NAMING IN CONDITIONAL DISCRIMINATION AND STIMULUS EQUIVALENCE

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Using a matching-to-sample procedure, McIntire, Cleary, and Thompson (1987) taught monkeys the conditional relations A1-R1-A1-R1, A2-R2-A2-R2, A1-R1-B1-R1, A2-R2-B2-R2, B1-R1-C1-R1, and B2-R2-C2-R2, where the first and third terms in each relation refer to the sample and comparison stimuli, respectively, and the second and last terms refer to the emission of a distinctive pattern of responding. The subjects were then tested for the emergent relations A-C, C-A, B-A, C-B, and B-B, with the differential response produced by a given stimulus during training also emitted on test trials (e.g., A1-R1-C1-R1). The performances of both subjects were as accurate on the tested relations as they had been on the trained relations. The new relations were characterized as demonstrations of stimulus equivalence. However, the conditional discrimination literature shows that such training procedures generate control of comparison selection by the differential response patterns. Therefore, no emergent relations were demonstrated because all of the trained response-stimulus relations were preserved on test trials. This paper suggests that these procedures do not provide an appropriate analogy for the kind of emergent stimulus-stimulus relations exhibited by human subjects in equivalence studies and outlines a paradigm for assessing the relative influence of stimulus-stimulus and response-stimulus relations.

Key words: stimulus equivalence, conditional discrimination, differential sample response, coding, response mediation, naming

A recent study by McIntire, Cleary, and Thompson (1987) was characterized as a demonstration of stimulus equivalence relations by nonhuman animals. The procedures used by McIntire et al. reflect a response mediation account of equivalence class formation. This account is distinctly different from that of some other authors studying the development of equivalence classes based on conditional discriminations. The necessity of posing a mediating response has been questioned since the early work in this area (Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974), and recent accounts of equivalence are in terms of control by stimulus-stimulus relations (Sidman & Tailby, 1982). The goals of the present paper are to contrast these views, to show that McIntire et al. did not demon-

strate derived stimulus-stimulus relations, and to discuss the relevance of the procedure and results to human equivalence class formation.

The demonstration by McIntire et al. (1987) was achieved by training differential motor responses to the stimuli involved in the conditional discriminations from which the tested relations were derived. The differential responses were considered to be analogous to naming, which is given the operational definition: "the performance of some arbitrary response in the presence of a specific discriminative stimulus" (p. 280). This addition to the usual procedure was based on the supposition that human subjects in equivalence studies may name stimuli, thus facilitating the formation of equivalence classes. Thus, the rationale for the study was that "a procedure resulting in the establishment of stimulus equivalence in nonhumans may help clarify how humans form equivalence classes" (p. 280).

In the study, monkeys acquired three two-choice conditional discriminations. The stimuli involved were colors; for clear exposition, the colors were denoted by numbers. The six reinforced relations, grouped according to their potential classes, were 1-1, 1-3, 3-5, and 2-2, 2-4, 4-6. The first number refers to the color of the sample stimulus and the second to the

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correct comparison stimulus; the incorrect comparison stimulus was an odd-numbered stimulus for even-numbered sample-comparison trials, and vice versa. A trial did not terminate with reinforcement unless a distinctive motor response was made on both the sample and comparison stimulus presentation keys. There were two different motor responses: holding the key for 3.5 s and pressing the key eight times. One of these responses was required to all even-numbered stimuli and the other was required to all odd-numbered stimuli; for convenience, the different responses were referred to as *even* and *odd*. Thus, a trial consisted of a homogeneous chain (e.g., 1-odd-3-odd).

Differential responses were also required on test trials, for which there were no programmed consequences for accuracy; to be considered correct, a comparison selection had to be followed by the differential response reinforced in its presence during training. If the correct sample response did not occur on test trials involving a sample stimulus that had appeared only as a comparison during training, the presentation of the sample was repeated until the differential response was emitted.

