A THEORY OF HUMAN CURIOSITY

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I. Introduction

Few phenomena have been the subject of more protracted discussion than human knowledge. Yet this discussion has usually paid little attention to the motivation underlying the quest for knowledge, with the result that two important questions still confront us. The first question is why human beings devote so much time and effort to the acquisition of knowledge. Sometimes there is some obvious drive to whose satisfaction it can contribute. But, strangely enough, many of the queries that inspire the most persistent searches for answers and the greatest distress when answers are not forthcoming are of no manifest practical value or urgency. One has only to consider some of the ontological inquiries of metaphysicians or the frenzy of crossword enthusiasts to be convinced of this. The second question, and the main concern of the present article, is why, out of the infinite range of knowable items in the universe, certain pieces of knowledge are more ardently sought and more readily retained than others.

Modern learning theory leads us to look for motivational variables to answer these questions, and a drive which is reduced by the reception and subsequent rehearsal of knowledge is what we generally call 'curiosity'. However, we must draw a distinction between this curiosity and the curiosity drive that has been studied in lower animals (Berlyne, 1950). In the case of the rat, for example, there appears to be a drive which is aroused by novel stimuli and reduced by continued exposure to these stimuli. Its reduction reinforces exploratory activity, i.e. activity, such as approaching and examining the stimulus-objects, which increases stimulation of the animal's receptors by them. Now, similar exploration is undoubtedly elicited by strange objects in adult and especially infant human beings. But in an animal as well endowed for learning and remembering as the human adult, exploration is bound to leave a stock of permanent traces in the form of symbolic representations ('pure stimulus acts' or 'cue-producing responses'), which are manifestations of what we call 'knowledge'.

The curiosity which leads to increased perception of stimuli and the curiosity whose main fruits are knowledge may well turn out to be closely related. But, as we are using different defining operations for them, we shall have provisionally to use two different terms. We shall therefore call the first '*perceptual curiosity*' and the second, which is our concern in this article, '*epistemic curiosity*'.

An account in behaviour-theory terms of the nature and origins of knowledge has been offered elsewhere (Berlyne, 1954). According to this account, which draws on concepts introduced by Morris (1946) and by Osgood (1952), knowledge consists of *habits mediating believed, designative symbols*, which form sequences (trains of thought). The actual course followed by a train of thought is determined jointly by (1) *cue-stimuli*, which include

external stimuli (S) and the self-stimulation (s) resulting from previous items in the sequence and (2) *motivational stimuli*, which include drive-stimuli (S_D) and the goal-stimuli (s_G) produced by fractional anticipatory goal-responses (r_G).

The learning that produces knowledge can clearly be biologically helpful because (1) it can enable goal-directed behaviour to be more efficient through being better prepared for what is impending, and (2) it can enable warning signals to be recognized, so that danger can be avoided (Mowrer, 1939). But these effects are usually delayed, so that their advantages do not explain what reinforces the learning in question. For long-term consequences to influence behaviour, it is necessary for symbols to be used in such a way that the reinforcements of fear-reduction and secondary rewards can be brought to bear (Mowrer & Ullman, 1945). The drives that are reduced by knowledge are thus largely the 'coexistent emotional components', which, as Ullman (1951) argues, we must assume to be present in all primary drives and to be capable of functioning anticipatorily. These components are what are called 'fears'—Ullman speaks of 'shock-fear' and 'hunger-fear', for example—and knowledge can lead to fear-reduction in various ways: (1) by depicting the future situation as a desirable one (reassurance), (2) by reducing 'fear of fear' or 'fear from a sense of helplessness' (preparation) (Mowrer & Viek, 1948), or even when the outlook is hopeless, (3) by reducing the increment of drive (conflict) due to uncertainty (the comfort of 'knowing the worst'), or (4) extinction of fear by repeated exposure to frightening stimuli ('getting used' to unpleasant prospects).

