Getting animals to understand the experimenter's instructions*

HENRY GLEITMAN

University of Pennsylvania, Philadelphia, Pennsylvania 19104

A general procedure is described whereby animals may be trained to understand certain instructions posed by the E. Animals trained in this way could then provide the answers to some questions that have often been dismissed as anthropomorphic and untestable, such as: Are conditioned reinforcers sought or avoided because of what they signal or for their own sake? Can animals distinguish between "before" and "after"? Can they recall? Special emphasis is paid to some issues in the learned taste aversion literature.

Many questions about animal behavior are often dismissed as anthropomorphic and essentially untestable. This is a strategic error. We will examine several questions of this sort, such as: Are conditioned reinforcers sought or avoided because of what they signal or for their own sake? Can an animal distinguish between "before" and "after"? Can it recall? Our thesis is that such questions are, in principle, answerable if the animal can first be taught to abstract the relevant concept from a wide range of situations and can also be trained to perform an appropriate set of indicating responses. We will outline the required training and testing procedures, most of which are variants of learning-set techniques commonly used in primate research. Such procedures may permit the resolution of a number of substantive empirical issues. Over and above this, they have an intrinsic interest of their own, because the analysis of how a given question must be posed to a nonverbal creature may yield a better understanding of what the question really means, whether it is asked of an animal, an infant, or an adult human S.

ACQUIRED INTRINSIC VALUE

Recent discoveries of learned taste aversions (e.g., Garcia & Ervin, 1968; Rozin & Kalat, 1971) have reopened an old question about acquired preferences of all kinds. Is the hitherto neutral stimulus sought or avoided because it somehow signals a desired or aversive consequence (such as food, footshock, or sickness) or has this once-neutral stimulus become desired or aversive in its own right? The second alternative may be described as the hypothesis of *acquired intrinsic value*. It has been raised in various contexts. For example, it is implied in Freud's notion of libidinalization as inferred from the behavior of the fetishist for whom boots and corsets have become gratifying in and of themselves. It also underlies such related concepts in personality theory as functional autonomy (Allport, 1937) and

canalization (Murphy, 1947). A similar interpretation has been offered by Garcia for acquired aversions to tastes followed by poisoning or X-ray irradiation (Garcia, Clarke, & Hankins, 1973). According to Garcia, the animal avoids the previously neutral or preferred flavor, not because the flavor signals later sickness, but rather because it now tastes worse. This interpretation apparently accords with the introspective accounts of humans who have developed taste aversions (Garb & Stunkard¹). The question is how one can decide whether the flavor really tastes worse than before—whether the acquired value is ever really intrinsic—when the S is an animal.

Such evidence as has been offered is not convincing. For example, Rozin reports that thiamine-deprived rats tend to spill familiar food eaten while they became thiamine-deficient; this is just what they do when presented with intrinsically unpalatable foods such as quinine-adulterated diets (Rozin, 1967). This finding is consistent with the hypothesis of acquired intrinsic value, but it does not demand it: a similar defensive reaction might occur if the familiar food becomes a signal for illness. Another line of evidence concerns the generalization of learned aversions when tested outside of the experimental situation. Thus, Garcia, Kovner, and Green (1970) showed that although a flavored fluid which preceded footshock may become a CS for an appropriate locomotor avoidance response, this same liquid will be readily accepted when offered in the home cage. On the other hand, if the flavor is followed by X-ray irradiation, the resulting taste aversion holds wherever the fluid is encountered later (Garcia, McGowan, & Green, 1972). These results have been interpreted as indicating a cue function in the first case and a change in hedonic tone (palatability) in the second. But it is possible that irradiation-produced aversions simply reflect a link between the flavor and the subsequent illness; the strength of this link and its broad generalization may then be ascribed to special factors such as "belongingness" (Garcia & Koelling, 1966).

