

COMPLETENESS OF RESPONSE AS AN EXPLANATION PRINCIPLE IN LEARNING

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Though in more or less agreement with the recent discussions on the subject of selection principles in learning by Carr¹ and Watson,² the writer is of the opinion that an important principle or consideration is omitted in both discussions. It is to be noted that neither of these writers has made any claim to an attempt at completeness in his suggested explanations. Watson omits the factor of intensity and associates 'the process of substitution' with recency and repetition, though in a manner that hardly makes it coördinate with the latter factors.³ He also mentions, without making further use of them, certain other factors, all of which are included with substitution in the principle here suggested by the writer. "Unquestionably," Watson says, "the principles of reënforcement, inhibition, and summation of stimuli are constantly operative. When the separate stages of habit have been more carefully analyzed we can more readily see how such factors operate in detail."⁴

Some years ago the writer attempted an explanation (unpublished) of the 'stamping-in-process' of successful acts on the principle of frequency in about the manner suggested by Stevenson Smith,⁵ whose article he had not at the time seen. While the frequency factor, or principle, cannot cover every case of learning, and in itself is probably insufficient in any one case, its *modus operandi* has been indicated in a

¹ Carr, H. A., 'Principles of Selection in Animal Learning,' *Psych. Rev.*, 1914, XXI.

² Watson, J. B., 'Behavior: An Introduction to Comparative Psychology,' 1914, Ch. 7.

³ *Ibid.*, pp. 272 ff.

⁴ *Ibid.*, pp. 275, 276.

⁵ *Jour. Comp. Neur. and Psych.*, 1908, 18.

general way by Carr and Watson. Professor Meyer has attempted a mechanical statement¹ of what may conceivably go on in the nervous system in the learning act.

The value of the factors of recency and (especially) intensity can be adequately stated, it appears to the writer, only in the case of the joint action of a number of tracts; not in terms of any one single neural tract. There is no question that many of our attempted neural explanations involving one arc, or at best a few neural arcs, are altogether too simple adequately to explain in such physical terms as we desire how one act can survive over the other more or less random acts because of its greater success in meeting the needs of the organism. Even in the simplest act involving so-called conscious control numerous neural tracts are called into play, varying in degree of directness or indirectness of connection with the muscles immediately concerned in the act. Professor Meyer's explanations are suggestive in this regard, but not of much use as they are based on analogies chosen from mechanical structures which make experimental application to behavior phenomena difficult. In a complex condition such as we actually find in the nervous and muscular systems, where various more or less related acts are involved in each reaction, some of these acts may be of an inhibitory nature to others under certain circumstances, while occasionally under other conditions all may tend rather positively to aid or strengthen one another. These mutually inhibiting or reinforcing effects would be determined not only by the nature and complexity of the stimulus but also by the inherited and acquired disposition—neural connections, bodily structure, etc.—of the organism. I shall refer to these mutually reinforcing and mutually inhibiting functions, in all the degrees between these two extremes, as the *principle of completeness of response*.

In certain passages Dr. Carr, in the article referred to, seems to have come close to this principle. *E. g.*: "From the standpoint of the immediate sensori-motor situation in which the animal is placed, the true path and the cul de sacs

¹ Meyer, Max, 'Fundamental Laws of Human Behavior,' 1911.

are to be distinguished from each other on the basis of the degree to which they impede or encourage the animal's activity. A blind alley . . . means hesitation, caution, investigation, or disastrous sensory consequences. The true path presents fewer obstacles; it offers greater encouragement to freedom, continuity, rapidity, and vigor of motor expression.¹ The difference is merely one of *degree*. The blinds check, thwart, and suppress activity more than does the true path, while the latter encourages and facilitates activity more than does a blind alley. The principle of relative intensity is here effective; acts are selected or eliminated according to whether the sensory consequences tend to facilitate and intensify them on the one hand, or to disrupt and suppress them on the other."² Yet this suppression or facilitation is here in no way explained by the principle of relative intensity; relative intensity, as well as the suppression and encouragement, of certain of the attempted acts is rather a consequence of a sort of cumulative attitude, or incomplete activity brought about by the overlapping of partially complete responses. Again, "The animal does not react to this complex situation as a unitary whole, as a single stimulus. He reacts to it selectively, and as a series of stimuli. There is a circular interaction between the sensory stimuli and the animal's movements. Each act modifies the stimulus in some respect, and the change of stimulus in turn modifies the act."³ Here Dr. Carr recognizes the need of the complex situation affecting the response, though the nature of the selection is not made clear.

