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UNCERTAINTY AND CONFLICT: A POINT OF CONTACT BETWEEN INFORMATION-THEORY AND BEHAVIOR-THEORY CONCEPTS[1]

D. E. BERLYNE

Center for Advanced Study in the Behavioral Sciences[2]

Information theory, originally designed to handle certain problems in communications engineering (41), needs to be distinguished from *psychological information theory,* which is one of its offshoots. The former consists of a mathematical language, incorporating a number of distinctive measuring techniques. Psychological information theory is, in contrast, a type of theory in the scientific sense: it applies information-theory measures to phenomena within the purview of psychology and uses information-theory language to formulate laws or hypotheses with testable implications about behavior.

Recent literature contains several sketches of such theory (e.g., 1, 26, 35), mostly concerned with how human beings code information or with how much information can pass through them in particular situations. There are many unmistakable affinities between this kind of psychological theory and S-R behavior theory (learning theory): they have overlapping interests in such matters as discrimination, remembering and reaction time, they share a predilection for operationally definable and quantitative concepts, and they start out, respectively, from the closely related "black-box" and "neobehaviorist" points of view. It is therefore rather disappointing that so little integration between theories of the two types has yet taken place. We can regard two theories as "integrated" if one can be deduced from the other or if both can be deduced from a third theory. Before any integration can be attempted, the scope of information-theory language within the domain of behavior theory must be examined, which means considering to what extent recourse to it is *possible* and to what extent, if possible, it is *useful.*

The use of information-theory measures is *possible* whenever we have a *partition,* i.e., a set of phenomena that can be divided into non-overlapping subsets, and a *probability distribution,* i.e., a way of associating with each subset a number from 0 to 1, such that the numbers associated with all the subsets in the partition add up to 1. Whenever these two requirements are fulfilled, such measures as "amount of information," "uncertainty," and "relative uncertainty" can be applied. As

[1] This article owes a great deal to discussions with Dr. I. R. Savage and several other colleagues at the Center for Advanced Study in the Behavioral Sciences. It was written while the author was on leave of absence from the University of Aberdeen, Scotland.

[2] Now at the University of California, Berkeley.

soon as we have *two* sets of phenomena satisfying both requirements, the two can jointly be regarded as a "transducer," and the relations between them described in terms of "transmitted information," "noise," and "equivocation."

The phenomena that concern behavior theory consist, in fact, of two sets that can be partitioned into subsets with associated probabilities, namely *stimuli* and *responses*. The language of information theory is therefore, in principle, applicable to everything within the competence of behavior theory. Two limitations to its appropriateness have often been pointed out (14, 47). One is that the behavior theorist is especially interested in learning, i.e., in situations where probabilities of responses are changing. The other is that information-theory measures take no account of any ordering of the subsets in the partition or, more particularly, of the fact that stimuli and responses are not confined to nominal scaling (44). But these limitations are not insuperable. Information-theory measures can be derived from response probabilities at different stages of a learning process and compared, or else they can be applied when learning is near its asymptote. Stimuli and responses can be successively described in information-theory terms and in terms of physical or psychophysical dimensions, and the different measures can be related. For example, a response-class can have attached to it both a mean reaction time and a rate of transmitted information, and connections between the two can be explored.

If the possibility of describing the domain of behavior theory in information-theory language is accepted, the question of its *usefulness* still remains. One of the principal functions of any language is to make secondary or mediated generalization and discrimination possible. A language incorporates classifications, of which measures are special cases. Classifications are procedures for attaching certain descriptive terms (values in the case of measures) as verbal responses to certain items in the universe of discourse but not to others. Items bearing a common verbal label come to evoke similar behavior in the users of the language. A classification is useful only as long as the items allotted the same label share some important quality, such that a common response to them will be rewarded (or reinforced) despite other qualities that might distinguish them. Information-theory measures are useful for the description of behavior, therefore, if these measures are closely related to other variables that have proved to be important for psychology.