Normal human subjects given this training without the differential response requirement would be expected to demonstrate additional emergent (untrained) relations: 3-1, 5-3, 4-2, and 6-4 (symmetry); 1-5 and 2-6 (transitivity); 5-1 and 6-2 (combined symmetry and transitivity); and 3-3, 5-5, 4-4, and 6-6 (reflexivity). Stated another way, two classes of equivalent stimuli would form: the first consisting of 1, 3, and 5 and the second consisting of 2, 4, and 6. Nonhuman subjects exposed to similar training procedures without differential response requirements have rarely demonstrated any of these relations. There have been no unequivocally positive demonstrations of symmetry (Lipkens, Kop, & Matthijs, 1988; Rodewald, 1974; Sidman et al., 1982) or transitivity (D'Amato, Salmon, Loukas, & Tomie, 1985; Lipkens et al., 1988) by pigeons. Monkeys have not shown symmetry (D'Amato et al., 1985; Sidman et al., 1982), and transitivity tests have produced mixed results, with failure to display transitivity reported by Sidman et al. (1982) and positive results reported by D'Amato et al. (1985). The monkeys in the McIntire et al. (1987) study demonstrated the

relations described above, with the addition that the trained stimulus-response relations were maintained (e.g., 3-odd-1-odd).

In evaluating the extent to which the performances shown by the monkeys in the McIntire et al. (1987) study were analogous to human equivalence class formation, it is necessary to compare the sources of control operating in this study with those operating in demonstrations of similar relations by humans. Based on the empirical evidence presently available, it is likely that the trained differential responses played a crucial role in the performance shown by McIntire et al.'s subjects, and there is some doubt that the same kind of response mediation plays a role in human equivalence class formation.

An understanding of conditional discrimination learning is fundamental to the study of stimulus equivalence. An important part of the basic research on conditional discrimination learning has addressed the role of response mediation. A response mediation account holds that an untrained coding response comes to be made in the presence of the sample, and this controls subsequent behavior (coding in the presence of the comparison stimuli has received little attention; see Carter & Werner, 1978, for a review of the coding hypothesis). Because these untrained mediating responses are idiosyncratic to the individual organism, they are difficult to define and detect. Their role has been studied by requiring different response patterns, usually produced by different schedules of reinforcement, in the presence of each sample stimulus. Completion of the response requirement produces the comparison stimuli. This procedure is virtually identical to that of the McIntire et al. (1987) study, except that McIntire et al. required the same differential response to both the sample and comparison stimulus in each relation.

The procedure of requiring a differential response to the sample has been shown to facilitate the acquisition of conditional discriminations by pigeons (Cohen, Looney, Brady, & Aucella, 1976; Eckerman, 1970). Analyses of the controlling stimuli in such procedures show that the sample-specific behavior acquires control over comparison selection; that is, if a sample stimulus (A1) controls a response (R1) that in turn controls the selection of a comparison stimulus (B1), then a different sample stimulus (X1) that controls the same

response (R1) will result in the same comparison selection (B1) (Cohen, Brady, & Lowry, 1981; Urcuioli, 1984; Urcuioli & Honig, 1980). Further, differential sample responses interfere with control by the sample stimulus (Urcuioli, 1984, 1985). Detailed analyses of these effects have been limited to pigeons. However, using monkeys as subjects, Sidman et al. (1982) used differential sample responses to facilitate the acquisition of line-line identity matching and line-hue arbitrary matching (both discriminations had the same sample stimuli). When the differential response requirement was removed, only the line-hue relation could be maintained for 1 subject; neither relation could be maintained in the other subject.

McIntire et al. (1987) did not test for control by the differential responses alone, but it is reasonable to assume that the differential responses to the sample stimuli may have controlled comparison selection in all the performances exhibited (trained and tested). This interpretation implies that the study did not demonstrate the emergence of derived stimulus-stimulus relations, but instead the rearrangement of stimulus-response-stimulus chains. If this was the case, the emergent relations demonstrated did not require that the stimuli be related by symmetry or transitivity, as in stimulus equivalence, and could have been produced by training identity relations only. The following illustrates these points, beginning with the possible role of differential responses in the trained relations.

