stimulation from handling, auditory and visual stimulation from the closing of the experimental box in the case of a rat in a Skinner box or runway. With repeated exposure these cues acquire special properties for the first reaction or the first few responses. The sequence of events is this: the occurrence of these special cues is followed closely in time by the prescribed reaction and then by presentation of the reinforcing stimulus. Thus these special cues become strongly associated with the early responses and become an integral part of the total stimulus compound for these reactions. If this cue reinstatement view holds, presentation of

these cues should increase response strength in the early part of a later extinction and omission of them should weaken it. Another way of putting the situation is that there is a unique component to the stimulus complex for the first few responses in the experimental setting. Responses in the presence of these cues are less subjected to extinction effects because they occur only briefly at the outset of the extinction session. Their influence clearly dissipates rapidly over time and later extinction responses when these special cues are not present are treated to weakening effects to a much greater extent than the early responses. This hypothesis needs testing.

The data on inter-extinction intervals fit the cue-reinstatement view of "spontaneous" recovery: The longer the interval (up to 24 hrs.), the greater the "spontaneous" recovery. This may be read: the longer the interval, the more the original cues are reinstated.

III. PRINCIPLES OF INDUCING BEHAVIOR

For reasons that are no means obvious, this basic area of research has been treated to very little systematic exploration. It is not only the initial fundamental step in behavioral investigation, but also in child training and the educational process. A few limited principles, however, can be cited.

6. Deprivation. Depriving organisms of substances or activities leads to predictable changes in behavior that can be channelled into the response class to be acquired. For example, the rat deprived of

food shows an increase in gross body movement in the presence of novel stimulation. If the response class to be learned is a locomotory one, such deprivation will facilitate its acquisition. If, however, a more precise fine movement such as manual dexterity is involved, food deprivation will introduce competing responses that will interfere with acquisition. The limiting case involves teaching rats to sit still as a function of varying degrees of deprivation. Here the greater the deprivation, the longer it takes to learn.

7. Adaptation or Habituation. Exposing organisms to the experimental situation without requiring the response to be learned permits occurrence of behavior that competes with the prescribed response so that they are damped out or dissipated. The reinforcing stimulus is sometimes presented during this adaptation period both to facilitate loss of interfering responses and to condition S to respond to it in the experimental setting prior to requiring the ultimate response. Prolonged treatment of this variety conditions other classes of competing behavior so as to retard learning. For instance, prolonged feeding of rats from the food magazine of a Skinner box without requiring lever pressing most probably conditions the rat to sit in front of the food magazine so that the body activity prerequisite to bar pressing is interfered with.

A similar case arises in child research where "rapport" is being established by engaging in play prior to, say, assessment testing. In this instance, the child may be so conditioned to "fun and games" in the presence of the examiner that it may be difficult to get him to con-

centrate on the test task. The antidote would seem to lie in making the test materials and situation as much like play as possible and thereby maximizing transfer.

8. Priming. The stage may be set for response occurrence by providing cues for the consummatory reaction in the initial course of acquisition. For example, pasting grain on a piece of scotch tape over the pecking window of a Skinner box for pigeons will generate considerable pecking even without food deprivation. Removal of the tape produces only slight decrements in behavior and the response comes out almost full blown. Again, small bits of food scattered down the runway of a maze or wet mash smeared on the lever of a Skinner box will usually get behavior started in a hurry.

Another form of priming lies in what might be called the hors d' oeurve effect (see Principle 20). It consists of pre-feeding small bites of food or sips of liquid prior to introduction of the organism into an experimental situation involving food (or water) deprivation. This technique is most effective after some initial conditioning has occurred since the pre-feeding or pre-watering is a matter of cue reinstatement by way of the consummatory response.

Presentation of novel stimulation to rats and children is an effective method of increasing activity so that certain classes of behavior can be selected out for application of reinforcement operations. It fits into the priming rubric. With gross novelty, however, antagonistic responses such as freezing may be generated.

9. Approximation and Shaping. This procedure overlaps to some extent with priming. It consists basically of broadening the class limits of the required response at first and then by differential reinforcement narrowing the limits to the desired point. In the traditional procedure, pigeons operating in the Skinner box are presented with food reinforcement for any form of pecking at first followed by gradually focusing the response in on the pecking window.

In teaching a child to talk, the same procedure is employed. It is first rewarded for any sounds remotely resembling words such as "Da Da". By gradual steps the behavior is then shaped into the more formal word "Daddy" or even "Father".

A great deal of more adult human behavior appears to be environmentally influenced in this manner. The whole business of teaching and learning in the formal educational sense is in considerable part based on a kind of shaping procedure in which approximations to the final response are rewarded at first with more definitive behaviors required on later occasions.

10. Guidance. During the 20's there was a flurry of experimental activity dealing with guidance, primarily in educational circles, although the work spilled over into the experimental area. Rats were leash-led through mazes, and children's hands were moved through the letters of the alphabet. The upshot of all this research endeavor seems to be that guidance facilitates learning when S actively participated in an approximation of the final response class to be acquired. Passive

participation may lead to interference effects in that S may simply learn to be led through the motions. A rat pulled through a maze in a cart clearly does not learn to run the maze, but does learn to have the maze world go by him without any action on his part.

Verbal guidance may, of course, facilitate performance in verbalizing organisms by way of pointing up the parts of the stimulus situation to respond to, what the gross characteristics of the response class are and the like. Instructions to human Ss fit this mold and will be treated in detail in a later section.

11. Imitation. This is a complex form of inducing behavior in one sense and simple in another. It consists essentially of performing the same behavior as another organism. In the simple case, the rat can learn to turn left in a T-unit in response to the cue of another rat just as it can respond to some visual stimulus such as a light. In its more complex form, it involves a considerable verbal component and to some extent overlaps with verbal guidance. The everyday case is "Watch Mommie and do what she does ... ". "Spontaneous" imitation may occur in lower organisms, but it appears more frequently in ones higher on the phylogenetic ladder such as chimps and children.

12. Instructions (Verbal Cues). Instructions to human Ss are an integral part of defining the response class and pointing behavior in the direction specified by E. They are external signals that specify the gross limits of the required behavior. They pre-set S to respond in a certain way.

Unless the goal of the experimental instructions is ambiguity, they should be checked and pre-tested in this regard. Clarity is essential. For example, there is a case in the literature of an investigation of the "spread-of-effect" phenomenon where E failed to instruct his Ss to learn, an essential ingredient of the effect. Of course, he failed to obtain learning and the "spread" phenomenon, not being anchored, failed to emerge.

Pre-test instructions, just like other pre-experimental operations for inducing behavior, must set the stage for triggering off the response and guide behavior into the required channel.

IV. STRENGTHENING BEHAVIOR: REWARD CHARACTERISTICS

There are some half dozen dimensions of parameters along which the reinforcing stimulus can be varied. In this section we are concerned with reward properties that contribute to strengthening behavior. By this term is meant variations in reward characteristics that increase response strength, i.e., expedite learning, maintain post-learning performance at a high level and increase resistance to extinction.

13. Presentation of a Reinforcing Stimulus. Although this concept and the overall one of reinforcement have been given previous definition, it seems appropriate to spell out the principle involved. Certain kinds of stimulus events occurring immediately after the occurrence of a response have the property of increasing response strength as shown on some later test occasion, trial or response occurrence. The

reason for this property lies in the capacity of the post-response stimulus to alter behavior. That is to say, to be effective as a reinforcing agent, a stimulus must lead to a particular response or more precisely a change in behavior from what it just was. Food is a very effective means of doing this when the organism has been food deprived. When the reinforcing stimulus is presented, the organism stops its current behavior and initiates new and different behavior. The rat no longer presses the bar, but eats. When food has been consummed, the organism finds itself in (or is returned to) the original stimulus situation for, say, bar pressing. The crux of the matter is generalization - the degree of similarity between the two sets of stimuli and responses, those associated with the measured response and those involved in the consummatory reactions. The more dissimilar the two sets of stimuli, the more marked the differences in their corresponding response classes. The greater the differences in both the stimulus and response classes, the more effective the second set is as a reinforcing agent in removing S from the original cue context and placing him in one that brings about appreciably different behavior.