A large body of data demonstrating that such is the case has been amassed within the last ten years. Reaction time, retention of verbal material, and accuracy of psychophysical judgment, to cite examples, appear to be functions of "uncertainty" and "amount of transmitted information." The situations in which such associations have been found have, however, been situations in which *subjects have some knowledge of the range of alternative stimuli that might occur and of their probabilities*. This knowledge is provided by *E*'s instructions, or by the presentation of a sufficient sample of material for estimates to be made, or, as in experiments using natural languages, by previous training. It has, indeed, been contended by Cronbach (14) that information-theory measures in psychology should be confined to cases where "the receiver knows the probabilities and joint probabilities of the source." As Cherry reminds us, information theory is part of the "metalanguage of an external observer; it is not a description of the process of communication as it appears to one of the participants" (13, p. 170). An observer can compute information-theory measures from data not accessible to the individuals he is observing. But there is not likely to be much connection between these measures and variables of psychological importance, unless there is some isomorphism between the situation as viewed by the observer and the situation as it impinges on the observed organism.

The situations in which the use of information-theory terminology has had some success can be analyzed further as follows:

1. There is an antecedent stimulus-pattern, S_x. It may consist of the background conditions of the experiment, of an *E*'s warning signal or, in sequential studies, of any item in a sequence.
2. Whenever S_x occurs, it is followed by one and only one of a set of consequent stimuli $\{S_1 \ldots S_n\}$.
3. Whenever one of the consequent stimuli occurs, a particular response corresponding to it is performed.
4. The responses corresponding to the consequent stimuli are such that no more than one of them can be performed at once, whether because of the *E*'s instructions or because of some physiological incompatibility between them.

In such situations, one can predict that all the n responses corresponding to the n consequent stimuli will become conditioned to S_x. No more than fractional components of these responses can be expected to occur immediately after the onset of S_x, both because simultaneous performance of the complete responses is precluded by the conditions of the experiment and because performance of any of them before the consequent stimulus appears will not be reinforced, so that the conditions for inhibition of delay will be fulfilled (38). S_x will thus come to evoke *competing response tendencies*. For Hull's theory (27, 28), these response tendencies will be "reaction potentials." Cognitive behavior theories (e.g., 45) would describe them as "expectations" of the consequent stimuli, and the "expectation" resembles the "reaction potential" insofar as both imply the occurrence of a particular response, if certain additional conditions are met.

Furthermore, the relative *strengths* of the competing response tendencies will reflect the probabilities of the corresponding stimuli. Whether one regards the number of reinforced trials (27, 28), the variety of stimulus situations that have been contiguous with the response (23), or the number of times an expectation has been confirmed (45) as the decisive factor, responses associated with more frequent consequent stimuli will become more strongly associated with S_x. There is, in fact, experimental evidence (17, 21) that the strength of a predictive verbal response (which is especially relevant here), as judged by the asymptote of response probability, increases with the probability of the corresponding stimulus.

To sum up, the situations in which information-theory language has been of value are ones in which *conflict* is an important factor, and the theory of conflict seems to be one area where linkages between information theory and behavior theory may hopefully be sought.

DEGREE OF CONFLICT (C)

If the study of conflict is to progress beyond noting the effects of its presence or absence, some way of distinguishing *degrees of conflict* will have to be adopted. The degree of conflict is, of course, not necessarily the same as the *severity of the effects of conflict*, of which it is likely to be merely one determinant. Other determinants would be the nature of the conflicting response tendencies (e.g., whether they are approach or avoidance tendencies [36]) and the conflict tolerance of an individual organism. Brown and Farber (11) suggest two conditions for the degree-of-conflict function (or, as they call it, "frustration"), viz., that it increase with the *absolute strengths* of the competing tendencies, and that it increase as their strengths approach *equality*. They, like most writers who have considered psychological conflict, confine their attention to conflicts between two response tendencies. If conflicts involving three or more alternatives are to be included in the treatment, as would seem desirable, the *number* of competing tendencies can be proposed as a third variable with which degree of conflict increases (4).

