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ABSTRACT

This paper points out the inadequacies of emotional or drive-based theories of exploratory behavior and offers instead a behavior analysis conceptualization. Exploratory behavior as an emotional state was rejected because the environmental conditions said to arouse exploration and the behaviors said to manifest curiosity are too general to separate from other kinds of interactions. The drive theory was discarded for two reasons: (1) physiochemical change as the distinction between exploratory and non-exploratory behavior has not yet been clearly demonstrated and (2) the collative stimulus approach, in which the comparison of stimuli is said to arouse curiosity and thus lead to specific exploratory behavior, has not facilitated research. Behavior analysts contend simply that exploratory behavior generates repertories that facilitate the development of complex cognitive behavior and is the sort of behavior that is established and maintained by nonappetitive reinforcers. (JMB)

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Symposium: Functional Analysis of Complex Behavior in Children

Presentation: Exploratory Behavior

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Exploratory behavior or curiosity is a fascinating topic for study and one that enjoys an honorific status in our society. Yet little is known about its determiners or its relationships to other kinds of behavior, such as play, creativity or problem-solving. Edmund Burke claimed that "The first and simplest emotion which we discover in the human mind is curiosity" and Samuel Johnson maintained that "Curiosity is one of the most permanent and certain characteristics of a vigorous intellect."

Aside from such extravagant claims, one might say, on the basis of findings from laboratory research, that exploratory behavior probably generates repertories that facilitate the development of complex cognitive behavior and is the sort of behavior that is established and maintained by nonappetitive reinforcers. I should like to (1) examine the two main ways in which exploratory behavior has been treated in the psychological literature, (2) present a behavior analysis of exploratory behavior, and (3) indicate some of the problems and implications of this analysis. This presentation will be a brief overview. A more comprehensive treatment is included in a book on a behavior analysis of the preschool years (Bijou, in press, 1976).

Formulations of Exploratory Behavior

In contemporary child development literature, exploratory behavior is treated either as an emotion or as behavior motivated by a hypothetical

exploratory drive. Hurlock (1972), for example, states the case for exploratory behavior as an emotion. "Curiosity is a pleasant emotional state. It provides motivation to explore and to learn new meanings both of which activities are satisfying and conducive to good personal and social adjustment. Curiosity adds a pleasant excitement to life. It acts as a stimulus to physical well-being without disturbing body homeostasis as the unpleasant emotions do" (p. 202). According to this formulation, certain kinds of new and strange situations produce exploratory behavior. (Other kinds of new and strange situations arouse fear.) The young infant expresses exploratory behavior and curiosity by "tensing the face muscles, opening the mouth, stretching out the tongue, and wrinkling the forehead. By the second half of the first year, he stretches his body, leans forward, and grasps the curiosity-provoking object. As soon as he gets it, he begins a more thorough exploration by handling, pulling, sucking, shaking, and ratting it" (Hurlock, 1972, p. 203). In early childhood, curiosity is mainly directed toward the physical world and toward the anatomical differences between boys and girls (Mussen, Conger, & Kagan, 1974, p. 369-370). Because many kinds of direct exploration are punished, "...as soon as the child is able, he asks questions about things that arouse his curiosity. The 'questioning age' begins around the third year and reaches its peak approximately at the sixth year" (Hurlock, 1972, p. 203).

This notion that exploratory behavior or curiosity is an emotional state has little scientific promise because the environmental conditions said to arouse it, and the behaviors said to manifest it at the various stages of development, are too general to separate from other kinds of interactions. Furthermore, the successive changes in the forms of exploratory behavior are expressed as age-related norms, and like all norms, they are descriptions of the behavior of groups of children rather than descriptions of the behaviors of an individual child.

The conception that exploratory behavior is motivated by a hypothetical exploratory drive is shared by many psychologists (Berlyne, 1960 & 1963; Harlow, Harlow, & Meyer, 1950; and Reese & Lipsitt, 1970). Berlyne, who developed this view most thoroughly, states that "Exploratory responses have the function of altering the stimulus field," and then adds, as he rightly should, that "all responses change the stimulus field in some way, and one might very well claim that any one response must have the production of a change in the stimulus field as a part of its function..." (1963, p. 287). He goes on to say that, nevertheless, a distinction can be made between exploratory and non-exploratory behavior. "...the stimulus changes introduced by non-exploratory behavior are accompanied by biologically important effects on tissues other than the sense organs and the nervous system, and this is not true of the changes due to exploration" (p. 287). Thus, he distinguishes exploratory behavior from non-exploratory behavior on the basis that exploratory behavior does not have biological functions; it serves only to change the stimulus field.