In the case of the maze problem the animal on entering a cul de sac—or any other path, in fact—responds at first more or less incompletely, *because all the subordinate activities involved cannot take place at once*. If the animal's progress is soon checked in a blind alley the animal is not seriously non-plused. Certain elements of the general response are tending to drain into other alleys that may recently have been passed,

¹ This is of course true not for any momentary status of the animal but only for a larger situation involving successive stages of acts, or series of acts.

² *Op. cit.*, p. 162.

³ *Ibid.*, p. 157.

thus partially dividing the animal's activity. These elements now prevail when the others are checked. Let us suppose that the correct path, *A*, has just been passed when the animal suddenly comes to the end of the cul-de-sac, *B*. The tendencies to respond to *A* are still surviving and now direct the impeded activity into this, the successful, path. If, on the other hand, the correct path had been chosen the first time the distracting impulses toward *B* would have become fainter and fainter as the animal proceeded into *A*, and would finally have faded away. The principle is not different when the complexity of the situation is increased. When the food is finally reached all the remaining delayed reactions, the tendencies, still persisting, to go into other alleys recently passed, are relaxed—the act as a whole is complete.

Thus by an actual overlapping of many tendencies to respond in diverse ways the erroneous tendencies are directed into the successful ones, and the latter are strengthened by reinforcement. Without such overlapping of various impulses in the same general response, the inhibiting effects of the successful upon the unsuccessful or irrelevant tendencies are incomprehensible. How can a successful result act backwards and strengthen the impulses leading up to it and stamp out the unsuccessful impulses? It is a mistake to look upon these tendencies as separate *acts* each complete in itself and occupying the whole arena for the time being. This seems to make clear why the pleasurable act survives over the other acts: the pleasure itself is not a cause or natural antecedent of the surviving act, but only the inner or 'felt' aspect of it and therefore valueless in explanations, though no less a fact to the individual performing the act. If analogies help us in conceiving this selective process we can find very good ones in a stream of water making its way initially over an uneven and loose soil. Now the water plunges mainly into this little hollow place drawing noticeably upon neighboring portions of the stream; now, this place being filled (cul de sac), the principal part of the current passes on to fill some other depression into which a small overflow had

already begun but was impeded by the main plunge of the stream into the preceding hollow.

The selectiveness, then, is due finally to the entire conformation of the organism together with the present more or less complex stimulating conditions; more immediately it is due to the cumulative effect of various incomplete partial-responses. This is admittedly a rather complicated matter to introduce, too complex adequately to state in terms of simple nerve tracts. Yet without considering the whole situation *together* such terms as free or impeded activity can hardly mean anything. The selectiveness of the organism is simply its more easy adaptation to certain direct and indirect stimuli than to others; but worked out in detail this is not a simple matter. In the case of impeded activity there are more internal conflicts—conflicts among elementary neural and muscular processes than in unimpeded activity. The latter type of response is more *complete*, or unitary, than the other. That responses are always more or less complex is a fact that is not fully enough considered in our usual simple neural explanations. And more complex explanations in terms of nerve impulses are extremely difficult, because of insufficient knowledge on many points of importance. The usual statement is that a lessened resistance is formed along certain tracts due to repetition, or recency, or intensity, or to the combined action of any two or all three of them. Intensity (of what?—stimulus or response? or both?) obviously implies on the motor side a harmonious action of a system of tracts and of various muscular responses, a mutual reinforcement; while on the sensory side it may mean a more effective stimulus for such harmonious activity, not merely physical intensity. The latter condition is illustrated in the heightened effect of a very weak stimulus that is intensely interesting, such as a moving object. The interest is obviously due to some bodily organization, inherited (instincts) or acquired (associations), making certain kinds of responses complete and others considerably impeded on account of the inhibitory, or mutually blocking, action of the constituent elements. The pleasurable tone which accompanies certain

of our acts is of course only a subjective indication that the response is along the line of least resistance. This is true only up to a certain limit at which the act approaches a neutrally toned reflex. We are coming to the point now in psychology at which we cannot look upon states of feeling as *causes* of action. The same is true, of course, of 'ideas.'

