AN OBSERVATION ON STIMULUS CONTROL IN A TILT DISCRIMINATION BY CHILDREN¹

LAWRENCE T. STODDARD

MASSACHUSETTS GENERAL HOSPITAL

Most children who learned to discriminate opposing 45° line tilts on a relational basis—oddity—did not learn the specific direction of the positive tilt. Most children who did not use oddity did discriminate the specific tilt.

When a teaching method permits more than one basis for a discrimination, different stimuli may control the behavior of subjects whose observed behavior appears identical. Which stimulus aspect acquires control may be unpredictable from the training procedures themselves (Butter, 1963; Fink and Patton, 1953; Lashley, 1938; Newman and Baron, 1965; Ray, 1967; Reynolds, 1961; Warren, 1953). The present study extends this finding to a relational discrimination—oddity—and to children as subjects. Oddity is a relational concept, specifying nothing about the positive and negative stimuli except that they are different. It is relevant to inquire whether children who learn to use oddity also learn to discriminate the particular stimulus aspect which would permit them to recognize the positive stimulus without an oddity basis.

The children in this experiment had successfully completed a series of discrimination-transfer programs which taught them to choose a line tilted 45° to the right of vertical from seven lines tilted 45° to the left of vertical. Throughout training, every trial simultaneously presented seven identical incorrect stimuli and one correct stimulus. A child could thus learn to use an oddity basis for correct choices, *i.e.*, to choose the one stimulus that differed from all others. Techniques were devised to identify the children who had learned

the oddity discrimination and those who had not. The children were then tested to determine whether they had learned a specific tilt discrimination as a basis for choosing the odd stimulus. Those children who had learned the oddity concept had not learned which tilt was positive and which negative; those who did not learn oddity were able to discriminate the positive and negative tilts.

METHOD

Subjects

The experimental subjects were 37 children, divided into two groups: one containing 25 oddity subjects (age range: 4-yr-10-months to 12-10; median: 6-7), and the other containing 12 nonoddy subjects (age range: 4-7 to 9-3; median: 5-7). In addition, 25 older children (age range: 8-0 to 15-8; median: 10-11) served as controls, to be described below. Except for two retarded children in the nonoddy group, all subjects were considered behaviorally and neurologically normal by their physicians at the Massachusetts General Hospital, where the children were temporarily hospitalized for general medical reasons.

Procedure

The child worked at a panel of eight translucent response keys, onto which stimuli could be projected from the rear by means of 35-mm slides (schematically diagrammed in Fig. 1). A trial ended when the child pressed the key containing the correct stimulus for a given stimulus array; chimes rang and automatic devices dispensed an M&M chocolate and a token exchangeable after the session for toys or pennies. If the child's first choice on a trial was

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correct, the slide tray advanced to present the next array. When the child made an error nothing happened; the array did not change until the child selected the correct stimulus, and then the slide tray backed up, presenting the preceding array to the child again (correction and backup procedures).

Instructions were limited to acquainting the child with the experimental room and the reinforcement-delivery and token-exchange systems, and to shaping his first key-press. (Complete descriptions of the apparatus and general procedures are contained in Sidman and Stoddard, 1966; 1967.)

Fig. 1. Schematic diagrams of the key matrix showing the placement of the stimuli on the following slides: the last three slides of the criterion test (A, B, and C) containing the correct line tilted 45° to the right of vertical and seven incorrect lines tilted 45° to the left of vertical; the stimulus-reversal probe slide (D) to test for oddity performance; and the four two-choice slides (E, F, G, and H) to test the effects of removing oddity as a possible basis for the discrimination.

The Original Tilt Discrimination

Figure 1 illustrates the series of test arrays; each lettered box schematically diagrams the stimulus array on a given slide. A, B, and C illustrate the last three of six criterion slides which measured the children's performance on the eight-choice tilted-line discrimination. The single 45° line tilting right of vertical was the correct stimulus. The 37 experimental subjects completed these six slides with no more than two incorrect trials (*i.e.*, a trial on which the child made at least one incorrect key-press). Because of the backup condition, two incorrect trials then necessitated a total of eight correct trials for the child to advance through the six slides.

Probe and Test Procedures

After the children completed the tilted-line program, they were tested first to determine if any had learned to use oddity as a basis for choosing between the opposing tilted lines. If so, would the removal of an oddity basis affect their discrimination performance?