Berlyne maintains that the strength and direction of exploratory behavior come under the control of the state of the organism and the properties of external stimuli. The properties of external stimuli are divided into two classes. One pertains to the properties that are important in other areas of behavior, such as stimulus intensity and stimulus affective value; the other to collative properties, which depend on information derived from comparing either the stimulus in question with others accompanying it, or a present stimulus with stimuli encountered in the past. Collative properties include novelty, surprise, change, ambiguity, incongruity, blurredness, and the power to induce uncertainty. These properties of stimuli, Berlyne's theory goes, induce a state of arousal, or a drive state, which naturally leads to <u>specific</u> exploratory behavior which in turn lowers this drive state, and in so doing strengthens the antecedent exploratory behavior.

Berlyne (1960), Hutt (1970a,b), and others claim that in addition to specific exploratory behavior, there is a second category called diversive exploratory behavior, motivated by boredom (a hypothetical drive) that leads to a change in the environment. It is as though the individual becomes satiated or "fed up" with the same situation and does things to bring about a change.

Berlyne's analysis of exploratory behavior is questionable on several grounds. First, the distinction between exploratory and non-exploratory behavior on the basis of the occurrence of physiochemical changes (biological functioning) has not as yet been clearly demonstrated and can hardly serve as a differentiating criterion. Second, the claim that specific exploratory behavior is aroused by the collative stimulus properties of novelty, surprise, change, ambiguity, incongruity, blurredness, and the power to induce uncertainty has not facilitated research on exploratory behavior. For the most part, investigators concentrate on stimulus complexity and novelty (see Hutt, 1970a), either ignoring the other collative categories or treating them as part of complexity or novelty. This is not to say, however, that the terms complexity and novelty themselves are easily definable (Nunnally & Lemond, 1974). Third, the hypothetical variables and processes, such as arousal, arousal-balance, boredom, and drive reduction, have equivocal meanings. Hutt (1970a) claims that "...any drive is defined by the operations chosen to demonstrate it; the precise relationship between dependent and independent variables is still insufficiently explained to make the term 'curiosity' much more than a description of the observed phenomena" (p. 71). Cantor (1963), who has done extensive research with children, has questioned the soundness of Berlyne's postulated hypothetical internal chains or events, and Cofer and Appley (1964) have concluded, after a review of the literature, that the drive-induced concept of exploration is a liability to an analysis of exploratory behavior.

Behavior Analysis of Exploratory Behavior

From a behavior analysis point of view, exploratory behavior is a sequence of operant interactions that is strengthened and maintained by contingent non-appetitional ecological stimuli under specifiable setting factors (Bijou & Baer, 1965, pp. 5-7). Let us elaborate on the concepts of ecological stimuli and setting factors for exploratory behavior.

Ecological Stimuli

Ecological stimuli originate in interactions with physical objects and with the physical dimensions of social and biological stimuli. Physical objects include natural objects (stones in a river bed), and man-made objects (pots in a cupboard); social and biological stimuli include the anatomical structures of others (the movement of father's finger as it makes a "come here" gesture), and of the individual's own anatomical makeup (a loose tooth); his own biological functioning (the changes in his respiration); and his own actions (jumping into a swimming pool). As the child interacts with objects, or with the physical aspects of social and biological entities, stimuli are produced. If he were to approach these stimuli and manipulate them, changes would occur in the size, shape, and color; if he were to hit, bend, squeeze, or break them, noises would be emitted; if he were to rub them against his face, they would feel smooth, rough, cold, or wet; if he were to suck, bite, and chew them, they would taste bitter, salty, or sweet, and if he were to put them near his nose, they would smell pleasant or foul. If stimuli of this kind strengthen the behavior that precedes them they have reinforcing property for that child under the setting conditions in effect at that time. We call these stimuli ecological stimuli, and when they have reinforcing properties, ecological reinforcers, to distinguish them clearly from appetitive reinforcers, and we refer to the behavior they strengthen as exploratory behavior or curiosity.