To give a classic example, the more different the start and end boxes of a runway, the more effective is confinement in the end box as a reinforcer. Conversely, the more similar the two boxes, the more competing responses are brought into play so that the rat has tendencies in the start box both to run and to sit. Such a situation clearly retards acquisition.

Much is made of food deprivation and food presentation ("drive reduction") in this context. But food is only one of many ways of radically changing the stimulus situation so as to change the response. (Physical removal of the organism from the apparatus by hand is another.) The "drive reduction" view appears to be a subset solution to the general problem. The broader scope solution focuses on degree of stimulus and response change introduced by the reinforcing agent. Incidentally, independent, non-circular definition can be given to various potential reinforcing agents by measuring their effects apart from the particular experimental situation.

14. Number of Reinforcements. For many behaviors, response strength increases as the number of presentations of the reinforcing stimulus increases. A behavioral asymptote is reached beyond which additional occurrences of the reinforcing stimulus for behavior add little to response strength.

It might be commented in this context that it is conceivable but not common for response strength to attain an asymptote with one occurrence of the reward. In the relatively stripped-down environment of the Skinner box, for instance, one reward response can be followed by a large number of extinction responses. One-trial learning has not been systematically explored on any appreciable scale. Two parameters are cue minimization and cue constancy.

15. Delay of Reinforcement. The longer the time lapse between the occurrence of the response and the presentation of the rein-

forcing stimulus, the slower the learner. There may well be an asymtotic point in the delay continuum beyond which learning does not occur and behavior remains at or below operant level.

The reason for greater interference or increased retardation in learning with longer delay intervals seems quite obvious. The delay interval clearly allows for the occurrence of behavior other than the response specified and measured. It seems highly likely with longer delay intervals that some other class of behavior is occurring when the reinforcing stimulus is presented. The strengthening of this class in almost all instances is incompatible with the occurrence of the "desired" response class so that interference effects occur on future occasions of measurement with a concomitant retardation in learning of the prescribed response class.

The delay of reinforcement dimension of variation fits in a rather special way the parabolic function mentioned earlier of increased response strength in the middle ranges and decreased response strength at the extremes. The case in point is traditional backward conditioning deriving originally from so-called "classical" conditioning in which the UCS or reinforcing stimulus is presented first, followed by the stimulus-to-be-conditioned. For instance the US is presented and then the buzzer or bell in the Pavlovian set-up. By the token of the previous discussion, it seems unlikely that much conditioning over and beyond operant level can be expected. Food presentation strengthens whatever behavior is ongoing at the time. This behavior may have little or nothing

to do with the response to be acquired and most likely is at least partially incompatible with it. Thus little acquisition is to be expected. In the instrumental layout such as the Skinner box when a light or buzzer follows food, it would seem to become a conditioned or discriminative stimulus for consummatory behavior rather than a signal for the occurrence of the behavior to be acquired of lever pressing.

Simultaneity of presentation of reinforcement and response occurrence constitutes a special case. The organism is called on to initiate the first links in the consummatory response chain as he begins the response that brings about the reinforcing stimulus. Some incompatibility is built in and some retardation in learning follows.

16. Amount of Reinforcement. The principle is well established that the larger the amount of the reinforcing stimulus that is presented, the more rapid the acquisition and the higher the level of post-learning performance. This principle, like the others cited, holds for a variety of organisms in many kinds of experimental settings.

There is a corrolary to this principle that leads into an explanation of why the amount of reinforcement variable has an impact on behavior. The corrolary reads: The more the consummatory response is involved, the faster the acquisition and the higher the lever of performance. The traditional experiment illustrating this point involves presentation of food as the reinforcing stimulus presented to deprived rats in one large amount or several smaller amounts equalling the one larger one. It can readily be seen that the intensity and frequency of

reaction to food, e.g., approach and grasping, is greater in the multi-piece situation. By this token, there is increased behavioral change from the instrumental response stimulus situation. As has been previously indicated, the more the stimulus situation changes and thereby, the more behavior is changed after the instrumental response is performed, the more effective the stimulus as a reinforcing agent. Another way to put it is the more the organism is removed from the previous situation, the more reinforcement is operating. The effect in the case of the consummatory response has not been thoroughly explored, but the evidence available is clearcut in suggesting that greater eating activity is associated with greater reinforcement as indicated by increased rate of acquisition.

17. Kind of Reinforcing Stimulus. The previous discussion leads nicely into a treatment of the qualitative characteristics of reinforcing stimuli. The basic principle is: The more a post-response stimulus changes behavior from what it has just been, the more effective it is as a reinforcing state of affairs. This point hinges on stimulus similarity and stimulus change. In essence, the more the stimulus situation is changed from that associated with the instrumental response, the more the behavior is correspondingly changed, and the greater the probability that the response will recur when the stimulus setting for the instrumental response is re-presented on some later occasion. Thus food presented after a bar press in the Skinner box constitutes a new and different stimulus situation, one setting the stage for eating, as

contrasted to the immediately preceding setting that was associated with lever depression. The rat, so to speak, is removed from the bar-pressing situation by the presentation of food and placed in the eating situation. The key points are the similarity between the stimuli associated with the post-instrumental response and those preceding it and the corresponding response similarity. The more stimulus change is operating, the more response variation is introduced and the more effective the reinforcement.

One other point needs emphasis, namely, focus on the response associated with the stimulus change called reinforcing. The response class must be clearly observed and recorded. The last, terminal or postreme response occurring just prior to the reinforcing stimulus is the key. It is the response class that is associatively conditioned to the stimuli present at the time it occurs with removal by stimulus change immediately following. A nice example is given in an experiment in which rats ran down a runway and were dropped through a trap door into a padded bucket in the last unit. If average curves are examined, little behavioral change is noted. If individual behavior was observed, a quite different state of affairs emerges. About half the rats were progressing forward when dropped and the other half had started to scramble back at the time of dropping. The individual rats continued to perform in a consistent manner. The forward-going rats ran faster and faster while the retreating rats showed an increase in avoidance and ran more and more slowly. Behavioral measurement must zero in on the terminal

response; it is crucial in indicating what portion of the response compound is operated on by the stimulus changes introduced to serve as removal or reinforcing stimuli.

Ligon's (1929) Ph.D. dissertation serves as a good illustration of these several points. At several deprivation levels, Ligon had groups of rats traverse a complex maze to an empty end box, another rat, a buzzer with auditory and vibratory characteristics, food and food plus buzz. Since these stimulus events are arranged in rough order of behavioral consequence, rate of learning should increase according to this "scale" of behavioral change. The prediction is borne out. All groups learned, with maximal learning occurring for the groups exposed to maximal stimulus change, i.e., food and food plus buzz.

Instances could be multiplied, e.g., rats learning to run to distinctive end boxes in the absence of experimentally induced deprivation and introduced drive-reducing agents, but the overall point is clear: A post-response stimulus is effective as a reinforcing agent, the more it changes the situation and thereby changes the ongoing behavior. This is the essence of the reinforcing process.

18. Schedule of Reinforcement. The facts of partial or intermittent reinforcement are so well known as to hardly need enumeration, but a brief treatment will be given. Partial reinforcement is defined as presentation of the reinforcing stimulus on less than 100% of the trials or responses of a given "learning" set-up. The upper limit is continuous reinforcement (100%) and the lower limit is 0% reinforcement

or extinction. The frequency of reinforcement can range anywhere between these limits. In the free-responding situation of the Skinner box, the schedule of reinforcement can be tied to either time or number of responses. In the trial imposed arrangement à la the T-unit or the maze, only the response ratio schedules apply. In both time and responses, the reinforcing stimulus can be applied regularly or irregularly, for example once every minute or on the average of once a minute or every 100 responses or on the average of once every 100 reactions.