A stimulus-reversal probe slide (Fig. 1D) immediately followed the criterion test. Twelve children chose one of the seven previously correct tilted lines and were classified as "non-oddity" subjects. Twenty-five children selected the odd line, which had been incorrect during training. These children became "oddity" subjects. Whichever stimulus the child selected, his first key-press ended the probe trial without reinforcement; no backup was permitted from the following slide if he made errors.

The next four slides (Fig. 1E, 1F, 1G, 1H) contained only one incorrect line, instead of seven, and tested the effects of removing oddity as a possible basis for the child's choices. As in original training, the child's selection of the line which tilted to the right was again reinforced. Children who had learned to recognize the particular correct tilt could continue to respond correctly; children who had not would make errors.

RESULTS

Figure 2 shows, for each group, frequency distributions of subjects who made the indicated number of errors on the four two-choice slides. The number of errors includes only the first error on a trial. Multiple errors on a trial

were infrequent and almost always were repeated presses of the single incorrect tilt. The children rarely pressed blank keys (only three times as first choices, by two oddity subjects).

Only three of the 25 oddity subjects (12%) responded to the two-choice slides without error; 8 of 12 nonodddity subjects (67%) did so. Eighteen of 25 children in the oddity group made errors on more than one trial; only 1 of 12 in the nonodddity group did so.

Did the oddity subjects choose the wrong line on the two-choice slides simply because they had selected that line on the preceding reversal probe (Fig. 1D)? To answer this question, 25 additional children received the two-choice slides directly after the eight-choice criterion slides, without the intervening reversal probe. This control group was composed of somewhat older children (minimum age, 8-10) in order to increase the likelihood that they would have learned to use oddity. Previously reported data support this expectation (Sidman and Stoddard, 1966); also, the oldest normal nonodddity subject was 7.5. The no reversal-probe subjects completed the discrimination-transfer programs and met comparable criteria for learning the original eight-choice discrimination.

Figure 2 shows that only six of the 25 no-probe children (24%) made no errors on the two-choice slides. Nineteen children chose the incorrect tilt at least once even without a history of having chosen it on the reversal probe. Therefore, it seems unlikely that the oddity subjects' choice on the reversal-probe trial could account for their errors on the two-choice test.

If the children had not learned to recognize the correct line, 50% would be expected to make errors when they encountered the first two-choice slide. In the oddity and no-probe groups, 64% and 60%, respectively, made an error on the first slide; in contrast, only 17% of the nonodddity subjects did so.

DISCUSSION

Although the recorded behavior of all the subjects on the eight-choice discrimination appeared identical, testing them on the two-choice discrimination revealed different bases for their correct performance. A majority of nonodddity subjects recognized the specific tilt, or some specific stimulus correlated with tilt.

Fig. 2. Frequency distributions of subjects who made the indicated number of errors on the four two-choice slides. Data are shown separately for each of the three groups. The number of errors includes only the first error on a trial. The open bars show subjects who made no errors.

On the other hand, most children who were intelligent enough to have learned an oddity basis for discriminating the correct line did not observe its specific direction of tilt. Even most children in the no-probe group, despite being older and presumably more skilled in noticing details in their environment, made errors. (Five oddity-group subjects were 8 yr of age or older and four of them made errors.) This finding has proven sufficiently reliable to serve as a classroom demonstration with adults.

The procedures of this experiment do not permit a precise statement of what stimuli each individual child observed. The non-oddity subjects need not have used line tilt; for example, they might simply have observed the location of the upper (or lower) end of the correct line on its key.

What the oddity subjects observed as a basis for choosing the odd stimulus had to depend on some relation of the odd tilt to two or more opposing tilts. Figure 1 may suggest some possibilities; for example, the odd line always intersects at right angles with the two adjacent lines. Some of the children's comments when they saw the first two-choice slide may be illuminating: "This is one that's hard; they're both pointing the same way." "I don't know which one to do; they're both each way." Both of these children made several errors, their initial errors occurring on the first slide for one child and on the second for the other. Both comments suggest that these children could select the odd line by means of some feature related to angular orientation, but that the opposing tilts without an oddity basis were identical to them. An articulate older child summarized the problem: "They suddenly make you realize you should have paid attention to which way they go."

The present results expose and clarify the

need to identify the specific controlling stimulus in experiments on children's discrimination and oddity learning, even when the control seems adequately described by an abstraction like "oddity". When a teaching technique explicitly requires oddity-based responses, the child's selection of the odd stimulus might not necessarily include attention to the particular features of the stimuli that the teacher has specified as relevant and wants the child to learn.

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