It is worth noting that various other effects observed in learned taste aversions are largely irrelevant to the question of whether these aversions are based on cue

*This research was supported by Public Health Grant 23505-01. The author wants to thank F. W. Irwin, J. Jonides, J. Nachmias, P. Rozin, M. E. P. Seligman, and R. L. Solomon for helpful comments and criticism.

function or on acquired intrinsic value. An example is the observation that the animal's response to the critical flavor is quite different from its reaction when actually ill (Garcia et al, 1973). While this finding argues against the Pavlovian hypothesis of stimulus substitution, it is not inconsistent with the hypothesis of acquired intrinsic value: the animal may come to detest a flavor without confusing it with the subsequent illness. Of equally dubious relevance is resistance to extinction. One might assume that learned preferences based on signal function will extinguish more rapidly than those based on acquired intrinsic value. But this conclusion only follows if one is prepared to make further assumptions about the modifiability of learned preferences or aversions after they have been established. At least in principle, one can conceive of signal functions that are highly resistant to extinction and of acquired intrinsic values that are not.

The problem is that there is presently no behavioral index that spells out the notion of acquired intrinsic value directly. The available evidence is relevant only if one is willing to make some further assumptions about various empirical consequences that follow from the distinction between cue function and acquired intrinsic value, and such assumptions are often hard to justify. Our present purpose is to describe a direct test for acquired intrinsic value. Hopefully, this test is formally analogous to the question one might pose to a human S: "Are you avoiding this flavor [or this sight or this sound] because you dislike it as such or because you believe that it will make you feel ill later?" To answer this question, the S must previously have abstracted the cross-situational concepts "like" and "dislike" which apply to all reinforcers regardless of their nature, whether toothaches, steaks, or sexual experiences. He must also have acquired the conceptual distinction between "liking or disliking as such" and "seeking or avoiding because of some consequence." He must finally have learned to map these distinctions onto a system of indexing responses such as phrases like "I like it for its own sake." This paper describes some procedures whereby an animal might be taught the relevant conceptual distinctions and the indexing responses that go with them. Whether animals (for example, monkeys) will, in fact, learn all these prerequisites is, of course, an open, though not uninteresting, question. Whether they will show acquired intrinsic value, given that they have learned all of the necessary preliminaries, is equally open.

The proposed procedure trains the animal to abstract the concept of "more or less preferred," independent of the nature of the reinforcers, by the use of learning-set techniques (Miles, 1965). The individual tasks are conditional discriminations in which the cues are pairs of (mildly) reinforcing stimuli, one of which is more preferred than the other, with one response (e.g., left bar) always correct when the cue is the more preferred stimulus and the other (e.g., right bar) when it is the less

preferred one. This procedure guarantees that the indexing response is neutral. By pressing the left bar, the animal "declares" that the prechoice stimulus used on this trial is the more preferred one, but this response is not itself an approach to the cue or an avoidance. In this sense, it is like the phrase "I dislike it" which one may utter quite truthfully, even while approaching the disliked object (e.g., when taking medicine).

We will now describe the procedure in detail. Considering the complexity of the required learning sets, the Ss should probably be primates, though in principle the procedure is applicable for other animals as well.

The Basic Paradigm

Stage 1

The first step is the establishment of the learned preference or aversion whose acquired intrinsic value is in question. We will assume that this is an acquired taste aversion. One flavor, S_1 , will be followed by poisoning or X-ray irradiation, while another, S_2 , will not. Subsequent preference tests will assess the acquired aversion in the traditional manner. Such tests will be interspersed throughout the following training stages. If the aversion declines, the original treatment will be readministered as required.

Stage 2

The next stage is training the animal to abstract the concept "more or less preferred." The animals will learn a series of conditional successive discriminations in a two-response apparatus (e.g., right and left bar). The first problem will utilize two cues, Z_1^* and Z_1^{**} , presented separately on different trials, which serve as signs indicating the correct response. Z_1^* and Z_1^{**} are reinforcing stimuli in their own right that belong to the same general category of reinforcers (e.g., two solutions of different sweetness). Moreover, Z_1^{**} is known to be more desired (or less aversive) than is Z_1^* , as indicated by appropriate preference tests (e.g., Irwin, 1971) performed outside of the present situation. For example, Z_1^{**} may be a concentrated sucrose solution, while Z_1^* is a more dilute one. The correct response is followed by a reinforcer, G, which is very much more preferred than either Z_1^* or Z_1^{**} . G is also more preferred than any other such cues (Z_1^* and Z_1^{**}) used in subsequent discrimination problems and, furthermore, belongs to an altogether different category of reinforcers. To obtain G, the animal must follow the response rules:

If Z_1^{**} , R_1

If Z_1^* , R_2

If and when the animal masters this first discrimination, he proceeds to learn a second one in

which the responses are the same as before but in which the cue stimuli are two new reinforcers, Z_2^* and Z_2^{**} , where Z_2^{**} is more preferred than Z_2^* (e.g., a mild electric shock and a somewhat stronger one). To obtain G, the response rules are analogous to those used previously:

If Z_2^{**} , R_1

If Z_2^* , R_2

This procedure is repeated for as many pairs of Z_i^* and Z_i^{**} as necessary. The hope is that the animals will acquire the appropriate learning set and will eventually perform R_1 given Z_i^{**} and R_2 given Z_i^* with a minimum of exposure to these cue stimuli. If so, they may be said to have abstracted the concept of "more or less preferred."

Stage 3

If the animals have attained the learning set required in Stage 2, they are ready for the final test. This is a conditional discrimination utilizing the same general set-up as before, except that now S_1 (the flavor followed by illness) and S_2 (the neutral flavor) will serve as signs. The question is whether the animals show appropriate transfer. Are they more likely to perform R_2 (the response previously required in the presence of the less preferred cue) when given S_1 (the flavor which preceded illness) as assessed by a lesser difficulty in learning the response rules "If S_1 , R_2 ; if S_2 , R_1 " than in learning the reversed rules "If S_1 , R_1 ; if S_2 , R_2 "? If no such positive transfer is found, the hypothesis that S_1 has acquired intrinsic value becomes very dubious. If it is found, we will still have to rule out some further factors.

Discriminating Between "Value Now" and "Value Later"

Positive results in the test stage of the basic paradigm are not necessarily evidence for acquired intrinsic value. One may argue that the indexing response R_1 is given in the presence of the more preferred cue regardless of whether this preference is based on the intrinsic value of the cue or the preference for the event that it signals. To deal with this possibility, the animal must now be trained to disregard the consequences of the cue and to respond only to its present (i.e., intrinsic) value.

Stage 1

The Ss may or may not be animals that are already trained on the basic paradigm. If they are new to the situation, they are first given an acquired taste aversion as in Stage 1 of the previous procedure.

Stage 2

The animals will be trained on a series of Pavlovian discriminations in which CS+ and CS- are pairs of mild reinforcers Z_i^* and Z_i^{**} of the kind used in the previous paradigm. The UCS is some new, strong reinforcer that is qualitatively different from all Z_i and also from G, the reinforcer that is used in the conditional discriminations. On half of the Pavlovian discriminations, Z_i^{**} will serve as CS+ and Z_i^* as CS-; on the other half, Z_i^* will be CS+ and Z_i^{**} will be CS-. This arrangement unconfounds intrinsic preference and subsequent outcome.

Stage 3

Once these Pavlovian discriminations have been learned, all of the Z stimuli that were used as CS+ and CS- will serve as cues in a series of conditional discrimination problems patterned after the procedure of Stage 2 of the previous (basic) paradigm. For all of these problems, Z_i^{**} will signify that R_1 is correct and Z_i^* that R_2 is correct. Whether a given Z_i has been CS+ or CS- previously does not affect the response rule. To guarantee that the various Z_i s continue to be effective as CS+ and CS-, appropriate tests (and if necessary, further Pavlovian discrimination training) will be interspersed throughout the entire procedure.