But our main concern is with the second question, viz. the question of the factors underlying the selectivity of epistemic curiosity. Why does an individual seek or learn one piece of knowledge rather than another? Representatives of various schools of psychology have provided hints but scarcely more:

(1) *Psychoanalysis.* The writings of Freud (e.g. 1905) and his followers (e.g. Abraham, 1927) make it clear that psychoanalysts would attribute the desire to know to any of several 'component drives' of the libido—scoptophilic, oral-incorporative, oral-sadistic, anal-aggressive or anal-retentive—according to the direction it takes. But this leaves many questions unanswered. How are we to predict when one of those 'component drives' will find an outlet in curiosity, and how intensely? And which particular items of knowledge will be sought?

(2) *Gestalt psychology.* Although the Gestalt psychologists have not produced a systematic account of curiosity, it is not difficult to guess how such an account would go. They explain much of behaviour by the '*principle of closure*', the tendency to act in such a way as to close a 'gap', whether in a perceived figure or in some other aspect of the 'behavioural world' (Koffka, 1935; Wertheimer, 1945). It is evident that curiosity consists precisely of a drive to fill in such gaps in the subject's experienced representations. But again, we have no definition precise enough to tell us infallibly what will constitute a 'gap', nor which gaps will have precedence over others.

(3) *Reinforcement theory.* The tendency to acquire the verbal or other responses which constitute knowledge is a product of learning, culturally conditioned, according to such reinforcement-theorists as have considered the problem. Dollard & Miller (1950), mention learned drives to 'make a correct report of the environment' and to 'have an explanation' and the punishment that social training, as well as the demands of reality, imposes on those who fail to do so. Skinner (1947) similarly describes how a child learns to emit 'tacts' (i.e. verbal responses controlled by properties of objects or situations)

under the influence of 'generalized reinforcers', particularly approval. Mowrer (1950) appears to identify the acquisition of 'beliefs' (p. 5) and 'knowing that' (p. 268) with the conditioning of emotional responses, but this does not acknowledge the role of symbolic responses in distinguishing pieces of knowledge with similar affective value but different content.

We shall take these treatments as a starting-point, although it is clear that they leave some essential questions unsettled. There is, for one thing, the paradoxical fact that curiosity seems to be evoked most uniformly by situations that are new and strange. They would be the last we should expect to have any influence at all, if it were a matter of generalization from prior training (Berlyne, 1950, p. 71). It will be our contention that conflict supplies the clue to these cases.

II. The sequence of events

Stimuli which are used to elicit verbal behaviour, unless they resemble the behaviour they call forth or have unique responses, are what Skinner calls '*thematic probes*' (1953, 1947). They can take the form of verbal or non-verbal stimuli, and they can be administered to oneself ('self-probes'), as a reaction to a perceived situation, or come from outside in the form of writing, speech or non-linguistic cues. We can extend Skinner's concept a little, but not, it is hoped, inexcusably, by including under it all stimuli which elicit trains of thought, whether verbal in content or not.

Skinner gives as illustrative cases of thematic probes the stimulus-words of association experiments and the material used in projection tests. But it has been known since the work of the Würzburg school (Ach, 1910) and of Lewin (1917, 1922) that it is not possible to predict what association, if any, will be given to a stimulus without taking into account the 'set', 'determining tendency', 'tension-system', etc., induced by other stimuli, usually instructions. In other words, we must have not only cue-stimuli to act as a starting-point, but also motivational stimuli to limit the responses to the general category required by the task on hand and to supply the persistent motive force for the process. The thematic probe must thus have two parts or aspects with these distinct functions, and the clearest example, as well as probably the commonest in practice, is the *question*. The question of the type called by linguists the 'specific interrogation' (as distinct from the 'yes-or-no question') (Bloch & Trager, 1942) has the two parts easily distinguishable. As an example, we may take the question, 'how does the starfish eat?' We assume that the question, in common with all synonymous questions, evokes mediating 'concepts' or 'meaning' responses (r_m) (Berlyne, 1954). The meanings corresponding to 'starfish eat' act as the cue-stimuli with a patterning effect peculiar to that stimulus-complex; in some cases, such as when the question is put by an authoritative person, they may be tantamount to an assertion that the starfish eats, while in other circumstances the question may be taken to mean 'how, if at all, does the starfish eat?' The group of concepts that act as cue-stimuli we may, following Morris's terminology, call the '*designator*'. On the other hand, the interrogative adverb 'how' produces a meaning which acts as a motivational stimulus. It limits the train of thought to 'how-concepts' and evokes a learned drive-state which motivates the reaction.