The research on ecological reinforcers with children is exemplified by the meticulous work of Rheingold and her colleagues. In their study on the effects of visual and auditory stimulation on manual responses, Rheingold, Stanley, and Doyle (1964) provided two- to five-year-old children with an opportunity to touch a ball and to discover that it resulted in a 3-second motion picture of brightly colored geometric figures (circles, squares, stars, and crosses of various sizes) moving slowly across a dark field to the accompaniment of a Swiss music-box rendition of "Annie Laurie." The experimental question was: Do these visual and auditory stimuli function as reinforcers for this class of operant behavior? Since operant behavior is influenced by schedules of reinforcement, a comparison of children's performances on two schedules of reinforcement yielding different response patterns should suggest an answer. For example, with established reinforcers, children respond faster with increasing fixed-ratio schedules of reinforcement (schedules in which the reinforcer is delivered following a fixed number of responses). Of the 20 children in the Rheingold experiment who were assigned to fixed-ratio schedules, 15 showed increasing rates of responding with advancing fixed-ratio schedules. On the other hand, none of the five children who were given a continuous-reinforcement schedule (in which each response is followed by the experimental contingency), showed such a progressive increase in rate of responding. The findings strongly indicated that the contingent visual and auditory stimuli in this study functioned as reinforcers for these young children. The authors concluded that "...the present results supply evidence for the reinforcing properties of exteroceptive, rather than primary biological, or homeostatis-preserving stimuli (Rheingold, Stanley, & Doyle, 1964, p. 325).

Studies with nursery school children by Antonitis and Barnes (1961), Frey (1960), Friedlander (1966), and Hutt (1966), showed that lights, chimes, bells,

buzzers, movement of numbers on counters, and tape recordings of "That's bad," "That's good," and "That's good" in a garbled form were all reinforcing; studies with babies and infants by Friedlander (1967), Watson (1969), and Rovee and Rovee (1969) revealed that tapes of parents' conversation and visual, auditory, and somesthetic stimuli were also reinforcing.

Setting Factors for Exploratory Behavior

An ecological reinforcer, like all reinforcers, is functional only under certain setting factors (Bijou & Baer, 1961, p. 21). Investigators report, for example, that infants under certain conditions will display exploratory behavior to novelty and complexity. The "certain conditions" include: (1) The absence of setting factors that increase the probability of occurrence of behaviors more powerful than exploratory behavior, and (2) the presence of setting factors that increase the reinforcing function of ecological stimuli.

Setting factors that generate behaviors more powerful than exploratory behavior means that a child at the moment is not substantially deprived of appetitive reinforcers (that is, he is not hungry, thirsty, etc.); he is not fatigued, sleepy, nor ill (Piaget (1929), for example, states that exploratory behavior usually takes place in healthy children; he is not responding to strong emotional predispositions (e.g., anger, fear, or joy); he is not responding to strong aversive stimulation (e.g., a wet, cold diaper); and he is not under medication with stimulating or debilitating effects. All of these setting factors generate behaviors that compete against, or override, exploratory behavior, at least during the basic stage of early childhood.

Setting factors that increase the reinforcing function of ecological stimuli include the lack of prior exposure or the deprivation of opportunities to engage in ecological behavior (Kish, 1966). In everyday language, one might say that not having opportunities to explore creates in the child "a need" for

exploratory behavior. It should be noted that deprivation of ecological activity does not include deprivation of sheer activity, such as running.

Summary

We have examined exploratory behavior as behavior motivated by an emotional state and as behavior "impelled" by a hypothetical exploratory drive, and have presented a case for analyzing it as operant behavior supported by ecological reinforcers in the context of certain setting factors. It follows from the view taken here that exploratory behavior cannot be identified by a special set of response topographies, such as seeking, searching, and manipulating. The responses in exploratory behavior can be any dimension or any combination of dimensions of physical objects or the physical aspects of organismic and social entities - temporal, spatial, and movement. Whether a given set of physical properties is discriminative for exploratory behavior under the prevailing circumstances depends on whether the child interacts with the stimuli and is reinforced by the consequences, that is, whether the frequency of responding rises above the operant level.

According to the analysis presented here, exploratory behavior is neither an emotion; an indication of a vigorous intellect; play, although some forms of play may include exploratory behavior; behavior instigated by the collative properties of stimuli and strengthened by the reduction of a hypothetical state of arousal; behavior aroused by aversive stimuli or settings, such as strange places; behavior aroused by biological deprivations as food seeking; nor behavior precurrent to creativity, although problem solving that leads to creativity may include exploratory behavior.