The principles associated with the application of partial reinforcement are also clearcut: Across the board, less than 100% reinforcement leads to a slower rate of acquisition and a lower level of post-learning performance. At the same time, partial reinforcement generates increased resistance to extinction. Monotonic functions are involved. That is, the less frequent the reinforcement during conditioning, the slower the acquisition and the lower the level of performance. Conversely, the lower the frequency of reinforcement, the greater the resistance to extinction. The only exception is ratio reinforcement in conditioning where less frequent reinforcement brings about a higher level of performance in the free-responding instance. This is a special case where speed-ups in responding are differentially reinforced by bringing about reward sooner.

The increased resistance to extinction with decreased frequency of reinforcement in conditioning is clearly one of the parabolic cases cited at the outset. As frequency of reinforcement decreases, resistance

to extinction increases up to a point beyond which the latter decreases. This is saying nothing more than that, in the limiting case, frequency of reinforcement during acquisition can be so low that little response strength is acquired that can show up in extinction. It should be added however, that the more conditioning is made like extinction in terms of frequency of reward and responding, the longer behavior continues in extinction.

The switch from conditioning to extinction under partial reinforcement conditions can be thought of in discrimination terms. In the partial case, the discrimination between the presence and absence of reinforcement from conditioning to extinction is much more difficult than it is with 100% reinforcement. More broadly, generalization and generalization decrement apply in this case as in many others. One of the concomitants of reinforced responding in partially reinforced conditioning is responding in the absence of reinforcement so that there is greater carry-over or transfer in the partial than the 100% reinforcement case from conditioning to extinction. Conversely, in the 100% instance, there is marked cue change from acquisition to extinction and a corresponding behavioral decrement.

Across the board, while the extinction effects of non-reinforced responding under partial reinforcement retard acquisition, they make conditioning and extinction more similar, thus cutting back on cue change and increasing resistance to extinction.

19. Constancy and Variation in the Reinforcing Stimulus. The reinforcing stimulus is part of the gross compound involved in and associated with practically all conditioned reactions. By definition it is characterized by special operations and properties. For one thing it is presented after behavior has occurred; for another it is followed by an increase in strength in the response it follows. The question is, in other regards does it obey the same laws as other classes of stimulation? The answer is "yes", it does obey the same laws and follows the same principles that apply to the manipulation of other classes of stimulus events. There have actually been very few systematic exploration of variations in the properties of the reinforcing stimulus, except in the area of amount of reinforcement. For instance, changing from a larger amount of the reinforcing stimulus to a smaller bit generates decremental effects which confound change with the direct effects of lower responding associated with lesser amounts. When the change occurs from smaller to larger the direct incremental effect is pitted against the change, decremental one. Even in this instance there is a suggestion of a small initial decrement in response followed by the overriding incremental influence of increased amount of reward.

Overall, what incomplete evidence there is suggests that variations in the reinforcing stimulus produce the same kinds of behavioral changes as alterations in other aspects of the stimulus context.

20. Pre-Reinforcement and the Hors d'Oeurve Effect. Several investigations in the literature report incremental effects in behavior

as a function of pre-feeding and pre-watering organisms operating in experimental situations where these substances serve as reinforcing agents. For instance, after some degree of learning rats will run faster when given a bite of food prior to running a runway. The hors d'oeurve phenomenon seems to occur under conditions of massed trials or responses. Under these conditions one of the correlates after the first trial is the consequences of reward and the consummatory response. Bits of food may remain in the mouth, chewing may continue and the like when S is re-introduced into the start area for another run. Even more prominently, pigeons store food in their craw where it is chewed up by gravel in the absence of teeth. This situation may well provide a highly distinctive cue. The reinstatement of these cues at the end of the first trial or response helps complete the total stimulus compound and increase response strength on later trials. Since typically 23 hrs. elapses between sessions, the first trial or response has associated with it an incomplete stimulus compound, viz., the typical warm-up effect in the runway with slower running on the first trial. It might be added that with a large number of massed trials and a fairly large amount of the reinforcing stimulus applied prior to test, other cue changes such as increased body weight may well come into play to override the hors d'oeurve effect.

In any event, pre-feeding before intorduction into the experimental situation appears to operate by way of cue reinstatement to produce an increase in response strength. Again, the function relating

behavioral change to amount of pre-reinforcement is probably parabolic, with a behavioral peak in amounts corresponding to the amount of the reinforcing stimulus in the experimental set-up and a fall off in behavior on either side of this amount.

V. STRENGTHENING BEHAVIOR: SITUATIONAL AND TASK CHARACTERISTICS

While it is obvious that the reward cannot be separated from the response class to which it is applied and also obvious that both occur in a stimulus context, it is convenient to separate the three sources of principles for presentation purposes. It is not easy to say where one source ends and the next begins since S, R and reinforcement are defined in terms of the behavior of an organism. The ultimate focus is on the joint interaction of the situation, the organism and the reward, but certain principles apply to one over a broad range of variation of the others. The characteristics of the task *per se* and the features of the environment in which the task is embedded will concern us here.

21. Distribution of Practice. The overall principle is well established: The more trials or responses are spaced, the faster the learning and the unlearning. Putting it another way, the longer the interval between trials or responses, the faster the acquisition and the loss of behavior when the measure of learning is number of trials or responses to the specified criterion. Elapsed time is something else. Clearly, with one trial a day versus one a minute, elapsed time is greater in the former instance.

There is no disagreement regarding the influence of distribution of practice on initial learning. There is some quibbling about its effect on behavioral loss by way of extinction. It is a basic point since it is of considerable theoretical consequence whether extinction is a learning situation or not. If it is, distribution of practice should influence it in the same way it influences original acquisition. Considerable evidence has been accumulated that this situation prevails: Massed extinction produces increased resistance as contrasted with distributed extinction. Conversely, distribution of extinction practice facilitates loss of behavior. If one wishes to weaken a response in a hurry in terms of total number of trials or responses (not total time), the procedure to follow is distributed practice. Thus there is a clear communality between conditioning and extinction. Distribution of practice facilitates both original learning and eventual unlearning (extinction). The findings, of course, support the view that extinction is a learning process in which the old behavior does not simply fade away, but is replaced by new behavior.

22. The Number of Differential Cues. Learning is more rapid, the larger the number of cues provided for differential responding. This is not a matter simply of total number of cues provided. As Stevenson Smith pointed out 30 years ago (Guthrie, 1935) a man carrying a trunk on his back through a maze certainly is exposed to more cues than one who does not have the trunk, but there is no evidence he learns faster.

The point here is simply that the more information (environ-

mental cues) provided to S to discriminate between differential response classes, the faster he learns. The weight carried by the cues in contributing to discrimination formation is a matter for empirical determination. A rat provided a flashing light for right turns in a maze is likely to learn more rapidly than one not so "informed". Mild electric shock will serve the same function. If a human S is verbally cued in that every other turn in a maze is a left one, he need only determine the direction of the first turn and he's on his way.

There is an upper limit to the facilitative effects of differential cues. It seems quite obvious that . overwhelming S with large numbers of cues indicating differential responses may well lead to interfering and incompatible behavior, even immobility. Withing broad limits, however, the more differential cues provided for the selection of one response class rather than another, the more rapid the acquisition. The same point holds true for weakening behavior. The child learning a square-triangle discrimination is provided direct information that responding in the presence of one set of differential cues will be followed by reward while responding to the other set fails to produce the reinforcing stimulus.