When a question is put, whether by the subject himself or by somebody else, and the answer is already known, the appropriate response is made as a reaction conditioned by previous learning to the stimulus-pattern, and this relieves the drive immediately, so

that the subject can proceed to some other activity. However, when the answer is not known, the drive will persist, and some sort of trial-and-error process can be expected to follow as with any other drive-state. Of course, the trial-and-error will not be completely random, as it is not even for the rat in the Skinner-box: it will take the form of behaviour resembling what has succeeded in similar situations. The most likely behaviour-sequences to occur are: (*a*) *thinking*—implicit trial-and-error, insightful restructuring (Hull, 1952, chap. 10), stimulus generalization (as in 'deduction' Mowrer, 1950, chap. 11), 'intuition' (Piaget, 1947) and 'magical thinking' (Fenichel, 1945, p. 47); (*b*) *observation*—approach, receptor-adjustment, manipulation of environment, so as to perceive relevant stimuli, culminating in the controlled experimental and other techniques of science; (*c*) *recourse to authority*—asking experts, consulting books or oracles, etc. (Cf. intuitionism, rationalism, empiricism, and authoritarianism (Montague, 1936).)

If the processes lead to a pattern of responses that the subject's prior learning enables him to accept as an adequate answer, then the drive will be reduced. Since drive-reduction follows the rehearsal of the correct answer, the principle of reinforcement (Hull, 1952, postulate IV) implies that the latter will become strengthened as a response to the question. Furthermore, by the reinforcement-gradient principle, it will be learned more strongly than the responses that led up to it, so that in future the question will be followed by the answer immediately, and intermediate steps will be omitted.

If the answer is not arrived at readily by any of the procedures mentioned, then the process may be brought to an end in other ways. Some distraction may occur, i.e. an incompatible response-tendency with a higher reaction-potential may arise, or extinction may supervene. There will be extinction of each line of inquiry as it turns out to be unsuccessful and gives way to another, exactly as in trial-and-error learning (Hull, 1930), and also ultimately the drive-producing responses may be extinguished, so that the subject gives up altogether. It is unlikely that extinction will affect the intervening link, that between the words and the drive, since the motivating power of interrogative adverbs is frequently and partially reinforced in everyday life.

Let us now suppose that the subject fails to hit upon the correct answer in the course of striving for it. And let us suppose that on some future occasion he is told or shown the answer, i.e. exposed to some stimulus-complex which evokes the response he was seeking. We can expect this answer to elicit, by ordinary redintegrative remembering, an internal rehearsal of the question, so that it is *recognized* as the answer he was looking for on the earlier occasions. The stimuli produced by the response of rehearsing the question will thus occur about the same time as the rehearsal of the answer, and the stimuli produced by rehearsal of the answer will be followed closely by reduction of the drive that the question has re-aroused. Thus we can see the answer being learned by reinforcement as a response to the question, so that a new piece of knowledge is acquired.

It will by now be evident that the drive aroused by questions and other thematic probes is, by our definition, a form of epistemic curiosity. And an important consequence follows from the principles of behaviour theory, if our account so far is valid, which gives us a way of measuring this curiosity through its effects on remembering. Both introspective and behavioural evidence reveal that, when an acceptable answer to a question has been encountered and rehearsed, curiosity is reduced to a subthreshold value. But the higher the drive before such reduction, the greater the *amount of reinforcement* or quantity of drive-reduction (K). And according to Hull's (1943, 1952) postulates, the

probability of a response occurring on future occasions increases with reaction-potential (S^ER), which in its turn increases with K. It follows that those questions which originally aroused most curiosity are most likely to be answered correctly if they are encountered again after the answer has been presented to the subject, and we can use the probability of recall as a measure of curiosity. An additional measure depends on the fact that subjects are likely to have learned to respond with tacts to their own internal stimuli (Skinner, 1953, 1947), although less accurately than to external stimuli. They can accordingly be instructed to indicate which questions arouse the greatest desire to know the answer.