The left panel of Figure 1 shows the three trained relations and the observed outcome of a transitivity test trial from one of the two stimulus classes studied by McIntire et al. (1987). The different bracket styles delineate the stimulus-response and response-stimulus relations engendered in training and show the places that these relations hold in the emergent transitivity relation. In the trained relations, each sample stimulus controls the odd response, which controls the selection of each comparison stimulus; each comparison stimulus also controls the odd response. In test trials, these relations are preserved. For example, in the transitivity-like test trial illustrated, Stimulus 1 controls the odd response (as in the trained relation 1-odd-3-odd) and the odd response controls the selection of Stimulus 5 (as in the trained relation 3-odd-5-odd).

Fig. 1. Left panel: Schematic of the trained relations for one of the two classes produced in the McIntire et al. (1987) study, and of the observed outcome of a test for transitivity. Numbers refer to stimuli of particular colors, and *odd* refers to one of the two different schedule-controlled patterns of responding. The three styles of brackets show the stimulus-response and response-stimulus relations that were trained and the places that these relations hold in the test for transitivity. Right panel: Similar to the left panel, except that only identity relations are trained.

Similar analyses can be performed for all of the emergent relations demonstrated by McIntire et al.

The right panel of Figure 1 shows the stimulus-response and response-stimulus relations that might occur if a common differential response was required in the presence of the sample and comparison stimuli in two different identity matching trials. Also shown is the expected outcome of the same transitivity test shown in the left panel. In this test, Stimulus 1 controls the odd response (as in the trained identity relation 1-odd-1-odd) and this odd response controls the selection of Stimulus 5 (as in the trained identity relation 5-odd-5-odd). This outcome would indicate that transitive and symmetric relations between the stimuli were not necessary to the subjects' performances on test trials, and suggests that the similarity of the procedures used by McIntire et al. (1987) to procedures typically used to demonstrate equivalence relations may be in appearance only.

McIntire et al. (1987) designed their procedure as a possible analog for the role of naming in the formation of equivalence relations

Fig. 2. Schematic of a test for relative control by stimulus-stimulus and response-stimulus relations. The trained sequences are similar to those of the McIntire et al. (1987) study, except that two different differential responses occur within a conditional discrimination. *Odd* and *even* refer to these schedule-controlled patterns of responding. The arrows in the test schematic show the comparison selection expected given each of the possible sources of control.

by humans. The congruence of this analog requires that, without training, the same differential response be made in the presence of both the sample and comparison stimulus in a conditional discrimination (and indeed to all prospective members of a stimulus class). It seems unlikely that this would occur as a differential naming response in humans, unless spoken words were used as sample stimuli, because the subject would probably name the stimuli according to a physical resemblance to some known object, and the sample and comparison stimuli in a (nonidentity) conditional discrimination are physically different. These issues were raised with respect to equivalence by Sidman et al. (1974), and a general resolution of the role of coding or differential responses in the presence of both the sample and comparison stimulus has yet to be achieved.

The relation of stimulus naming to the demonstration of equivalence classes has not been fully explored, but there are some relevant

data. When instructed to do so, human subjects of equivalence studies have named both sample and comparison stimuli overtly. When a spoken word has been used as a sample stimulus with at least one visual stimulus (in a class of visual stimuli) as the correct comparison, the visual stimulus members were likely to be given the same name as the auditory sample. Subjects who did not do this, however, still showed equivalence (Sidman et al., 1974; Sidman, Kirk, & Willson-Morris, 1985; Sidman, Willson-Morris, & Kirk, 1986).