The neural correlates of learning processes could not be stated in terms of changes along any particular tract even if it were conceivable that certain of the 'controlled acts' involve but a single nerve tract. Such processes really involve more or less complex *attitudes*, and light is thrown upon them by the delayed reaction experiments of Hunter and others. On account of the complexity of stimulating conditions—some stimuli being direct, others indirect by means of association, and all varying enormously in their degrees of intensity—the various elementary movements involved are doubtless always more or less in conflict; *i. e.*, the total reaction is in a degree incomplete, tentative. It is conditioned by various muscular 'sets,' or tensions, partial responses to immediately distracting stimuli, which cannot relax wholly until relief is obtained from confinement, or food is reached; and even then they likely fade away gradually, if we may trust introspection of our own attitudes. If Dr. Watson will permit a bit of anthropomorphism—a fault of which his recent book is not, by the way, wholly spotless!—this hesitant, delayed, or incomplete response is such as a person may experience in relation to the position of the head if he has just passed some mischievous lad preparing to throw a snowball at him. The attitude may disappear rather soon after the ball has whizzed by the ears; it fades slowly if the ball does not come at all until one is out of reach. This incompleteness in reaction need not imply the sort of imagery which many comparative psychologists are desirous of keeping out of explanations in animal behavior. It involves nothing more in this regard than do the delayed reactions which Watson attempts to explain on the basis of continuous bodily orientation, together with minor muscular tensions and neural inhibitions and reinforcements not observable externally.

These neural processes *may* of course in the case of man, and possibly also in the case of some of the higher animals, be accompanied by the consciousness of images. The writer is convinced that his own auditory and visual 'imagery' is mainly, or almost if not quite entirely, a matter of finer muscular adjustments and motor tendencies of body, head, eyes, and certain ear structures. He is not inclined, however, to deny that certain persons may be able to call into play a richer supply of brightness, color, and tone qualities to supplement these muscular tensions though dependent upon them. But, again, *images are not consistently regarded as causes*; they are the inner aspects of certain results of direct or indirect stimulation.

The solving of any problem, such as the inclined plane, involves numerous synchronous more or less subordinate responses, as well as a complexity of stimulating conditions. Some of these responses are certainly much more immediate and direct than are others. There is therefore a continuous overlapping of responses, some of which are in opposition while others are mutually helpful and serve to the main response as additional stimuli, the latter leading to a more easy and complete expression. In our observation of animal behavior we have been too much interested in the principal response of the animal and have neglected to note sufficiently all the subordinate attitudes and responses. This is to be expected in so new a science, one, moreover, in which we are obliged to resort to objective methods. The inadequacy of the usual procedure comes out more conspicuously, it must also be noted, only when the nicer questions of explanation of the learning process arise.

Certain acts on the whole are chosen, to recapitulate in part, not because they are pleasant but because they are on the whole the most natural. A wrong view on this point leads to serious complications in the explanation and control of behavior, and in the field of human conduct it has done much toward making the study of ethics a mere academic affair and in many of its stages and aspects surprisingly unscientific. That the more complete reactions, those finally

'chosen,' are the pleasant ones in the main is simply an indication of a subjective kind that the response is relatively complete, unimpeded, that it is harmonious with one's inherited and acquired organization; pleasantness, however much a fact—and a desirable fact—it may be in our lives, is not a serviceable explanation principle. This fact is made patent by two millenniums of ethical discussion, and comes out more strikingly in the simpler experimentally controlled behavior of lower animals. Since adjustment is hardly ever quite complete or at an end with any particular act, there may with rather short-ranged or temporary successes be momentarily increased activity and therefore a pleasant tone, only to be checked later. Such a procedure is evident even in a more nearly homogeneous mechanical process like a liquid flowing over an uneven surface.¹