We have therefore arrived at the hypothesis that curiosity is aroused in a subject when a question is put to him, whether by himself or by an external agent. Some component (s_{mD}) of the response-produced stimulation resulting from the meaning of the question (r_m) is assumed to act as a drive-stimulus. And we can see that the intensity of this drive-stimulus, which will in its turn depend on the amplitude of the response (r_{mH}) that produces it, will be one of the most important variables affecting the drive strength of the curiosity.

There is some experimental evidence for the curiosity-inducing role of questions, but it is also borne out by everyday experience. Many celebrated thinkers have been stimulated to a lifetime's meditation simply because they thought of new questions about matters that ordinary men have taken for granted. Similarly, the skilful lecturer excites curiosity in his audience by putting questions to them, perhaps about familiar phenomena, which it has never occurred to them to ask themselves.

However, the factors mentioned so far do not adequately explain the most striking cases of curiosity-arousal, those concerning the strange, the unusual, the puzzling. To attempt an explanation of this side of human nature, we shall have recourse to another variable, *conflict*.

III. The role of conflict

After the necessary preliminary phase of considering over-simplified situations, in which either only one response-tendency or motive is active or else one response-tendency or motive is so much stronger than others as to be virtually alone in its influence, psychological theory had to turn to more realistic situations where there are factors in competition. Even an elementary treatment of trial-and-error learning (Hull, 1930) forces us to consider the process whereby one response overcomes alternative ways of reacting, but special phenomena result when competing tendencies are fairly evenly matched in strength. The study of such phenomena was begun by Lewin (1935) and then carried further on both theoretical and experimental planes by Miller (1944, 1951) and his associates. Dollard & Miller (1950) have shown how the behaviour-theory of conflict can be extended to embrace the main effects ascribed to conflict by Freud, while Hull has endeavoured to reveal its roots in the basic principles of learning (1952, chap. 8). A theory of emotion, based on the assumption that conflict (F) is in itself drive-producing, is an important recent development for which Brown & Farber (1951) are responsible and there are various observations from experiments with rats that tend to confirm this assumption (Finger, 1941; Lowell, 1952; Miller & Stevenson, 1936).

A rather different recent emphasis on conflict has come from Hebb (1946, 1949). This is particularly deserving of mention here, because it involves the central processes inter-

vening between stimulus and response, and that is precisely where we must seek the kernel of curiosity. Behaviour, in Hebb's view, depends on the intricate and nicely timed co-operation between 'cell-assemblies' in the cerebral cortex. If the timing goes awry, or if the processes ('phase-sequences') in the cortex otherwise interfere with one another, disruption will result. Some phase-sequences require the support of externally initiated sensory processes, and if these are not forthcoming, as when something familiar with an unexpected feature is perceived, disruption is once again a likely outcome. This disruption, which leads to a diffuse and disorganized release of energy, is what, according to Hebb, lies behind emotion. His principal illustration is his description of the fear induced in chimpanzees by surprising sights, but it is easy to see that these sights might instead have aroused curiosity in slightly different conditions. In his treatment of perceptual learning, Hebb describes how repeated exposure to a complex of stimuli builds up integrated and organized patterns of activity in the cortex, and thus conflict is eliminated as the unfamiliar becomes familiar. If we admit the possibility that the curiosity aroused by unusual perceptions has something to do with conflict, then the elimination of this conflict by exploration and the consequent drive-reduction might well play a part in perceptual curiosity. If we then extend these ideas to the autonomous processes which are the result of prior learning but can later run off in the absence of the corresponding environmental events, we can readily imagine how strange and puzzling thoughts or concepts may likewise involve conflict, and the acquisition of knowledge may mean the formation of new structures which obviate this interference. If conflict is a drive, the reduction of conflict will be reinforcing, and it will provide the explanation for the reward-value of investigating things that are puzzling and the learning of knowledge resulting from this investigation. Epistemic curiosity also will thus be attributable in many cases to a similar mechanism.

Hebb's concepts are physiological and refer to neural processes. But since these processes are at present not observable and serve merely as devices for explaining what can be observed, they are best regarded as intervening variables. It should not be difficult therefore to translate them into behavioural terms. The preference for purely behavioural terms may be justified as more than a matter of verbal taste, since these terms point to relationships between the sort of conflict under discussion and other areas in behaviour theory, including other forms of conflict.

