trive a superior mechanism? The lesson for the present seems clear: *The germ plasm can be injured; some phases of the present man-made environment seem to enhance such injury.* Are the ablest the strongest, the wisest men merely grave-diggers in disguise? Is it possible to detect the factors and abort the danger so that man himself may not deflect or impede the river of life?

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A REVISION OF THE FUNDAMENTAL LAW OF HABIT FORMATION[1]

THE principles of learning, or habit formation, as they are taught by contemporary psychologists, include as fundamental the principles of recency and frequency. It is true that there are considerable differences in the relative emphasis placed on these principles by different authors—few, for example, going as far as Watson and the present writer have gone in the past in the ascription of importance to frequency. Nevertheless, the importance of these factors has been emphasized by almost all contemporary psychologists (with the possible exception of Carr), who seem to have assumed that they are of some positive value in the fixation of a response into a habit.

Behind these principles, however, there is a more fundamental assumption, which was sharply indicated by William James, but which has seemed too obvious to need statement by those of us who have nevertheless continued in the Jimmian philosophy. This assumption is as follows: *A response* (that is, even a single response) *to a given stimulus pattern definitely increases the probability that on the reoccurrence of the same, or substantially the same, stimulus pattern, the same, or approximately the same, response will occur.* This principle I shall call the *alpha-postulate* of learning.

That this principle underlies the "law of frequency" is obvious, for if one response had no positive effect, then the summation of an indefinite number would have no effect, the sum of zeros being zero. The pictorial statement of this assumption is to be found in the formulations of the old "brain path" superstition, with its analogies to the flow of water eroding a channel, the fold in a coat sleeve, etc.

It has not been denied by any one, so far as I know, that the positive effects of repetition might not be neutralized by other factors, nor that certain other factors may be, in some cases at least, more potent positively. But running through all our disquisitions on learning has been the implication that repetition itself, aside from other factors, has a positive effect; and in our practical work with adjustment cases, this implication has always been respected.

For nearly twenty-five years the present writer has been teaching, explicitly and implicitly, this orthodox doctrine, and attempting to fit the facts somehow to the theory. Even the contradictory results of the Pavlovians failed to shake his faith, because obviously (at least, so far as references in English indicate) neither Pavloff nor his students have ever performed the critical experiment of feeding the dog by stomach injection, without odor or other "conditioning" stimulation, during the period during which the newly formed associative response ("conditioned response") is being tested. The Russian work on this particular point (of the effect of repetition) is therefore beside the mark, and did not even suggest to the present writer a revision of the laws of learning. Psychologists, in fact, have long been acquainted with cases in which habit-tendency disappears in spite of repetition of the stimulus, and this phenomenon has offered no difficulties to the orthodox theory.

The cumulative effect of the difficulty of fitting facts to the theory, however, has, although no longer ago than last summer, suggested that it would be much simpler to fit the theory to the facts. It has seemed well, therefore, to question the fundamental assumption on which we have proceeded.

If we no longer take the assumption of the positive effect of response as a divinely revealed truth, but as a mere postulate, it is at once seen that there are two other postulates possible. One of these, the *beta-postulate,* as I shall call it, is that response, in itself, has *no* effect on the future probability of the same stimulus pattern producing the same response; the other, the *gamma-postulate,* is that response *decreases* the probability. Although the latter of these postulates is more consonant with our present-day neurological theories, and, as I shall show later, has interesting applications to a difficult psychological problem, a certain conservatism, which I think is intelligent, leads me to consider seriously the beta-postulate first.

If "repetition" has in itself no effect, but is important merely in that through it certain positive factors have their chance to operate, then it at once becomes a live possibility that negative factors also may be allowed to operate through repetition. Thus would be explained the apparent "neutralizing" of the effects of repetition, not as actual neutralization in this sense, but as either the operation of negative factors in the absence of positive, or the prevalence of the negative over the positive.[2]

[1] Read before the Section on Psychology, the American Association for the Advancement of Science, Nashville, December 27, 1928.