We can thus state the conditions for a degree-of-conflict function a little more precisely, as follows. Let us assume that response tendencies corresponding to a set of responses $\{R_1 \ldots R_n\}$ occur in an organism, that the responses in the set are such that no two of them can be performed at once, and that some non-negative quantity E (e.g., Hull's "reaction potential") can be associated with each response tendency (as a measure of its strength).

It should be noted that, although the *responses* cannot occur simultaneously, we are assuming that their corresponding *response tendencies* can. Second, there is no reason why several independent sets of competing response tendencies should not be aroused in the same organism at once. Third, we are considering cases where there is complete incompatibility, whether innate or learned, between alternative responses. It is, however, conceivable that two responses may be *partially* antagonistic, i.e., the evocation of one may reduce the amplitude or probability of the other without excluding its performance altogether. This may suggest *degree of incompatibility* between responses as an additional determinant of degree of conflict (4), which would complicate any mathematical treatment. Possible ways of reducing degree of incompatibility to other variables, when learned incompatibility is involved, are considered elsewhere (7).

The degree-of-conflict function $C(E_1 \ldots E_n)$ should then have the following properties:

1. C is continuous and symmetric in the E_i;
2. $C \geq 0$;
3. if $n = 1, C = 0$;
4. with $\sum_{i=1}^{n} E_i$ held constant, C reaches an absolute maximum when $E_1 = E_2 = \cdots = E_n$;
5. if $E_1 = E_2 = \cdots = E_n$, and a response R_{n+1} with strength $E_{n+1} > 0$ is added to the set $\{R_1 \cdots R_n\}$, C increases;
6. if every E_i is multiplied by $k > 1$, C increases.

Now, let us suppose that we have a way of translating the E value for each response into a p value, or measure of probability, such that

1. $0 \leq p \leq 1$;
2. $\sum_{i=1}^{n} p_i = 1$;
3. if $E_1 = E_2 = \cdots = E_n$, then $p_1 = p_2 = \cdots p_n = 1/n$;
4. if one E_i increases with the others held constant, then the corresponding p increases and the other p's decrease.

Some theorists (e.g., **12**, **16**) content themselves with probability as a sole measure of response strength. Others (e.g., **27**, **42**, **43**) recognize additional ones, such as latency, frequency, resistance to extinction, amplitude and vigor. Of these, mean latency and mean frequency are merely the reciprocal of the probability that a response of the class in question will occur during one unit of time. Resistance to extinction may be regarded as the rate at which response probability decreases when reinforcement is withdrawn. But other measures of response strength, expressing the energy with which the response is performed, are not the same as probabilities. Hull (**28**, pp. 25 ff.) and Spence (**43**, App. A) present methods for transforming Es into probabilities, when E is the Hullian reaction potential. Doing this means, however, losing information, since many sets of E values can be represented by the same set of p values. Whenever we have two or more independently defined response classes, as distinct from one response class and its complement, probability is a measure of *relative* and not absolute response strength. The distinction may be important. For example, Mr. A. may be torn between his duty to the community and his duty to his family, while Mr. B may have difficulty in deciding whether or not to spend a small sum on a newspaper. Both of them have two response tendencies with probabilities of .5, but in other respects the effects of the two conflicts may be radically different.