23. Amount of Material. Fifty years ago Lyon (McGeoch and Irion, 1952) demonstrated that learning rate is a direct function of number of items to be mastered. The more the items, the slower the learning in terms of both total learning time and time per item. Number of items to be learned refers, of course, to the number of links in the

stimulus and/or response chain, e.g., number of stimulus and response terms in paired associate learning. This dimension of variation can be considered a straightforward case of quantitative variation in task difficulty or complexity.

24. Serial Position. A well-established principle in any learning situation where sequential responses are involved is that of the "primacy-finality" effect in which responses or items early and late in the series are learned most rapidly while those centrally located are acquired more slowly.

25. Difficulty. The qualitative dimensions of task difficulty are much harder to define than the quantitative ones. One of the characteristics involved is the amount of effort or magnitude of response required in a particular learning setting. This item is clearly apparent in verbal-type tasks such as problem solving. For instance, nonsense syllables of low association values require more learning trials than ones of higher association value. Similarly, verbal material with a high Flesch count or other index of verbal complexity yields slower learning than material assessed on these counts as less difficult. The ultimate criterion of difficulty lies in the number of trials or amount of time required to complete the response or the task or solve the problem. A simple example is found in a comparison of acquisition of lever-pressing in a Skinner box and the double alternation sequence of a Hunter temporal maze.

Difficulty appears to be something of a residue, a behavioral

left-over, after the effects of other dimensions of variation are partialled out. It can also be considered a combination of other basic dimensions. Infrequent, delayed small reward increases difficulty in the sense that learning is retarded in the presence of these conditions. It would simplify matters and create greater parsimony if the effects of difficulty could be experimentally accounted for by these other parameters.

26. Temperature. Many environmental conditions yield an optimal range within which response strength is maximal and outside of which it is reduced. Temperature is one such dimension of variation. The classic study was conducted by Hellmer (1943). The overall effects in his investigation were clear: Within the limits of temperature variation employed (55, 80, and 90 degrees Fahrenheit), learning was more rapid the lower the temperature. Three large groups of rats lived from weaning on, one in each of the temperatures. For maze learning, each of the three major groups was subdivided into three groups, with acquisition occurring in each of the temperatures for one-third of each group. In this three-by-three "simple" factorial, the effects can be tested of temperature of living quarters, of maze situation and the interaction or change in temperature from one to the other. All three sources of variation had a behavioral impact with the greatest behavioral change associated with temperature change, next with temperature of living quarters and finally with maze temperature. Both error and time scores in original learning and in relearning showed these effects. The same

principles emerged in a replication of the investigation with second-generation rats.

27. Oxygen. The difficulties of physical exertion at high altitudes where oxygen deprivation enters the picture are well established. The experimental evidence on O_2 deprivation is somewhat scanty, but the incomplete data suggest that, across the board, the more the O_2 supply deviates from that usually encountered, the greater the depression in response strength. Most of the research has concentrated on deprivation rather than enrichment. This case, like many others, fits the cue change paradigm.

28. Radiation. With the advent of nuclear warfare, the impact of radiation on behavior has become a popular topic. As expected, investigation in this area indicates retarded learning and performance with increased radiation before the point of physical injury is attained.

At this juncture it might be indicated that there are other task and situational dimensions and characteristics that have not been thoroughly explored from an experimental standpoint. These include such items as carbon dioxide, humidity, air pollution, barometric pressure, and, time of day of testing and its correlates. In the natural habitat such considerations enter as availability of food and water and the basic ecological safety features of the environment. In the laboratory, the living conditions of the rats, pigeons and dogs are major potential sources of behavioral variation as well as the maintenance and care of these organisms.

29. The Experimenter. E is a major source of behavioral variation in a wide variety of experimental settings. In addition to E's behavior toward S, appearance, sex, familiarity with S, "unconscious" cueing in of S on expected behavior, and the like, there are a number of more sweeping matters. It is difficult to completely automate most experimental situations so that E is involved in most to a greater or lesser extent. He can be a major source of constant as well as variable error in the behavior of the organisms under his experimental scrutiny. E in the laboratory has potentially the same large influence on the behavior of his Ss as the examiner in a clinical, diagnostic setting.

The entire conduct of an experiment - the design, selection of Ss and apparatus, handling of Ss, analysis of data and communication of findings - are extensions of E. It is immediately obvious that his past history and training as well as his current status can make a major contribution of experimental outcome. Other characteristics of E clearly make a difference such as his physical health (colds, drugs, etc.) and his psychological condition (high anxiety, depression, and the like). In addition, the extensions of E for presenting stimuli and recording behavior known as "apparatus" must meet the usual standards of objectivity, reproducibility, reliability and validity.

VI. STRENGTHENING BEHAVIOR: ORGANISMIC CHARACTERISTICS

As has been indicated previously, it is difficult to draw a line separating the task and environmental circumstances from the response

of the organism, the mechanism for recording it and the reinforcing stimulus applied after the behavior. For instance in applying guidance procedures such as leash-leading a rat through a maze, it is hard to say where the organism leaves off and the environment begins. In any event we shall consider parameters in this section that are usually accepted as primary variations associated directly with the S. There are a large number of these categories and only the main ones will be treated in this presentation.

30. Threshold and Stimulus Intensity. For every sensory modality and for every stimulus impinging on that modality, there is a lower limit of intensity beyond which a response does not occur, i.e., is no longer a stimulus. The usual operating definition of the absolute threshold pivots on the 50% point where the organism responds on 50% of the presentations and fails to respond the other 50%. The function relating stimulus intensity to behavior above absolute threshold is a parabolic one. Behavior strength is low at the extremes and high at middle intensities. A similar state of affairs exists with regard to the differential limen. Detectable differences - ones responded to - occur 50% of the time along the intensity dimension. The differential threshold, of course, pertains to dimensions of variation other than intensity, e.g., frequency of sound and light waves and qualitative characteristics such as shape.

The behavioral point is clear. To set the occasion for the occurrence of behavior it is essential for stimulus values to be fixed

well above absolute threshold. Further, if differential response is desired as in a discrimination set-up, the sets of stimuli must be separated by a number of jnds.

31. "Motivation". It is somewhat redundant to repeat previously treated material, but it seems worthwhile in this core area of theory and research. Most of the pertinent material has been covered in Section III, Principles of Inducing Behavior, particularly Principle 6, Deprivation; and Principle 12, Instructions (Verbal Cues). Here it was stated that these operations can be employed to facilitate acquisition, raise the level of performance and increase resistance to extinction.

In some instances, there seems to be a basic misunderstanding of the concept of "motivation", particularly in various human endeavors. It is sometimes attributed post facto to behavior that occurs frequently and/or regularly. But this is sheer redundancy, not explanation. To say a person is "motivated" to play tennis because he plays frequently adds nothing to a description of the behavior. The "why" of the matter goes far beyond simple description.

Another characteristic attributed as inherent to motivation by some writers is an "energizing" feature. This notion may well have arisen from tautological reasoning derived from the observation that rats deprived of food move about in the presence of novel cues and learn to locomote faster and faster in mazes and runways. But non-deprived rats do this too.

The behavioral facts are that certain operations such as food deprivation for infra-human organisms and verbal cues for human ones enhance acquisition and performance and retard loss in the specified behavior. To invoke a concept of "motivation" as a label for these methods is a moot point. The matter of "motivation" can be bandied back and forth like a seesaw, but the behavioral facts remain: Deprivation, verbal cues or other means can be used to increase response strength.

32. Current Status of the Organism. There are a number of characteristics of individual organisms that are variables with potential for interacting with experimental treatments and behavioral measurements unbeknownst to the investigator. It behooves him to consider their possible action. The main ones are as follows:

Species. Versatility of behavior increases with phylogenetic standing. The repertoire of man is larger than that of rat. Investigators need to pump the behavioral well dry for a given species, exhaustively examining its response supply.

Age. An asymmetrical parabola holds between age and behavior. At very young ages, response strength for most classes of behavior is at a low ebb. It rises to a maximum that continues through the middle years followed by a gradual, moderate decline late in life.