[2] I am informed by Dr. T. V. Moore that Thomas Aquinas enunciated this doctrine. I should certainly feel honored if I am in any wise treading in the footsteps of the *Doctor Universalis.*

The deductions from our postulate are still more interesting. If the negative factors, those which decrease the probability of the recurrence of the response, can be discovered, repetition may be used practically for the abolition of a habit already formed. This is, I think, a new idea, and worth trying, even aside from the possible light the results may throw on our postulate. Can we, for example, cure stammering, through causing the patient to stammer voluntarily in as nearly as possible the same way in which he ordinarily stammers? Can we abolish tics through causing the tic to occur? If so, we should have a method of "catharsis" of enormous value, and the method should be applicable to a host of minor defects of response and conduct, as well as to such major troubles.

The first question which arises is as to the negative factors which may be called into operation. Consideration of the experimental techniques such as dart-throwing and other practice work which had led to my scepticism concerning the orthodox postulate brought out conventional factors of *"interest," "anticipatory idea,"*[3] and *satisfaction.* It seemed useful, therefore, to proceed tentatively on the assumption that the satisfaction of abolishing an annoying process (and perhaps the futuric interest and expectation of such satisfaction), together with the expectation of attaining an end definitely thought of (anticipatory idea), and, where possible, the desire of this end, would be useful negating factors, and to see what could be done with the aid of these.

The first opportunity which occurred for the testing of this method lay in an idiosyncrasy of my own in typewriting. For some years I have been annoyed, when typing rapidly, by an occasional transposition of the letters of a word, the word "the" being especially troublesome, so that in reading over a manuscript of my own typing I would sometimes find two, three or more of these transpositions into "hte." Several times I have attempted, by careful practice, to train myself out of the habit. The fact that in the majority of cases I actually wrote "the," exchanging it for "hte" only in a minority of cases and when typing rapidly, in itself indicates the futility of increased repetition of the "right" spelling.

On the basis of the neutral postulate, I now proceeded to try the typing of "hte" voluntarily, as a means of destroying it. I set to work deliberately and wrote about a half page, single spaced, of the "hte" combination, with the futuric thought that this was a "word" that I would *not* write in the future (unless deliberately and voluntarily). Somewhat over a week later, I followed this with a second "practice period," writing less than a third of a page. This was over three months ago. Since that time I have typed many pages, some rapidly, but have not found on reading them over a single case of "hte"! This may sound too easy to be true, but as a matter of fact a long-standing and troublesome habit has disappeared.

Having just changed from driving a Ford to operating a gear-shift car, certain minor vices of technique, such as a tendency to step on the accelerator, when meaning to apply the brake, manifested themselves. The application of the catharsis method seems to have overcome these faults very quickly. Such trials on myself have, of course, no scientific value, but served merely as encouragement in the application to more critical cases.

The application of the method to speech defects offers an interesting field. In the case of stammerers, the vital point of proceeding here is to study the specific type of stammering and then induce the patient to reproduce voluntarily his characteristic verbal performance, criticizing and assisting him until his voluntary stammering is as nearly as possible like his involuntary. From that point on, the technique is complicated, and we do not expect to have it perfected until many cases have been experimentally subjected to it. In the meantime, the results even with the crude preliminary method are very favorable.

Tics offer another interesting field of application, where methods are being developed. Thumb-sucking and similar wrong habits of two or three year old children have been treated with results that apparently show that the method is useful at these ages, where I feared it could not be applied. There are many other directions of application, such as bed-wetting and masturbation, where the method can probably be applied as soon as the technique is better developed. It has already been applied to a case of homosexuality, with astonishingly rapid results. It is hard to set the limits of possible application, and from present indications a vast number of hitherto insoluble problems may be solved in this way.

So far, in all applications, we have assumed the importance of anticipatory ideas and desire as elementary factors. The patients are (1) selected on the basis of their desiring, for one reason or another, to cure the habit, and (2) are carefully instructed that the voluntary performance, under the experimenter's control, is something which will assist in the abolition of the behavior at other times.