A study by Lazar, Davis-Lang, and Sanchez (1984) provides an example that is more relevant to the procedure used by McIntire et al. (1987), because it involves only relations between visual stimuli. In this study, subjects almost always gave different names for the sample and comparison stimuli in conditional discriminations, yet equivalence relations were demonstrated. Taken together, these findings call into question the necessity of a common name for the establishment of an equivalence class. However, these findings must be interpreted with caution, because subjects' performances in naming tests might not accurately reflect naming while performing the conditional discrimination. Another way of approaching this question might be to require subjects to engage in a distractor task designed to prevent covert verbal behavior. There are no published studies on equivalence class formation that use this control procedure.

McIntire et al. (1987) note the findings of Lazar et al. (1984) in recognizing that training subjects to emit the same name to the sample and comparison stimuli may be an oversimplification of subjects' verbal behavior in an equivalence task. They speculate that training heterogeneous chains (e.g., 1-odd-3-even) may have facilitated the monkeys' performances as effectively as did the homogeneous ones they used. This is an important empirical question. There is evidence that homogeneous chains such as were produced in the McIntire et al. study can be rearranged in any manner that preserves trained stimulus-response and response-stimulus relations (Cohen et al., 1981; Urcuioli, 1984; Urcuioli & Honig, 1980), but all of the trained response-stimulus relations would not be preserved when heterogeneous chains are rearranged. Thus, this procedure would test the relative strength of stimulus-stimulus versus response-stimulus relations.

Figure 2 outlines a heterogeneous chain

procedure that could be used to determine whether comparison selection on test trials is under the control of the sample stimuli or the differential response. The top panel of the figure shows the same trained stimulus relations as were acquired in the McIntire et al. (1987) study, except that heterogeneous even-odd and odd-even response chains would be used. The two possible transitivity tests would present either Stimulus 1 or Stimulus 2 as a sample and Stimulus 5 and Stimulus 6 as comparisons. If comparison selection is primarily under the control of stimulus-stimulus relations, Stimulus 5 would be selected in the presence of Stimulus 1 and Stimulus 6 would be selected in the presence of Stimulus 2. In combination with similar findings on tests for symmetry and reflexivity, these results would constitute a convincing demonstration of stimulus equivalence. On the other hand, if comparison selection is primarily under the control of the differential responses, Stimulus 6 would be selected in the presence of Stimulus 1 and Stimulus 5 would be selected in the presence of Stimulus 2. These relations are the opposite of what would be predicted on the basis of transitivity. It should be noted that, if response-stimulus control is operating, one of two possible symmetry relations from each of the two classes could be demonstrated after this training (e.g., 5-odd-3, but not 3-1, because the even differential response produced by Stimulus 3 has never been required prior to the reinforcement of the selection of Stimulus 1). Similarly, other possible heterogeneous chain arrangements could produce symmetry but not transitivity. However, a test of equivalence requires the demonstration of all possible reflexive, symmetric, and transitive relations (Sidman & Tailby, 1982).

The findings of McIntire et al. (1987) appear to depend on the emission of the *same* differential response in the presence of every sample and comparison stimulus of a prospective class prior to testing. There is presently no evidence that human subjects will do this, without training, with a set of visual stimuli. When subjects do spontaneously give the same name to stimuli in a class, as they are more likely to do when one of the prerequisite conditional discriminations has a spoken word as the sample stimulus, a parsimonious assumption would be that both performances (stimulus equivalence and naming) emerge as a result of the training procedures, and not

that one (equivalence) depends upon the other (naming) (Sidman et al., 1986).

This conclusion is compatible with the notion that conditional discrimination performance does not require or depend on differential motor responses in the presence of the sample and comparison stimuli, although the occurrence of differential responses such as naming may facilitate equivalence class development (Sidman & Tailby, 1982). As Lazar et al. (1984) put it, "human matching is governed by a relation between the sample and its corresponding correct comparison. In the case of arbitrary matching, the critical variable controlling choice responses is a relation between two physically different stimuli" (p. 263).

The notion that stimulus equivalence is related to language plays a prominent role in discussions of equivalence research. The exact nature of the relation between language and equivalence requires clarification, and the paper by McIntire et al. (1987) exemplifies one approach. It remains to be determined whether such an approach reveals processes operating in stimulus equivalence.

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