Some Problems

Are contingent ecological stimuli natural reinforcers, as food for a food-deprived person, or are they acquired reinforcers developed through their close

relationships with natural reinforcers? The answer is empirical. Recent findings seem to favor the position that they are natural. In reviewing the animal literature, Kish (1966) concluded that available data do not support the view that ecological reinforcers are acquired and recent research on human infants and young children strongly indicates that contingent auditory and visual stimuli strengthen operant behavior. Hence, both animal and human laboratory research findings suggest that ecological stimuli are innate reinforcers, that under proper setting conditions they strengthen the preceding operant behavior. Furthermore, stimuli that are discriminative for ecological reinforcers, or stimuli that are paired with contingent ecological stimuli, acquire conditioned reinforcing properties (Bijou & Baer, 1961, pp. 53-58).

The literature indicates, too, that exploratory behavior strengthened only by ecological reinforcers is weak when compared with behavior strengthened by appetitive reinforcers, or by the withdrawal of strong aversive contingencies. However, exploratory behavior may be strengthened by non-ecological reinforcers. For example, social reinforcement may be added to ecological reinforcement by members of a child's family and by his preschool and kindergarten teachers, who, believing that exploratory behavior should be encouraged, make a special effort to provide the child with opportunities to engage in this kind of activity. Social reinforcers frequently accompany ecological reinforcers because of the natural coexistence of many social and ecological reinforcers (Little brother watches big brother's goldfish, not only because of the movement of the goldfish but also because it provides an opportunity for him to be near his brother.). Likewise, there are situations in which appetitive reinforcers augment ecological reinforcers, as in the case of a child's "discovering" that the pretty red berries on a bush in his back yard also taste sweet Looked at this way, exploratory behavior contributes substantially to an individual's network of interests, values, and inclinations.

Occurrences of aversive contingencies from physical sources must also be taken into account in understanding the development of exploratory behavior. It is obvious that exploratory behavior in any situation may produce aversive consequences and may thereby reduce or eliminate similar behaviors on future occasions (e.g., a child playing in a pool falling down and almost drowning, and his subsequent fear of going into the water). To be understood, the effects of an aversive consequence must be viewed functionally, that is to say, in terms of a child's biological make-up and interactional history. We see then that exploratory behavior may be weakened, modified in form, or extinguished through the aversive contingencies brought about by exploratory behavior itself.

Aversive contingencies from social sources also affect the development of exploratory repertories. New and strange situations, per se, are probably not naturally aversive (Rheingold & Eckerman, 1969). However, aversive contingencies may arise from apparent conflicts with moral standards. Many forms of exploratory behavior may be perceived by parents and teachers as immoral and, as such, are punished. The best-known example is, of course, a young child's examination of the anatomical differences in a child of the opposite sex. Another source of aversive contingencies is the practices of parents and teachers that restrict exploratory behavior because a child might hurt himself or might inconvenience someone. ("The swing will come back and hit you in the head if you push too hard on it.") Punishment of exploratory behavior for any reason may change the positive reinforcing properties of ecological stimuli to conditioned aversive contingencies. When this happens, escape and avoidance behaviors replace exploratory behaviors.

Some Implications

This analysis points up two interesting characteristics of exploratory behavior. First, because ecological stimuli originate in the interaction of a child with physical objects, or in the physical aspects of social and biological

stimuli, the reinforcement of exploratory behavior occurs immediately following the response, that is, the interval between the response and the ecological reinforcer is practically zero; consequently that behavior is strengthened quickly. Second, reinforcement tends to occur on a continuous reinforcement schedule, suggesting that after it is acquired it is not particularly resistive to extinction. Hence, one would expect that exploratory behavior observed in laboratory settings would be strengthened and weakened relative rapidly (Hutt, 1966). These characteristics hold for objects with unpredictable consequences, like "crazy clay," bouncing as it does, a different way each time, thus making it consistently interesting.

The most significant implication of this analysis of exploratory behavior is the reconfirmation that a large portion of a child's behavior repertory is strengthened and maintained by non-appetitive reinforcers When one thinks of the thousands and thousands of reaction patterns that evolve from a child's interactional history and of their maintenance as parts of his personality structure, one must remember that the main process involves strengthening through the action of a wide range of reinforcers. The fact that so much of the learning seems to come from "trivial" or "unimportant" activities, such as play, should encourage one to study the conditions that produce them and to pinpoint their relationships with other behaviors, especially those considered "important."

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Footnote

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