Be that as it may, the use of probabilities to express response strengths provides us with the partition and the probability distribution that are necessary conditions for recourse to information-theory measures. And if we examine the information theorist's formula for "uncertainty" or "entropy" ($-\sum_i p_i \log_2 p_i$), we find that it satisfies the first five of our requirements for a degree-of-conflict function, but not the sixth. It increases with the number of alternative responses and is at a maximum when their strengths are equal. But it does not vary with their absolute strengths. In order to make "uncertainty" fulfill all our conditions, we can multiply it by some such quantity as the mean E. French's hypothesis (**20**) that the frustrating effects of a binary conflict are a function of the weaker of the two opposing forces suggests that "uncertainty" should be multiplied by the minimum rather than the mean E. But this would produce rather anomalous results in higher-order conflicts when there are one very weak and several very strong response tendencies in competition. Our expression for degree of conflict then becomes $-\bar{E} \sum_i p_i \log p_i \cdots 1$. Put somewhat differently, "uncertainty" can be regarded as an indication of the "complexity" of a conflict, or of the difficulty that an observer would have in predicting which of the conflicting responses will be the first to occur. It does not reflect the "scale" of the conflict, which depends on the energy invested in the competing response tendencies. There may be a temptation to relate these two components to the *utility* and *probability-of-outcome* factors that must be taken into account in decision theory, or to the *motivational* and *structural* factors that often have been distinguished in psychological literature. But any such correspondence would be misleading. Both the "uncertainty" and the $\bar{E}$ are determined by absolute response strengths, which depend on both motivational (utility) and structural (probability-of-outcome) variables; e.g., Hull's "reaction potential" (**28**) depends on "drive" and "amount of reinforcement" on the one hand and on "number of reinforcements" (habit-strength) on the other. It is interesting to observe that Shannon (**41**, p. 19) gives $-K \sum_i p_i \log p_i$ as the only function satisfying his assumptions, and goes on to describe K as amounting to a "choice of a unit of measure" or, in other words, to some scaling factor comparable to our $\bar{E}$.

Expression 1 is, however, by no means the only one that will accord with our requirements. Another function, for example, that will do so without necessitating a transformation of E, is $\sum_i (\log (\sum_i E_i) - \log E_i) \cdots 2$. If E represents Hull's reaction potential, this function will not, in general, have the same values as Expression 1, because probabilities are not proportional to reaction potentials. It will, however, be an increasing monotonic transform of Expression 1.

We are not even confined to logarithmic functions, since we lack the additivity requirement that makes them mandatory for Shannon's purposes. A non-logarithmic function that will pass muster is

$$\frac{(\sum E_i)^2(n-1)}{1+\sum_i (E_i-\bar{E})^2} \cdots 3.$$

Our requirements are, in fact, very weak ones, which a large number of functions will fit. Further research will, no doubt, add stipulations, allowing the range of possible functions to be narrowed down. For instance, one additional requirement that may be held reasonable, in view both of everyday observation of persons confronted with choices and of the logarithmic relation that obtains between number of alternative stimuli and choice reaction time, is that C should be a negatively accelerated increasing function of n. If this were adopted, then Expression 1 would be among those still meriting consideration, but Expressions 2 and 3 would be ruled out.

Correlates of Degree of Conflict

A degree-of-conflict measure, like an information-theory measure, can be justified as a classificatory device only if situations that have a common value assigned to them by the measure result in similar behavior, much as they may differ in other respects. The following are some psychological variables that appear likely, in the light of present knowledge, to depend on degree of conflict. They may actually turn out to be closely interrelated, but they are here separated for convenience.

1. *Emotional disturbance.* Various writers, from Dewey (15) on, have mentioned conflict as a cause of "emotion." Both the special reaction patterns (24) and the disruption of habitual behavior (31) that are characteristic of "emotional disturbance" have been ascribed to the occurrence of divergent neural processes. The power of conflict to precipitate neurotic behavior was pointed out independently by Pavlov and by Freud, employing very different research techniques. So far, merely the dependence of these phenomena on relatively severe conflict has been noted, but future progress may well demand a quantitative treatment, in which intensities of disturbance are differentiated and related to degrees of conflict.