The recognition of this principle of completeness of response, or the overlapping of responses, makes more comprehensible than heretofore results obtained by certain experimenters, showing that an animal which has learned certain problems adapts itself to others—*i. e.*, learns them—more readily than one which is wholly untrained. In the former experiences the animal has habituated itself somewhat to the incomplete or tentative attitude so that it can more readily remedy its errors, or find the right response. Among themselves animals differ widely, as do also persons, in the degree to which they throw themselves whole-heartedly into each possible outlet that presents itself in a difficulty. Experience has important effects in modifying this general aspect of behavior. The general unnaturalness of apparatus to an animal is sufficient readily to give the animal this tentative attitude even though the new problem requires a response considerably different from those on which it has been trained. Of course in cases of this kind various factors enter, all of which are not reducible to any one principle.

In the case of the inclined plane problem it is noticeable

¹ Whatever is ultimately true—if ultimate in this sense has any meaning at all—as to the 'freedom of the will,' scientific explanation seems to be most successful in the field of behavior, as in other fields, when it proceeds on the assumption of determinism. Consider, *e. g.*, certain recent progress in applied psychology and sociology.

that rats proceed to the plane, after failure to get into the food, with considerable tension toward the door of the food box. Frequently at a certain stage in the learning the animal comes to a standstill, and then scurries back in vain to the door. The uncritical would say that the rat was trying to recall which way it went to success before. Since it must invariably push the inclined plane before entrance to the food can be obtained it is forced in every case to return to the plane, but it does this as if an elastic cord were constantly pulling it toward the food. These muscular tensions are released only when the proper reactions have made entrance to the food possible and when the food has been reached. In this way all the relevant acts are associated effectively together by what is tantamount to *simultaneous action*. The apparent backward effect of certain acts is thus made comprehensible. Even in cases when the animal goes directly to the inclined plane, if the habit is not fully established, it frequently shows hesitation and the effects of impulses toward the food box. The writer has frequently noted this hesitant behavior, and Dr. Florence Richardson's monograph supplies many instances.¹

Applying this principle of overlapping of incomplete responses to a specific instance we find it of considerable help. Take the case of the choice of the correct alley as against the cul de sac discussed by Watson² on page 267. The figure is here reproduced. If the animal goes in the direction indicated by the arrow in *A*, it is not simply a matter of probability as to whether it will finally establish the habit of turning into *B*—for this probability argument gets very flimsy when you take into consideration a number of successive culs de sac. As the animal passes *B* on its way to *x* there are impulses to enter *B*, but they are outweighed by those tending

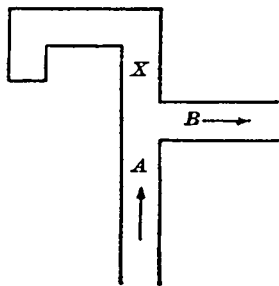


FIG. 1.

¹ 'A Study of Sensory Control in the Rat,' *Psych. Rev. Mon.*, 1909, Whole No. 48.

² 'Behavior.'

into *X*. As it returns from *X* these impulses, still carried over to an extent and therefore still effective, are potent toward directing it into *B*. Besides this fact is another one, based on the same principle: the attitude resulting from the general direction of the animal's moving, so long as it has not retraced its steps except in a blind alley, is operating against its returning into *A* in our figure. A study of illusions usually called being 'turned around,' to be published later, has convinced the writer that we are yet too neglectful of these larger attitudes in our studies of behavior. The correctness in general of this idea of the overlapping of responses in learning as a principle of explanation seems to be supported by the fact that a short cul de sac is less confusing than a long one, even though neither of them has any turns. This is true of very short ones; how far it will hold true in general is a matter yet to be determined, one the working out of which will make an interesting modification of the delayed reaction experiment.