One of the most important applications of the new postulate, and one of its most interesting points theoretically, is in the explanation of dreams. So

[3] I can't well use the term "purpose" in this connection, because "purpose" has been given an anti-mechanistic, *i.e.*, mystical, interpretation, and I wish to discuss and investigate this problem on the plane of strict mechanism.

far, dreaming has been assumed to be a pathological function, although of minor importance in most cases, or else has been assumed to be a mere by-product of mental life, in itself of no value. It has long seemed to me, however, that the development and retention of function, generation after generation, indicates a strong probability that the function is not pathological, but has some important value for practical life. The difficulty has been in discovering the practical value of dreams.

As soon as we reject the old alpha-postulate of learning, however, and assume either the beta-postulate or the gamma-postulate, the function of the dream becomes apparent. The dream is a process of eliminating, or "forgetting," details of mental performance which it is useful to take out of the habit-systems, either because of their irrelevancy, or perhaps because of their interference with orderly mental life. The importance of forgetting as compared with remembering, or, in a more comprehensive way, of elimination of habit tendencies, as compared with their fixation and retention, has long been recognized. The greater part of daily experience must be forgotten, and removed from the danger of associative recall, if the remaining small parts of the experiences are to be effectively utilized. The greater part of our daily activities of all sorts, also, must be prevented from becoming response habits. Ideational retention, that is, the tendency to reproduce in thought the contents of preceding perception and thoughts, is of especial importance. If one should retain, subject to complete recall, all the experiences of a single day, his mental efficiency would be sadly reduced thereby. One aspect of this incompetence is nicely portrayed by James in his account of "total redintegration," characteristic of many women and some men.

Many experiences, we may well assume (if we reject the alpha-postulate), leave no tendencies to recall, or towards partial recall which would interfere with other processes. Others, however, because of the operation of favorable fixation factors, tend to persist, and require some help in their elimination.

The known peculiarities of dreams fit in very well with this hypothesis, and with general suspicions regarding important fixation-factors. Dreams are most characteristically about trivial and unimportant matters—just the sort of things which need to be eliminated. In other cases, they are reproductions of emotionally stressed factors of working life, which especially need elimination. In many of these cases, it is obvious that an unsuccessful effort is being made to eliminate, and this effort may be repeated in many successive dreams. It is to be expected, too, that not only will repetition fail to eliminate in some cases, but that even the repetitive process will itself partially fail, and the dream be composed of factors associated with the factors which ought to be eliminated, rather than of those factors themselves. The importance of the problem of *improving* dreams, of making dreams more effective and of the *production* of dreams to assist in eliminating disturbing factors of daily life is at once seen. Much research needs to be done here. As I have earlier pointed out, dreams consist mainly of, or center about, experiences in which a futuric factor has been a feature. That is to say, anticipatory ideas, centered often in hopes, fears, expectations and desires, are the chief causal factors in dreams. This agrees with the supposition, made on other grounds, that an important fixation factor in habit formation is expectation, or anticipatory ideas of the result to be obtained.

In considering the dream situation, one might perhaps incline to the adoption of the gamma-hypothesis instead of the beta-hypothesis, were it not for the consideration that even here it is not, as yet, necessary to make the assumption that repetition has, in itself, an eliminative effect. All we need to assume, for the present, is that conditions are favorable, during sleep, for the operation of eliminative factors, whatever these may be. If, later, we have to assume that repetition itself is the factor, that is a matter to be faced then. For the present, we may follow the principle of parsimony, and make the simpler assumption; namely, the beta-postulate.

The same consideration appears in the problem of the ancient confessional as utilized in the "psychoanalytic" method. The expression of troublesome thoughts need not be assumed to be cathartic in itself; the conditions of the confessional may introduce eliminative factors which are not operative in other phases of the patient's repetitions. Many other factors need to be investigated in these cases, including the relation of speech formulation in processes which have previously been internal (cerebro-cerebellar, according to my own hypotheses).

In conclusion, it may be pointed out that the successful eventuation of methods of therapy deduced from the beta-postulate do not prove the final truth of the postulate. But its value is certainly demonstrated by the practical benefits derived from these deductions.

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WITH the death of Henri Bosmans, of the Jesuit College of Saint-Michel, at Brussels, there passed away one of the most active men of the present century in the field of the history of mathematics. Bosmans died on February 3 of the present year, at the