Sex. Outside of physical and physiological factors, there seems to be little long-range, large-scale difference in acquisition as a function of sex. Human females seem to mature more rapidly than males

in certain regards, e.g., verbal behavior in early life, but the differences are by no means big and wash out quickly.

Sub-Species or Race. With human organisms, no clearcut differences have been uncovered on the race variable per se. Sub-species differences do, however, emerge, e.g., hooded versus albino rats in visual ability. Behavioral genetics have recently pointed up strain differences in mode and rate of acquisition along with other behavioral dissimilarities based on genetic features of the organism.

Physical Condition. This variable can have a marked impact on behavior. Physical characteristics clearly limit behavioral performance. In addition, factors must be considered such as illness, brain damage, and other physical impairments, drugs, alcohol, sleep, exercise, diet, and the like. All of these potential variables can operate in some form to impede acquisition and lower the level of performance.

Behavioral Condition. The past history immediately prior to experimentation must be considered. Exposure to severe stresses and strains and to "anxiety" or fear provoking situations just prior to introduction into the experimental situation can well produce marked behavioral changes that interfere (or conceivable facilitate) behavior. In rats, exposure to noises, smoke and food odors and to special handling may well contribute in a distorting fashion to laboratory measurement. Human Ss may respond differently to the color cards on the Rorschach on a brightly foliaged fall day than in the dead of winter. The least investigators can do is standardize controllable conditions and report . . .

them. Ideally, experimental treatments with large effects will override the influence of these other sources of variation.

Special Human Features. The culture of the human organism leads to some specialized characteristics that should be enumerated as possible sources of variation in behavior. These include: education, religion, vocation, avocation, marital status, children, friends and relatives, income, cultural and constitutional heritage and background, socio-economic status, intellectual level and behavioral deviations ("mental" status). The conditions for the collection of information - be it interview or experiment - must, of course, be described in detail. With infra-human organisms it is typically difficult to obtain the data, but with human Ss it is helpful to know responses to standard stimuli such as people and the major features of everyday operant behavior such as eating, drinking and sleeping.

33. Past History. This major source of behavioral variation is primarily a matter of interaction, transfer and generalization to the extent that the experimental situation resembles in its stimulus and response features a previous situation in which S has behaved. The potential is clearly bidirectional; that is, the transfer can be either positive or negative, the experimental behavior can be facilitated or impeded. If the current experimental setting is similar to one encountered by the organism in the past and if the previous response differs from the required one, incompatibility exists and interference will ensue. On the other hand, if the two situations are grossly equivalent and if

the responses are also similar, facilitation will result.

There are many nuances and ramifications to the past history area. Rats constitute a major case in point since they contribute, as Ss, the data of well over half the published psychological experiments. In most instances little systematic information is collected or reported about the living quarters and their many characteristics such as noise, illumination, temperature, type and frequency of food, cage size and crowding, mechanisms for presenting food and water, and so forth. It hardly seems necessary to comment that such variegated, unknown past experiences provide a broad base for learning of behaviors that can have a most marked impact on the behavior of the experimental situation and that investigators are obligated to gather more information about their Ss along these lines and test their behavioral influence.

The problems are innumerable with regard to past history in human Ss as they relate to experimental behavior. They constitute a number of long-range experimental programs in their right. "Volunteer" college sophomores from introductory psychology courses are a special breed of organism and hardly constitute a sample - far less a random one - of anything.

A complete accounting of the past history of a human organism is obviously out of the question. Clearcut guidelines have been set (Pascal and Jenkins, 1961), however, for the types or classes of information to be gathered. These include the behaviors of the environment as stimuli toward S, particularly parents, siblings, grandparents, friends,

relatives and spouse. Other known stimulus categories cover school, job, sub-culture, physical environment and unavoidable illnesses and accidents. To complete the picture, responses to these large numbers of stimuli must be determined. Finally, operant behaviors toward people must be known along with everyday operant responses such as oral habits, sleeping, elimination, cleanliness, motility, health, social and conforming behavior, solitary behavior, alertness to environmental stimulation and level of responding and hobbies and avocations.

While no investigator will run the gamut of these behavioral measurements (unless he is studying them directly), it behooves Es to consider what portions of these behaviors might be pertinent in the selection of his Ss and to examine selected facets of Ss whose behavior deviates markedly from expectancy for his status, i.e., differs appreciably from his peers.

VII. PRINCIPLES OF WEAKENING BEHAVIOR

This section is concerned with principles for behavioral alteration defined in terms of retardation of acquisition, a lower level of post-learning performance and decreased resistance to extinction. The common thread running throughout this exposition is change. Whenever environmental change takes place a decrease in response strength occurs. For instance, changing the setting from trial to trial slows down acquisition of a response class. A similar variation after asymptotic performance is attained will also generate a lowered level of

response strength. Such alterations associated with extinction operations will facilitate loss of the origianlly learned behavior.

The format of this section is quite different from that dealing with strengthening behavior. In the current instance, it is more convenient to spell out the principles in terms of the basic methodologies that have been employed, i.e., removal of the reinforcing agent as in extinction and removal of deprivation ("motivation") as in satiation.

As a summary and to complete the picture, it seems profitable to present the other side of the coin first, i.e., the negative aspects or counterparts of the basic principles thus far presented that deal with the induction and strengthening of behavior.

As far as inducing behavior goes, the main point is not to provide the special cues that facilitate the occurrence of the specified behavior or to present them with variation so that the environmental context is continuously changing. In both instances, of course, the initial occurrence of the behavior is put off and acquisition, thereby, retarded.

On the reward side of strengthening behavior, the following points apply to weakening behavior:

a. Non-presentation or removal of the reinforcing agent slows down learning and/or speeds up extinction.

b. A decrease in the number of presentations of the rewarding stimulus leads to more rapid extinction.

c. A long time lag or delay between response and reward re-

tards acquisition.

d. Small amounts of reward lead to slower learning than large amounts.

e. Partial or intermittent reinforcement retards acquisition while 100% reinforcement facilitates extinction.

f. Stimuli presented as reinforcing after a response has occurred that produce only slight changes in the ongoing behavior retard acquisition.

g. Variations in the characteristics of the reinforcing stimulus, like other cue changes, slow down learning.

h. Once learning is underway, absence of pre-reinforcement produces less rapid learning than presentation of it.

As far as task characteristics are concerned the following principles for weakening behavior emerge:

i. Massed practice retards learning and extinction while distributed practice facilitates both.

j. A reduction in the number of differential external cues slows down learning.

k. A large number of items or responses or amount of material to be learned retards acquisition.

l. Items and responses imbedded in the middle of a series show retarded learning.

m. An increase in difficulty retards acquisition.

n. High temperatures slow down learning as does

o. Low oxygen content of the air.

p. Increased radiation leads to a retardation in acquisition.

q. Various variations in E such as his theoretical bias and treatment of Ss lead to slower acquisition.

On the matter of organism parameters, the following principles are relevant:

r. Presentation of stimuli near both the absolute and differential threshold leads to retarded learning.

s. A lower level of "motivation" - deprivation of substances or activities in infra-human organisms and absence of or distorted verbal cues for human ones - slows down the learning process.

t. A number of current-status characteristics of the organism contribute to slowed-down increments in behavior. S's physical and behavioral condition may be mentioned.

u. S's past history can contribute negatively on a large scale to current acquisition of new behavior. S may well bring a number of incompatible responses or habits to the experimental situation that transfer negatively to and interfere with the behavior to be acquired.

It might be noted in passing that investigators sometimes use these methods of weakening behavior as a temporary expedient to suppress a response class of considerable current strength so that some other class of behavior can emerge in relatively strong form and be treated with various strengthening procedures.