We can begin our inquiry into the conflicts affecting trains of thought by recalling Miller's (1944) list of ways in which responses may be incompatible and therefore conflict. Sometimes the incompatibility is physical and innate, like that between approaching and avoiding the same object. But at other times, the conflict is learned. The responses are not inherently antagonistic, but learning has made the organism unlikely to perform both simultaneously or in close succession. This means that the response-produced stimulus (s_1) resulting from the first response (R_1) has become conditioned to a response (R_{-2}) which is physically incompatible with the second (R_2). If R_{-2} is stronger than R_2, the latter will thus be inhibited. When we extend these notions to symbolic responses, it is clear that physical incompatibility will not be of major importance. It may be that certain perceptual responses are innately incompatible, so that the conflict between an expectancy and a perception, for example, may be unlearned. But most of the antagonisms between symbols are almost certainly the results of learning, which trains us not to apply two particular words to the same object or combine two particular

concepts (r_m) in the same complex. Thus a thought or a perception may conflict with past experience by incorporating two elements previously learned as incompatible. There are two cases of learned incompatibility that are particularly likely to affect trains of thought. One is the learned incompatibility between *contradictory* beliefs, which enables us to recognize and avoid fallacious symbol-sequences. The other is the conflict between the learned fear of *irrelevance* and the tendency to perform an irrelevant verbal response. As we have already noted, the Würzburg school were impressed with the way in which the determining tendency kept thought in the right direction by excluding irrelevant associations. Modern learning theory (Dollard & Miller, 1950) leads us to the conclusion that this happens because the emergence of an irrelevant thought evokes a learned drive and its inhibition reduces the drive and is consequently reinforced. The existence of a strong 'drive to be relevant', at least in our culture, can be demonstrated in almost any session of psychotherapy with a neurotic. Long before his free association has led him to touch on anything delicate, he shows resistance, due to his previous training to speak relevantly and coherently. It takes several sessions before he can flit inconsequentially from one topic to another or expatiate on matters that seem unconnected with his symptoms, as he must if he is to obey the 'basic rule'.

In order to show how conflict can affect curiosity, it is helpful once again to take a concrete example of a question: 'what crops do some ants cultivate in underground "farms"?' We have already introduced the assumption that a question arouses concepts (r_m), including some which are drive-producing. But, in addition, we can indicate, with the aid of our illustrative question, four stages, at any or all of which conflict may occur to bring about an increment of curiosity-drive:

(1) The question itself may evoke concepts which past experience and instruction have made incompatible for the subject. In the case of our example, learned conflict may well exist in a zoologically naïve person between all concepts relating to farming and all relating to subhuman animals. This is what happens when the designator of the question is said to be 'surprising' or 'unexpected' or 'strange' or 'puzzling'. Instead of such a question being put to the subject by an outside source, he might have come across a stimulus-situation arousing perceptual responses which he has been trained to regard as incompatible. This might lead him to take a closer look (perceptual curiosity) or to formulate such a question himself.

(2) Even if the question itself did not imply any surprising fact (e.g., 'how does the starfish eat?') conflict may well arise immediately after its formulation, if the answer is unknown. If the answer is known, then there will be a response already learned to the stimulus-pattern produced by the question, and this response will probably occur without delay. But if the answer is unknown, then we must turn to behaviour theory for some hints as to what might ensue. If the organism is confronted with a combination of stimuli to which it has learned no response, we shall not expect it to do just nothing, unless it is a very primitive or young organism indeed. As Hebb (1949) has aptly reminded us, even the most novel situation for an adult rat or human being is built up of elements which resemble some things he has met many times before. Therefore, if a new question is the stimulus-situation, the responses that we can expect to occur are those which are aroused by stimulus generalization from similar patterns or elements. The strongest will be those conditioned to patterns consisting of some identical and some slightly different elements, as compared with the present pattern, or else those conditioned to single elements. For

example, if no responses have been learned to a combination of 'ants' and 'farming', we can expect responses to occur which are associated with 'ants' plus some other activity, or 'farming' plus some other animal, or with 'ants' or 'farming' alone. This follows from Hull's treatment of stimulus generalization and of patterning (1952, chaps. XII, XIX). However, the trains of thought leading out from 'ants' and from 'farming', etc., are likely to be of comparable strength and incompatible. So, here again, conflict may add to the drive-strength.