Let Z_i^{*+} indicate a less preferred cue that previously served as CS+, Z_i^{*-} a more preferred cue that previously served as CS-, and similarly for another pair Z_j^{*-} and Z_j^{*+} in which the more preferred stimulus served as CS+. Then the response rules will be as follows:

If Z_i^{*-} , R_1 If Z_j^{*+} , R_1

If Z_i^{*+} , R_2 If Z_j^{*-} , R_2

Stage 4

When the animal acquires the appropriate learning set, it can now be tested with S_1 (the flavor preceding illness) and S_2 (the neutral flavor) using the same procedure outlined in Stage 3 of the basic paradigm. If the appropriate transfer occurs (i.e., R_2 when presented with S_1), we have plausible evidence for acquired intrinsic value, because the animal has previously learned to consider only the present value and to disregard future value during the preceding training.²

An even stronger test might be provided by putting present against future value initially. The Pavlovian discrimination would then always have Z_j^{*+} as CS+ and Z_j^{*-} as CS-. In the subsequent conditional discrimination problems, Z_j^{*+} would always require R_2 and Z_j^{*-} would always require R_1 . If the final test shows that it is easier to learn R_2 when presented with S_1 , this is clear evidence for acquired intrinsic value. However, if there is no such transfer, no conclusion can

be drawn: there may have been acquired intrinsic value which was overpowered by the perhaps more salient signal function (the future value).³

Evidence for acquired intrinsic value would be of considerable interest, for it bears on the question of whether acquired taste aversions represent a kind of learning that differs in some fundamental ways from that which is exhibited in "orthodox" classical conditioning situations. We already know that acquired taste aversions differ from orthodox classically conditioned reactions in several striking respects. They can be established with remarkably long delays of reinforcement (Garcia et al, 1966); they can be acquired under anesthesia (Roll & Smith, 1972); they show no generalization decrement when the exteroceptive stimulation is markedly altered (Garcia et al, 1970); they exhibit little or none of the blocking effect typically found in classical conditioning when shock is the UCS (Kalat & Rozin, 1972). Several theorists have suggested that this cluster of overt differences effects some fundamental differences in the underlying learning processes (Garcia et al, 1972; Seligman & Hager, 1972). This hypothesis will be rendered more plausible if it turns out that acquired taste aversions involve acquired intrinsic value, while orthodox classically conditioned reactions do not, a result by no means unlikely given the introspective accounts of taste aversions in humans (Garb & Stunkard¹). Such a result would suggest that an important difference between acquired taste aversions and ordinary classical conditioning is in *what* is learned. In the one case, there is a change in the affective tone of a stimulus; in the other, the change is in what a stimulus signals. Whether the two learned patterns also differ in *how* they are acquired (e.g., Garcia et al, 1972; Seligman, 1970) is a separate question, though one might well suspect that when the *what* of learning differs radically, its *how* is not likely to be the same.

SOME QUESTIONS ON ANIMAL MEMORY

Distinguishing "Before" and "After"

Human memory is in part organized within a temporal framework which lets us remember that some event occurred before another (e.g., Tulving, 1972). Do animals have a memory system that provides a similar distinction between "before" and "after"? To answer this question, the animals must first be trained to understand what the E's instructions mean.

Our proposed procedure is a variant of those sketched before. The S will be shown two different objects in succession: first A, then B. Both objects are then presented simultaneously. A signal panel indicates which of the two objects the animal must choose: if it is red, A is correct; if it is green, B is correct. This procedure continues with new stimuli (A_i , B_i) until the animal acquires the appropriate learning set. If it is consistently choosing A_i given a red signal and B_i given a green one,

one may conclude that it can remember which object was previously presented before the other.⁴

Some pretraining may be necessary to help the animal abstract the relevant temporal relation. One possibility is to begin by coloring the two objects, A_i and B_i , red and green, respectively, when they are presented successively. When later shown simultaneously, they will both be gray. The response rules will be the same from pretraining on: choose A_i given a red signal and B_i given a green one. This continues until the appropriate learning set is acquired. When this happens, the procedure is modified so as to force the animal to base its response solely upon temporal order without relying on the remembered color of the object. To this end, the color cue is gradually faded out during the initial (successive) presentations until it is finally omitted altogether so that both objects are gray throughout.

Given successful learning, one can obviously test for the role of various relevant factors such as time intervals. An interesting question concerns the generality of the concept of temporal order. If three objects, A_i , B_i , and C_i , are presented successively, will the animal "transpose" successfully by, say, selecting B_i given a choice between B_i and C_i and a red signal panel?

Can Animals Be Tested for Recall of Sensory Experiences?