34. Extinction. The principle of extinction as a basic method of weakening behavior has been clearly implied and touched on in a number of instances, but needs explicit statement. After some conditioning has occurred, removal of the reinforcing agent for later behavior produces a decrement in the originally conditioned response class. After a period of interpolated inactivity in the experimental setting, some ("spontaneous") recovery occurs at the beginning of the next extinction session. This latter matter is treated in detail in Principle 5.

Extinction is a major case of cue change associated with behavioral (generalization) decrement. Removal of the stimulus support provided by the reinforcing agent is usually followed by an appreciable and rapid decline in the behavior, particularly where a 100% reinforcement schedule has been employed in conditioning. (An initial increment in response strength appears in some operant behaviors at the outset of extinction after 100% reward in conditioning.) The point has already been made in connection with Principle 18, Schedule of Reinforcement, that the more conditioning is made like extinction, the greater the resistance to extinction. Conversely, the more marked the difference between the conditions of acquisition and those of extinction, the more rapid the extinction. Removal of the reinforcing stimulus coupled with other changes in the environment and the organism will maximize rate of loss of the learned behavior.

35. Counter Conditioning. This interference procedure involves reward of a response incompatible with the originally learned one along

with extinction for the latter. It hinges on two variations in the reinforcement theme: Reward is switched from the original response to some other class that cannot occur simultaneously with the first one. It might be noted that the original behavior is weakened in extinction by the radical cue change of reward removal and is replaced by a new class of response events that are contiguously conditioned by the mere fact of their occurrence. Prolonged operant level determinations or "adaptation" periods may condition a response class such as sitting that is incompatible with the movements required in locomotion or bar pressing. Such a position, of course, rules out any recourse to a passive, adaptation decay position regarding the process of extinction or any form of behavioral change. It rather supports an active interference viewpoint.

A clear case of counter conditioning is found in the T-unit. The rat is trained, say, to go right for food. After an asymptote of responding is reached the reward is switched to the left arm of the T-unit. Thus the right going behavior is no longer supported by presentation of the reinforcing stimulus, the behavior weakens, left-going behavior emerges, is reinforced and strengthened.

Another clearcut case of building incompatible response classes emerges from the runway situation where the start and end boxes are employed interchangeably. In this instance, the rat has two incompatible responses conditoned to the box cues: To sit and to leave. With increasing numbers of presentations of the reinforcing stimulus, sitting

becomes prepotent and starting time lengthens.

As in extinction, counter conditioning is a basic instance of stimulus change: Removal of the reinforcing agent from the originally conditioned behavior and application of it to a new, incompatible response class.

36. "Forgetting", Retroactive and Proactive Interference. The "law of disuse" is in experimental disrepute. The evidence is quite clear that behavior does not die out or decay with the sheer passage of time. On the contrary, loss of behavior ("memory") appears to be an active process involving the introduction of interfering elements into a previously learned situation. In this presentation, "forgetting" will be made synonomous with and defined by the operations and findings of proactive and retroactive interference. In a broad sense these can be considered instances or special cases subsumed under the rubric of "counter conditioning".

To communicate the basic nature of retroactive and proactive interference (RI and PI), we need to look at the simplest version of the classical transfer of training design. In it two groups are pre-tested and post-tested with one group's being exposed to an interpolated treatment procedure. In proaction the focus is on forward interference; in RI it is on backward interference.

The overall statement may be made that loss of behavior commonly classified as "forgetting" comes about through the operation of proactive or retroactive interference. What this adds up to is that "for-

getting" consists of learning and/or performing new responses in the presence of the "old" stimuli that formerly brought about some incompatible response. The principle works both ways: Changing the stimulus changes behavior and alterations on the response side bring about conditioning of incompatible behaviors to common stimulus elements.

In this connection, the Skaggs-Robinson Hypothesis (McGeoch and Irion, 1952) should be mentioned. In the RI setting, it states that as dissimilarity of interpolated material increases, interference effects increase to a maximum and then decrease as dissimilarity is radically increased. It follows that retention of the original material is maximal when interpolated learning occurs with these same materials, retention decreases as dissimilarity creates competing responses and, finally, with maximal dissimilarity, little relationship exists between original and interpolated materials so interference effects are again minimal with an overall U-shaped or parabolic function's emerging.

In summary, in this setting, the method of maximizing retention is to have a period of inactivity such as sleep interpolated between original learning and relearning. Conversely, to maximize loss in retention, interference should be increased by training the organism in an incompatible response in the same or a related stimulus situation.

37. Response Prevention. This procedure may be considered a special case of indirect or "latent" extinction to be treated in the next section, but differs sufficiently to warrant separate presentation. In this case, a major portion of the stimulus compound is presented, but

response occurrence is blocked. For instance, in the Skinner box for rats, the lever might be locked in place so it can no longer be depressed. Or the door to the end box of a runway might be closed so that the rat can no longer enter it. The final test consists, of course, of releasing the manipulandum for the terminal response. It is a technique sometimes used in guidance experiments to expose organisms to the true path of the maze by blocking off the entrances to the cul-de-sacs. This procedure prevents entries into the blinds (incorrect responses) and requires the organism to follow the correct path or make the correct responses.

Response prevention involves direct extinction in that the reward is not presented since the organism is prevented from responding. The procedure involves occurrence of most of the members of the response chain except for the terminal and consummatory responses. In a final extinction test, when the operandum is released for action, the treated group exhibits an appreciable loss in behavior as contrasted with a non-treated control group. Such findings can be interpreted in terms of contiguous conditioning of incompatible responding during the response prevention period.

38. Indirect ("Latent") Extinction. There is nothing "latent" about "latent" extinction. The organism is presented with most of the cues for the conditioned response except for a key feature, usually the manipulandum. Thus in Skinner boxes for pigeons, the pecking window may be covered or the bar removed for rats. In runways, the rat may be

placed in the "goal" box without the occurrence of the running response that formerly led up to it. Or again in Skinner boxes a glass plate may be interposed between S and the manipulandum.

The design is obvious: One group is given greater or lesser amounts of exposure to the experimental setting without the response's occurrence; the control group is not so treated. In a final extinction test the manipulandum is made available to both groups.

The findings are clear: Exposing an organism to a situation while preventing occurrence of an originally learned response produces decrements in the behavior in the later test. It also holds that the more the exposure, the greater the decremental effects. In addition, the more the indirect extinction situation approximates the original learning situation, the greater the loss in behavior in the ultimate test.

Indirect extinction may be looked on as a form of counterconditioning in which incompatible responses are built up to the cues of the experimental setting during the treatment period. The response is prevented. By definition, the organism must perform some other class of behavior, e.g., sit, in the presence of a large portion of the originally conditioned stimulus compound. These new behavior classes, conditioned by reason of their occurrence, are the last responses to occur prior to testing, have some likelihood of occurring during the test and interfere with the occurrence of the originally learned response class thereby reducing its strength in the test situation.

Again, it should be indicated that indirect extinction, like the other procedures cited, is basically a matter of cue change. In this instance the situation is held as constant as possible except for the introduction of response prevention.

39. Crowding the Threshold. This phrase, coined by Guthrie (1935), refers to moving in on an established response by such gradual stimulus degrees that the response threshold is not crossed until, eventually, a new class of behavior replaces the old one. A paradigm for this "toleration" procedure is found in psychotherapy where the therapist "talks around" the topic that triggers off a high-anxiety reaction without introducing the cues that actually bring about the reaction. The initial step is to so change the cues that the original reaction fails to occur. This phase is followed by introduction of cues that come closer and closer to those that set the stage for the response, at the same time shaping up the behavior so that the original response does not occur. By definition, some other behavior must appear. By this gradual approximation process, the original cue situation is moved in on and new behavior conditioned to it that is incompatible with and replaces the old behavior.

The classic studies in the use of the crowding-the-threshold technique are those of Watson and Rayner (1920) and Mary Cover Jones (1924) as reported in Watson (1924). In both, young children were exposed to furry animals that initially or by conditioning evoked a "fear" reaction such as crying. The animal was then "moved in" on the child

while it was engaged in other activities until the fear reactions dissipated and were replaced by approach behavior.