(3) As these associative processes continue, they are likely to lead, in the absence of other trains of thought, to some which are irrelevant to the motivation to answer the question. This will produce the type of learned conflict to which we have already drawn attention.

(4) Finally, in all probability, concept-patterns will be reached, which are recognized as possible answers. If one is strong and the others are not, then that one will be accepted and learned, and there the process will end. But it may very well be that the subject is faced, either through his own cogitations, or through the intervention of some external agency (as in 'multiple-choice questions'), with a number of possible answers which seem about equally plausible. In that case, conflict between them is to be anticipated. Moreover, if any answer is of such a strength that tendencies to accept or reject it are more or less equal, we shall have another source of conflict, reminiscent of the approach-avoidance conflict. The conflict characteristic of this fourth stage is, of course, particularly prominent in the 'yes-or-no question' (or the 'which—question'). The drive to have the answer will be strongest, according to our expectations, if the tendencies to say 'yes' and 'no' are about equal.

Now, the drive produced in these various ways by conflict can only rightly be called 'curiosity' or a 'drive to know' if it is reduced by the process of knowledge-rehearsal. We must then see how exposure to concepts which are acceptable as the correct answer might lead to conflict-reduction. There are in fact three ways in which this might happen, corresponding to our four cases of conflict as follows:

(1) The answer, by implying that two concepts formerly regarded as incompatible need not be so, may inhibit learned conflict. This would mean that the S–R bond between s_1 and R_{-2}, to use Miller's (1944) notation, would be inhibited by the action of verbal stimuli (Dollard & Miller, 1950). To revert to our example, the subject would cease to find surprising the idea that ants engage in a kind of farming.

(2) and (3) The answer may reduce the conflict derived from irrelevant, generalized trains of thought by evoking a new response-sequence which is strong enough to crowd them out and prevent them from arising. Thus, our subject, having been told something of the activities of harvesting ants, will in future, when confronted with a pattern of concepts combining 'ants' with 'farming', be led off along trains of thought peculiar to harvesting ants and capable of overcoming irrelevant digressions.

(4) The answer may reduce conflict by strengthening one competing response and weakening others, thus reducing the equality between them. This happens when we are made to believe that one of our suspected answers is right and the other is wrong. There is henceforth, therefore, no appreciable competition between them.

Since conflict (F) is an intervening variable, we must ask what variables affect its magnitude. Brown & Farber (1951) postulate that F increases with (1) the absolute strength of the competing tendencies and (2) the equality between them. There is some

experimental evidence for the first of these hypotheses. Sears & Hovland (1941) found that avoidance-avoidance conflicts provoke more blocking when the competing responses are stronger. The assumption that the symptoms of conflict only occur when the conflicting tendencies are about equal is confirmed time after time in Miller's (1951) experiments. Nevertheless, we are obliged to hypothesize that the intensity of the conflict-drive depends also on two more variables, which have been little studied, but which are of prime importance for conflict between thought-processes. These are (3) the number of conflicting response-tendencies and (4) the degree of incompatibility between them. A few remarks on each of these are in order.

First, Miller's treatment of conflict has been confined to cases where only two tendencies are in competition. For that matter, Lewin's, Freud's and Hebb's theories do not consider fully the possibility of there being more than two. Pioneering studies have of necessity to begin with the simplest cases, and there may be special reasons why dual rather than higher-order conflicts are the most frequent. When the theory of higher-order conflicts comes to be attacked it is likely to be found that two or more tendencies among those competing will usually have more in common than others, so that they form an alliance, and the situation resolves itself into what is virtually a dual conflict. It is interesting to note how this happens in Freudian theory. There are three components of the personality—id, ego, superego—but neurotic conflicts take the form *ego* + *superego* vs. *id* or *ego* vs. *id* + *superego* (Fenichel, 1945, p. 132). However, in the higher mental processes, higher-order conflicts may be common. Several trains of thought may be leading symbol-sequences in many incompatible directions at once, just as, in Hull's treatment of learning (e.g. 1930), one stimulus may arouse three or more reaction-potentials at once. It seems reasonable to assume that if the number of conflicting tendencies is increased, all things being equal, the severity of the conflict will increase.