2. *Reaction time.* A lengthening of reaction time (or decision time or choice time) has often been reported as a consequence of conflict (see Berlyne [7]). A link with information theory presents itself in the finding that reaction time increases linearly, at least in some conditions, with "uncertainty" (26, 29); mean reaction time has been found to increase when alternative stimuli approach equiprobability and when they become more numerous. If, as we concluded, the number of competing response tendencies corresponds to the number of alternative stimuli, and if the relative strengths of those tendencies reflect the probabilities of the corresponding stimuli, we can infer that two of the suggested determinants of C affect reaction time.

Both traditional experimental psychology and psychological information theory have hitherto concentrated on *"forced-choice"* situations, in which only one response is appropriate to each alternative stimulus, and selection of a response depends on identification of the stimulus. A recent investigation by the writer (7) compared forced choices with *free choices.* For the latter, two or more stimuli were presented together, and the response corresponding to any *one* of them was to be performed. Both kinds of choice can be assumed to entail conflict: the free choice means a conflict between response tendencies of about equal strength evoked by the stimuli that are simultaneously present, while the forced choice means an unequal and therefore relatively mild conflict between a strong tendency to respond correctly to the one stimulus that occurs and weak tendencies to make responses appropriate to other stimuli, resulting from generalization. The usual information-theory analysis of the forced choice, in which the *S* is viewed as a transducer with a limited channel capacity, is not helpful for the treatment of the free choice.

Free-choice reaction times invariably exceeded forced-choice reaction times, and both were longer when the number of alternative stimuli and responses was increased from two to four, as the hypothesis that reaction time increases with degree of conflict would lead one to expect. Furthermore, when the absolute strengths of the response tendencies—the determinant of degree of conflict that is disregarded by uncertainty—were manipulated by changing the intensity or extensity of the stimuli, changes in free-choice reaction time resulted.

3. *Drive.* Various considerations and observed phenomena have led a number of writers (e.g., 11, 30, 46) to conclude that conflict may be a drive condition. The drive resulting from conflict as such must, of course, be distinguished from other drives that may be at a high level because conflict blocks the behavior that would normally reduce them.

A certain amount of evidence for a conflict drive was obtained by Lowell (30), who found approach-approach conflict to produce a greater speed of running in rats than a single approach tendency. A supplementary observation fitting our conception of *C* was that the conflict drive was not so much in evidence when the stimuli were unequal in intensity or when learning was incomplete (and the competing response tendencies presumably relatively weak).

Wyckoff's experiment (48, 49) provides other data that might be predicted from our assumptions. His pigeon *S*s were rewarded with food when they pecked at a key of a certain color and not rewarded when the key was of another color. They were then tested with the key white, but the color indicating whether pecking would be reinforced or not appeared if the animal stepped on a pedal. The pedal response was rapidly learned, even though it did not affect the probability of receiving food. It merely diminished the pigeon's "uncertainty" by one bit. The white key is reminiscent of the stimulus that made the dog neurotic in the famous Shenger-Krestovnikova experiment (38, pp. 290 ff.). This stimulus, intermediate in shape between the reinforced circle and the nonreinforced ellipse, was thought by Pavlov (38, p. 318), to produce a "conflict between excitation and inhibition." If the white key produced a conflict in Wyckoff's pigeons between tendencies to peck and to refrain from pecking, or between tendencies to expect and not to expect food, the coloring of the key that was a consequence of stepping on the pedal must have reduced the conflict by strengthening one response tendency and weakening the other. If a conflict drive is proportional to *C*, reduction of the drive can be expected to reinforce the pedal-stepping response. When the discrimination was reversed, Wyckoff found that the frequency of the pedal response would temporarily decrease. This also fits our interpretation, as each color would then go through a stage of evoking both tendencies, and seeing the colored key would thus increase rather than reduce conflict. Wyckoff himself offers an alternative explanation in terms of secondary reinforcement, but this leads into difficulties, as Prokasy points out in his report of a somewhat similar experiment (39).