The principle of crowding the threshold can be stated: Removing the stimuli for a response class and then reintroducing them so gradually that the response rarely or never occurs results in a marked dimunition in behavior in a later extinction test. The degree of loss in behavior is a function of the duration of the crowding treatment and the gradualness of it as reflected by the amount of behavior that occurs during the treatment. The limiting case is elimination of the behavior.

40. Satiation. "Motivation" was treated in Principle 31; and Deprivation in Principle 6. Here we are concerned with removal of deprivations such as "hunger" and thereby removal, at least in part, of the action of reinforcing agents such as food. The elimination of "motivation" in human organisms when it is not of the deprivation variety appears to be a somewhat more complex matter involving manipulation of verbal stimulation. Certain features of the experimental setting can be varied for human Ss by way of verbal cues, but whether these matters fit the "motivation" mold is a definitional question.

In any event, the basic deprivation operation involving substances or activities can be subjected to a satiation procedure. In it the appropriate ("reinforcing") stimulus is presented for each conditioned response over a prolonged series (or in large quantities prior to testing). The response shows ultimately a progressive decline in strength to a low or zero level. Interpolation of another deprivation

period results in a large-scale recovery of response strength. The repeated elicitation aspect of this procedure makes it very like the operations defining "fatigue" but the latter involves accumulation of special chemical substances in the muscles. In addition, the recovery from satiation bears a resemblence to "spontaneous" recovery following a rest pause after extinction.

Satiation may well involve long-range effects. The basic cue change operation involved in satiation based on the food-deprivation operation involves a change in the physical characteristics of the organism, e.g., a change in body weight. A period of interpolated non-feeding allows body weight to return to its original level so that cue reinstatement is featured. In the case of the human organism, such as a child repeatedly striking matches, opportunity is allowed for conditioning of incompatible behavior (non-match striking) and if this latter response class is reinforced we have a case of counter conditioning and behavioral replacement. A similar situation exists with the rat in the Skinner box. Other forms of reinforcement can be applied to sitting behavior (such as hand removal) in the presence of the former cues for bar-pressing after some degree of deprivation change has been introduced. In the latter rat case as contrasted with the child example, the deprivation operations ("drive") are known. It is trite to point out that much human behavior occurs in the absence of identifiable deprivation.

41. Fatigue. The previous discussion of satiation slides over nicely into this topic. Both fatigue and satiation involve repeated,

massed elicitation of behavior with an ultimate decline in response strength to a low level. There are two basic differences, however. Fatigue involves accumulation of chemical substances in the skeletal musculature, satiation does not. Also, satiation, at least in the food deprivation instance, involves a measurable change in body weight not found in fatigue.

Although relatively "effortless" responses such as the ballistic-type movement involved in pecking in the pigeon show fatigue effects, some magnitude of effort is usually considered a basic parameter of fatigue. All other things equal, the greater the effort called for in a response, the sooner the decremental effects of fatigue set in. In the limiting case of prolonged severe effort, response strength reaches zero. Interpolation of a rest pause reinstates the response. Clearly cue change and counter conditioning are involved in this procedure.

42. Punishment. This term has many definitions, complications and ambiguities. At the core, the problem is not complicated, but an overlay is involved that confuses several issues. A punishing stimulus is one that when applied following a response, produces a decrement in that response. Part of the complication arises because a punishing stimulus can serve as a positive reinforcer as in escape and avoidance training. Punishment in a very real sense is the other side of the coin from reinforcement. A punishing stimulus brings about antagonistic behavior to the response that produced it. Where reinforcement serves to place the organism in a new situation, punishment acts to produce an incompat-

ible response. The rat that is shocked through the paws when pressing the lever in a Skinner box, jumps back from the lever. The last response - and the one conditioned - is withdrawal, not approach. As with reinforcement, punishment is measured by behavioral change on a later occasion, in this instance an increase in withdrawal and a decrease in approach.

Another complication in punishment is the appearance of recovery effects as shown in Estes' classic study (1944). Punishment operates to suppress behavior as long as it is applied. When the punishing stimulus is turned off, a marked increment in responding occurs so great in the case of a small number of mild punishments, that full response strength is recovered.

The behavioral facts of punishment, despite these complications, are clear. A punishing stimulus operates to suppress the behavior to which it is applied and thereby offers an opportunity for other classes of behavior to be conditioned to the stimulus setting in which the punishment was applied. Also, punishment is followed by withdrawal behavior toward the situation and the punishing agent. Finally, cessation of the punishing stimulus is followed by a greater or lesser recovery of the original behavior depending on such parameters as number, duration and intensity of the punishing stimulus.

In brief, application of a punishing stimulus to suppress behavior is an effective method of holding one response class down in strength so that other classes can increase in relative strength and be

positively reinforced. The negative consequences of punishment pivot around teaching the organism to avoid the source of punishment.

43. The Combined Use of Reward and Punishment. The previous discussion leads directly into this topic. The level of responding and rate of learning can be adjusted by the joint application of a reinforcing and a punishing stimulus. They are clearly a function of the degree of reward and punishment involved. If the frequency of application of the reinforcing stimulus is high relative to the use of the punishing stimulus, the rate of learning will be more rapid and the final level of responding higher than when the relative frequencies are reversed with application of the punishing stimulus prevailing. Obviously such parameters as amount of reinforcement and intensity of punishment are factors that must be taken into consideration.

Conflict behavior. The underlying process in the instance just cited involves the conditioning of incompatible response classes to the same stimulus situation. Approach and performance of the instrumental response required is supported by the positive reinforcer while withdrawal and avoidance are conditioned by the action of the punishing agent or negative reinforcer. The operations involved are somewhat different from those employed in standard approach-avoidance conflict set-ups. In the latter case, approach behavior as in a runway is first established followed by conditioning of avoidance behavior to set up the conflict. In the other instance cited at the outset, reward and punishment are intermingeled on a temporal and/or spatial basis and arranged

so that a final level of stabilized responding is attained. Responding under an APR schedule may be stabilized at 50% of its ad lib value by application of occasional shocks on an irregular schedule of some specified frequency, intensity and duration. The parallel case in the runway involves stabilizing the running response asymptotically and interspersing punishment trials so that running time stabilizes at a higher value. The behavioral consequences of this procedure as contrasted with the successive ones are obvious. In the latter instance the last response conditioned is the withdrawal and avoidance associated with the punishing stimulus. In such instances as Miller's studies of "displacement" (1948) based on approach-avoidance conflict it behooves the investigator to consider this point. Cue change weakens the last response conditioned to a stimulus complex. If the last response is approach, it is weakened and its mutually exclusive partner withdrawal is strengthened. On the other hand, if the postreme response is withdrawal, then cue change weakens it and thereby relatively strengthens approach behavior. Various studies of the "displacement" phenomenon can be reinterpreted in these terms with the key point being the last response class conditioned to the situation and the impact of cue charge on it.

44. "Stress" and Emotional Stimulation. While this topic has been touched on in Principle 32, Current Status of the Organism, it needs elaboration in the present context of weakening behavior. Matters of emotion and stress are usually thought of as disruptive to behavior, as

interfering with the ongoing behavioral process. "Emotion" to many writers has reference to a state of the organism, but can be treated in terms of stimulus and response events external to it. Stress is typically conceived as a marked departure from usual stimulation in the direction of an increase. Emotional behavior then becomes a set of reactions to a marked increase in stimulation or stress. But this is only part of the picture. Any marked deviation from usual stimulation - a decrease as well as an increase - can bring about the unusual behavior labelled "emotional". Removal of stimulation brings about a decrement in behavior and thereby relative strengthening of some other behavior class just as does addition of stimulation. The rat introduced into the unfamiliar situation of the open field crouches and freezes. This is not necessarily a matter of increased stimulation, but rather one of change in stimulation.