The preceding example dealt with the recognition of temporal order. Can animals be asked to *recall* which object came first and which second? In a recall test, a S is asked to *produce* one or more items that belong to a previously presented set. Successful performance is generally said to imply appropriate initial perception, storage, and subsequent retrieval. But there is another requirement which is rarely mentioned because human Ss meet it so readily. To *produce* the item requires a response system that is mapped to the relevant set of perceptual experiences and either recreates the appropriate experience (as in imitation) or indicates it by an appropriate sign (as in language). If animals are to be tested for recall, they must first be taught some appropriate response system that fulfills this function.

The proposed procedure assumes that the animal has successfully gone through the "before" and "after" training. The S will be trained by appropriate conditional discrimination procedures to perform various indicator responses ("words") in the presence of different stimulus objects. These indicators might be different locomotor or manipulative reactions, as in the Gardners' attempt to teach a sign language to chimpanzees (Gardner & Gardner, 1969), or the selection of some nonsense forms that are arbitrarily paired with the stimulus objects (as in Premack, 1971). Once these object-indicator relations are established, the animal will be exposed to A_i followed by B_i and will then be required to perform the appropriate indicator response depending upon the color of the signal panel. If

the panel is red, the appropriate indicator response is that associated with A_i ; if it is green, the indicator response is the one associated with B_i . Should it be able to do this, the animal has obeyed the instruction: "Tell me which object was the first one you saw."

CONCLUSIONS

We have described some examples of how one might train nonverbal creatures to understand certain instructions posed by an E. Whether a given animal will in fact learn these instructions is obviously an open question; given the progress reported by Gardner and Gardner (1969) and Premack (1971) in teaching language to chimpanzees, there is reason to believe that such efforts may be successful in primates.

But whether successful or not, training procedures of the kind we described may have some theoretical value of their own, for in developing them, one is necessarily forced to explicate in some detail what the E's question really means. Adult human Ss obligingly obey a large number of instructions such as "Try to remember as many items as you can," or "Draw the figures I just showed you." Some very important psychological issues are buried right inside of these instructions—the notion of central control processes in memory retrieval, of sensory-motor mappings which permit visual reproduction, and so on. The S evidently understands what the E asked of him, but does the E understand his own question at any deeper level than does the S? Does he understand it as a psychologist or only as a fellow human being? An analysis of the preliminary training that might teach the equivalent instructions to a nonverbal S may suggest something of what such instructions actually instruct the S to do.

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NOTES

1. Garb, J., & Stunkard, A. J. Taste aversions in man. Submitted for publication, 1973.

2. One may argue that this design will not adequately unconfound the relevant factors in the event: (a) that acquired intrinsic value exists and (b) that it is necessarily conferred upon CS+ in classical conditioning. As a result, the intrinsic value (original and acquired) of some Z_i pairs may be in the wrong direction from that demanded by the experimental design, with a higher value for Z_i^{*+} than for Z_i^{*-} . If so, the animals may be unable to acquire the appropriate learning set for the conditional discrimination problem. This argument, however, becomes irrelevant if this learning set is in fact obtained, because this could only be based on the original intrinsic values (e.g., concentrated vs dilute sucrose solutions) rather than on the hypothetical acquired values accruing from the UCS, since Z_i^{*+} and Z_i^{*-} were employed as CS+ equally often. In any case, we doubt that classical conditioning generally confers acquired intrinsic value upon any CS+, for we suspect that this effect occurs only when special conditions of "belongingness" are met. Since the UCS used in Stage 2 of this procedure will always be the same (e.g., shock or food), it is unlikely that belongingness will be a factor.

3. To rule out various alternative theoretical interpretations, it may be necessary to expand the range of Z_i^{*+} and Z_i^{*-} pairs during conditioning discrimination training by including (1) pairs whose members belong to different reinforcer categories, (2) pairs which straddle the affective zero point (e.g., mild electric shock vs sucrose), and (3) pairs in which one of the cues is at affective zero (e.g., tone vs sucrose). Such manipulations should provide a further guarantee of a sufficiently general concept of "more or less preferred."

4. In this design, A and B always stand for the first-presented and later-presented objects, respectively. A_i objects taken as a group have no greater formal similarity than do B_i objects taken as a group.