Yet another relevant experiment is one by Fonberg (19). She trained dogs to perform a certain response (R_1) as a way of terminating stimuli that had been associated with puffs of air or electric shocks. The animals then received training in quite a different response (R_2), which was followed by food reinforcement in the presence of a loud tone but not in the presence of a faint tone. When they were later subjected to a Shenger-Krestovnikova type of conflict by exposure to tones intermediate in intensity between the positive and negative alimentary conditioned stimuli, they reverted to their defensive response (R_1). This finding indicates that the physiological state produced by a conflict, even when noxious stimuli have played no part in it, may be sufficiently similar to the physiological state (fear or anxiety) resulting from a noxious stimulus for generalization between the two to occur.

4. *Curiosity.* There is currently a good deal of interest in certain sorts of behavior whose main function seems to be the provision of information, and information theory might reasonably be expected to throw some light on them. The behavior under discussion includes the "exploratory" activities that bring about opportunities to perceive objects more readily; the verbal activities, including asking questions, that elicit informative verbal behavior from other individuals; and the symbolic activities that allow thought processes to feed on information other than that supplied by the immediate environment.

"Novelty" has often been mentioned as a distinguishing mark of situations that provoke such activities (2, 6). But something can either be relatively novel, in the sense that it has never been encountered before in its present context, or absolutely novel, in the sense that it has never been encountered at all. In both cases, we have situations in which "amount of information" is high, since this measure is inversely related to the probability of an event, and the probability of particular novel occurrence must be low in the light of an individual's past experience. We can also speak of conflict in connection with the same occurrences. A relatively novel stimulus pattern is one in which perception conflicts with the expectations aroused by the context. Moreover, at least as far as human beings are concerned, any absolutely novel object is bound to consist of an unfamiliar combination of familiar elements or to possess characteristics intermediate between those of several well-known objects. Such an object can be expected to induce conflict, since it will inevitably evoke, by generalization, responses appropriate to a number of discrepant familiar objects.

Other words that seem apposite to situations that call for investigatory behavior are "doubt," "perplexity," and "ambiguity." These words likewise imply some degree of behavioral conflict; they indicate that different aspects of a situation evoke discordant reactions or else that a particular reaction is called forth by one aspect and inhibited by another. They are opposite in meaning to words like "clear" and "distinct," which generally imply that certain response tendencies have come, through discriminatory learning, to predominate over their competitors. "Doubtful," "perplexing," or "ambiguous" stimulus situations are usually also cases of high "uncertainty" in the information-theory sense, both because the subject cannot predict very successfully what the future behavior or the hidden properties of the entities will be, and because observers will not be able to predict very successfully how he will react to them. Nevertheless, curiosity is by no means always commensurate with "uncertainty"; there are many events whose outcomes are uncertain and yet which leave us completely indifferent. For knowledge of the outcome to be rewarding, the event must be of some "interest" to us, which usually means that strong habits or drives must be aroused. In other words, curiosity seems to be a matter of conflict rather than of "uncertainty" alone; "uncertainty" may be high, but there will not be much conflict if the absolute response strengths are low. That human beings, like Wyckoff's pigeons, find relief from doubt about vital matters rewarding, even when the truth is unpleasant, is attested by common experience. Of the convicts studied by Farber (18), those who did not know how much time they would have to serve suffered more than those who were certain that they would never be paroled.

The writer suggested a few years ago (4) that at least some forms of human curiosity spring from the drive-producing properties of conflict. The conflicts that seem especially pertinent are those between implicit, most often symbolic, responses, such as "beliefs," "ways of thinking," and "ways of perceiving," whose incompatibility is largely an effect of learning. There are experimental data supporting the conclusion that curiosity, measured in various ways, is an increasing function of C (5, 8, 9).