By this token stress and emotion are strictly reducible to matters of cue change and corresponding behavioral alteration. Their only special feature is that they are characterized by extremeness. That is, the stimuli are exceedingly intense and so is the behavior associated with them. Or the stimulation is rare and infrequently encountered. The organism has few responses in his repertoire to handle the unusual stimulation and even less cues never previously faced. The result is radically different behavior. Thus cue change and response variation are involved, but on an exaggerated, large scale with frequency and intensity constituting the major parameters.

45. Combinations of Principles for Weakening Behavior. It has been stated and implied in Principles 34 through 44 and in the counterparts to strengthening behavior, that combinations of various kinds can and are employed for weakening established behavior. Some of the most common and obvious ones may be listed as follows:

a. Counter conditioning combined with extinction where the application of the reinforcing stimulus is switched from the originally conditioned behavior to a new, incompatible class.

b. The joint application of reward and punishment to establish a performance level below that for reward alone and above that for punishment by itself or to create an approach-avoidance conflict situation.

c. Satiation and extinction fit nicely together in that an organism deprived of deprivation does not respond to the substance or activity appropriate to the former deprivation.

d. Response prevention, indirect extinction and crowding the threshold all involve a form of partial extinction in that the organism is exposed to a major portion of the conditioned stimulus compound in such a fashion that the response cannot occur.

e. Fatigue and satiation both involve extinction in that ultimately the response drops to zero so that reinforcement is no longer forthcoming. In addition, an opportunity is offered in both cases for the action of counter conditioning in the sense that the organism in the limiting case is performing some response, usually incompatible with

the one originally conditioned.

f. Retroactive and Proactive Interference are both cases of direct counterconditioning involving the acquisition of a new incompatible response class.

g. Punishment and extinction can be jointly applied to weaken a previously conditioned response while counter conditioning can "simultaneously" be applied to a new, incompatible piece of behavior.

Various other joint operations of these principles and procedures can be employed to weaken behavior.

46. Cue Change. The common thread running through all the principles and procedures for weakening behavior is cue change and its correlate or invariant covariant, response variation. It has been played up at a number of places in this presentation and hardly needs to be elaborated here. The basic operation characterizing all methods of weakening behavior is alteration in the stimulus situation to which the organism has been previously conditioned. The cue change is sometimes obvious as in extinction where the formerly reinforcing stimulus is simply omitted or as in response prevention where the manipulandum or operandum is simply withdrawn from the situation. Or the action of cue change may be more indirect and subtle as in the role of the terminal or postreme response in punishment or approach-avoidance conflict.

Cue change is ubiquitous and pervasive. It is probably the core principle of all behavioral change. Even reinforcement is subsumed under it in the descriptive sense that presentation of a reinforcing stimulus, by definition, induces new and different behavior and thereby re-

moves the organism from the original situation and places it in a new one. Matters of threshold, stimulus definition and refractory phase can also be handled in terms of the principle of cue change. Instances could be multiplied, but these should suffice. The behavioral facts are paramount: Where stimulus change occurs, response variation follows and where behavioral alteration has occurred, stimulus variation is involved.

VIII. METHODOLOGICAL PRINCIPLES

There are certain behaviors emitted by experimenters that need consideration. These, in addition to the ones treated under Principle 29, The Experimenter, are essential ingredients of research. Here we will treat, not the specific behavioral details of experimental conduct, but rather certain overall matters common to a wide variety of experiments.

47. The Criterion. At some point in the progress of experimentation, E must fix a termination point. This matter is usually treated in the context of acquisition, but applies equally to post-learning performance and the various methods of weakening established behavior. The main issue is to obtain a large enough sample of behavior so that the effects of the experimental treatment can be reflected. Too small a sample cannot only make the situation insensitive to the treatment, but even distort its effects. For example, early in extinction after partial and 100% reinforcement in conditioning, response strength higher for the former 100% group than the partially reinforced condition. To terminate extinction at this point and draw conclusions is highly misleading and

even erroneous. Continuation of extinction produces a cross-over in the two sets of extinction behavior with the partially reinforced group continuing to respond long after the 100% case has stopped. Using a brief sample of extinction behavior or a foreshortened criterion of non-response (say one min.) badly distorts the outcome of the experimental treatment in the long pull. This is not denying the experimental facts. In many instances more responses emerge initially after 100% reinforcement than after partial, but in the long run, partial generates many more.

The overall rule of thumb amounts to this: It is better - whether in acquisition, performance or the weakening phase - to accumulate too large a sample of behavior. After all, one can always cut back. But if the experiment is terminated too soon, there is no way of retrieving the later, lost behavior.

48. The Measure of Behavior. All behavior is measured in terms of one or more of the following: Frequency, rate, latency, duration, magnitude, amount, variety, direction and correctness along with a specification of the stimulus conditions in which the behavior is measured. Over and beyond tradition, E has an obligation to check his response class and its associated measure to insure that he has maximized the opportunity for the experimental treatment to show its effects. Selection of an inappropriate response class or a measure not applicable to that class can not only distort findings and prevent differences from emerging, but can lead to a complete misrepresentation of the underlying

principle. It behooves investigators to consider this matter carefully. It includes, of course, the obvious parameters of measurement such as characteristics of the apparatus and the organism studied.

49. The Experimental Treatment. There are clearly no principles for specifying problem significance on an a priori basis although reference to theoretical considerations and hiatuses in the body of knowledge help as rough guidelines. In the selection of values of the experimental treatment, there is a clear principle. The investigator must determine at least in crude fashion, the upper and lower behavioral limits of his experimental dimension. Within these limits he should select enough points so that a behavioral function (if one emerges) can be plotted showing the covariation between his treatment and his response class. Furthermore, it follows that the values of his treatment should be spread out over the range and not bunched up at any one point unless the latter is of special experimental or theoretical interest.

50. Statistical Treatment of Behavioral Outcomes. This is a subject on which one can become endlessly heubristic and windily sophistic. It is really a quite simple matter. Analysis of data must clarify, summarize and reflect the behavioral trends that occurred. If statistical procedures do not do this, they are more than useless. When the outcome of statistical analysis adds to or subtracts from the numbers that represent the behavior, they mislead and distort. Caveat emptor is the key phrase for statistics. Investigators are obligated to follow the behavioral trends of their data, inspect them visually, and select the

simplest and most direct statistical procedures for demonstrating the behavioral changes apparent to the naked eye. Statistics are not a first order of business. They are quite secondary. Their form and mode is exactly set by the nature of the experimental design and the behavior of the organisms involved. Nothing else is necessary. Statistics cannot refine and improve data; at best they can clarify behavior, at worst throw it completely out of focus.

IX. FINALE

An attempt has been made to present an overview of the major principles available for the prediction and control of the behavior of individual, intact organisms across species. The coverage is by no means complete; only the highlights have been touched on. A selection bias is clearly apparent. For example, little has been made of sensory or physiological psychology. The presentation has been restricted to principles that change behavior on a large scale where both the stimulus variations and response measurements occur and are visible without elaborate instrumentation outside and beyond the body surface of the organism.

Except in the instance of Weakening Behavior, little reference has been made to the joint action of the principles. It is clear that a combination of methods and principles for strengthening behavior will maximize response strength. For instance, if one wishes to expedite acquisition, the stimulus situation should be held constant, reward applied with little delay for each and every response, in large amounts and

of a variety that radically changes the stimulus situation and the response to it so as to thoroughly remove the organism from the original cue context thereby leaving the association intact between it and its correlated response. Related points come immediately to hand.

A final word of caution is needed. Whether in the laboratory, the nursery or the classroom a great deal of patience and a fair amount of care is required to insure the workings of these principles. They are not matters for slipshod, casual or superficial try-out. But they will usually work anyway.

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