Secondly, both Hull (1952, corollary xiv) and Miller (1944) speak of cases where the incompatibility between response-tendencies is absolute. But, as we have elsewhere mentioned (Berlyne, 1951, p. 144), even with innate reflexes intermediate degrees of incompatibility and partial interference are known. Learned conflict is likely to make even more indispensable the concept of degree of incompatibility, since the $s_1 \rightarrow R_{-2}$ bond may have various strengths. Subjects may, for instance, be surprised to different extents to hear of ants farming.

Our theory may link up with certain threads in contemporary social and developmental psychology. Many writers have been showing (Cantril, 1941, etc.) that one of the most distressing plights for human beings is not to know or to understand a state of affairs, particularly if it is important for their security or contrary to their expectations. One of society's most vital functions is to provide norms and frames of reference for the evaluation of new contingencies. If these are lacking or inapplicable to an unprecedented crisis-situation, people will be prone to accept and spread rumours or to succumb to suggestion. Many of the rumours and fanciful stories accepted by them in this gullible mood are the very reverse of reassuring. Indeed, they often show a tendency to believe in the most alarming prospects they can imagine, so that this desire to have an explanation available does not seem to be reinforced by fear-reduction. But the principal drive behind it may well be the conflict-drive, produced by uncertainty, which, as many wartime phenomena showed, is often more agonizing than realistic anticipation of unpleasantness. When there is a perplexing situation, raising an unanswered question, we predicted from the principles

of behaviour theory that responses due to generalization from similar stimuli would occur. This casts light on the inveterate proclivity, so often observed in children and in primitive peoples, to interpret in terms of familiar phenomena those things that are of moment to them but they have little objective information about, which gives their speculations an 'artificialistic' and 'animistic' stamp (Piaget, 1931). Similarly, when irregular figures are exposed in a tachistoscope, Bartlett (1932) reports that subjects evince an 'effort after meaning' which leads them, as their immediate reaction, to relate the figures to something familiar.

Our theory of curiosity implies that patterns will be most curiosity-arousing at an intermediate stage of familiarity. If they are too unlike anything with which the subject is acquainted, the symbolic response-tendencies aroused will be too few and too feeble to provide much conflict, while too much familiarity will have removed conflict by making the particular combination an expected one. Once again, we have a prediction that accords with the observations of psychologists working in several fields. McDougall (1908) contended that something with an intermediate degree of familiarity is the adequate stimulus for curiosity. Hebb (1949) expresses the belief that the mental processes corresponding to cortical processes ('phase-sequences') will be most rewarding, and therefore most likely to occupy the subject, when the phase-sequences are in the course of being built up. The cell-assemblies and phase-cycles will then be in existence, but they will not yet have been moulded into a firm unity. Freudians (Fenichel, 1945, p. 45) attribute many of the play-activities of children to the discovery that they are now able 'to overcome without fear a situation that formerly would have overwhelmed (them) with anxiety'. But this 'functional pleasure' will be attached to a given activity only during the comparatively short interval between coming to fear it and triumphing over the fear. Piaget (1931, 1945) writes of the apparently useless actions that infants are prone to indulge in repeatedly (primary, secondary and tertiary circular reactions); but each of these actions dominates a child's activity for a brief period while he has discovered the ability to produce the effects in question but has not yet assimilated them to the point where they cease to be interesting.

So far our discussion has concerned itself with postulated and unobservable central processes, which are represented by intervening variables. In order to reveal the empirical content of our theory and the testable predictions that can be derived from it, it will be necessary to state the relations between our intervening variables and their observable antecedents and consequents. This will be done in a forthcoming article in this *Journal*, which will also report some experimental data tending to confirm our hypotheses.

IV. SUMMARY

Human 'epistemic curiosity', to be distinguished from the 'perceptual curiosity' that is found in lower animals as well as in human beings, is defined as a drive reducible by knowledge-rehearsal. An analysis of epistemic curiosity, using a behaviour-theory approach, is presented, its principal features being (1) an account of questions as 'thematic probes' which evoke drive-producing meaning-responses, and (2) the attribution to learned conflict of the curiosity aroused by strange, surprising or puzzling situations or questions.

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