5. *Stimulus complexity.* Among the various properties by which stimulus patterns can be classified, there is a group that can only be described collectively by some such term as "complexity." They are hard to define rigorously, and a number of quite distinct dimensions will, in all likelihood, be unraveled by attempts to do so. But the influence of this aspect of perceived material is revealed in several contexts: the special properties attributed to less complex (more "prägnant") figures by the Gestalt school, the bearing of degree of complexity on aesthetic preferences, and, more recently, the influence of stimulus complexity on exploratory behavior on animals (see 10).

Attneave (1) has related the "complexity" dimension in visual figures to information theory through the concept of "redundancy," the inverse of "relative uncertainty." His treatment suggests a possible link between these variables and conflict. More "complex" stimulus patterns might well be those arousing more conflict, e.g., between perception of one part and expectations or redintegrative perceptual responses (3, 24, 37) aroused by other parts, between verbal or other classificatory responses, or between ocular and other orienting movements. If this hypothesis is well founded, we should expect more "complex" (or less "redundant") figures, like figures arousing conflict in other ways, to elicit more investigatory behavior. Experimental data confirming this prediction are available (8, 9).

6. *Reward.* While the punishing or drive-producing role of conflict is more evident and has received more attention, the possibility that conflict and uncertainty may at times be rewarding is suggested by gambling and aesthetic behavior. Similarly, journalistic practice seems to indicate a positive relation between the reward value of a piece of news and the "amount of information" it contains, which depends on its improbability or surprisingness (40). Surprise, like novelty, seems to mean some sort of clash between the reactions occasioned by an unexpected situation and those evoked anticipatorily through previously established habits (3). Surprising statements are, at least in certain circumstances, recalled more readily than others (5), and maze-learning experiments (see 10) show that exposure to a more complex environment (which, as we have seen, may mean a more conflictful environment) can be more reinforcing than exposure to a simpler one.

If conflict is usually an aversive condition but occasionally functions as a reward, it resembles fear, which likewise seems to be actively sought at times, e.g., at fairgrounds and in dangerous sports. The analogy with fear suggests two hypotheses to account for the paradox. One is that drive arousal may be rewarding at a moderate level. Hebb refers to "the *positive attraction of risk taking,* or mild fear, *and of problem solving,* or mild frustration," and speculates that "when arousal or drive is at a low level, . . . a response that produces increased stimulation and greater arousal will tend to be repeated" (25, p. 250). McClelland *et al.* (33) propound a rather similar hypothesis, whose bearing on conflict is a little more conspicuous: "positive affect is the result of smaller discrepancies of a sensory or perceptual event from the adaptation of the organism; negative affect is the result of larger discrepancies." There have been a number of recent studies (e.g., Marx *et al.* [32]) showing that an increase in illumination up to a certain intensity will reinforce a bar-pressing response in a rat, while light of much greater intensity is known to be aversive.

The second hypothesis is that such states as fear or conflict are sought only when their arousal in similar circumstances has reliably and speedily been followed by drive reduction in the past.

Two recent works by empirically minded aestheticians provide some corroboration for these hypotheses. Graves (22) contends that the appeal of a visual design depends on variety, but that one part or quality must be made to dominate the others if the effect is to be satisfying. This would keep within bounds any conflict aroused. In accord with the second hypothesis, Meyer (34) shows that music owes much of its savor to continual departures from what preceding or accompanying patterns lead the listener to expect. But what is initially heard as an incongruity is invested with a new meaning by what follows, so that the momentary conflict is promptly resolved.

SUMMARY

The use of information-theory measures is possible whenever there is a partition and a probability distribution. The stimuli and responses of behavior theory fulfill these conditions, but the situations in which information-theory language has proved useful to psychology have been ones in which conflict is an important factor. The "uncertainty" function satisfies some of the requirements that may reasonably be laid down for a measure of "degree of conflict." But it does not satisfy them all without some modification, because it depends on the relative but not the absolute strengths of competing response tendencies.

A discussion of six psychological variables that appear to depend on degree of conflict reveals several further links with information theory. The variables are emotional disturbance, reaction time, drive, curiosity, stimulus complexity, and reward.

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