***BRIEF REPORT***

# *ON THE ROLE OF INSTRUCTION IN CONDITIONAL DISCRIMINATION TRAINING*

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Which came first: the chicken or the egg? This question has perplexed professional thinkers for thousands of years and some version of the question can be found across a multitude of academic disciplines in modern times. Taken as a whole, theoretical developments in our thinking about the origins of equivalence relations have posed a sort-of chicken and egg problem. Which came first: equivalence relations or verbal behavior? Is the ability to behave [simultaneously] as a speaker and a listener necessary for the development of equivalence relations (cf. S. C. Hayes, 1991; Horne & Lowe, 1996)? Or, is the capacity to develop equivalence relations necessary for the development of speaker and listener repertoires (cf. L. J. Hayes, 1996; Sidman, 2000)?

Answers to such questions are important if we are to accurately interpret our empirical data and design more precise tools to ask questions about the origins of equivalence relations and other related phenomena. Sidman (1992), for example, has framed the issue in terms of a practical constraint:

> "Until we have answered the question of whether rules give rise to equivalence, or equivalence makes rules possible, we are going to have to be careful about our experimental procedures in investigations of equivalence. If we tell our subjects that stimuli "go with" each other (or that they "match each other", "belong together", "are the same", "go first" or "go second", etc.), the data may then tell more about the subject's verbal history than about the effects of current experimental operations" (Sidman, 1992, p. 21-22).

The main concern is the resulting inability to determine whether rules and instructions or relevant histories and baseline conditional discriminations are responsible for subsequently demonstrated equivalence-consistent choices (Rosales-Ruiz, Eikeseth, Duarte, & Baer, 2000; Smyth, Barnes-Holmes, & Barnes-Holmes, 2008; see also Sidman, 1994, pp.305-306).

The practical constraints involved in dissociating verbal and equivalence processes notwithstanding, the technological utility of instructions in promoting stimulus class development is well established. In particular, acquisition of conditional discriminations by children seems to require something other than simple exposure to differential reinforcement contingencies (e.g., Pilgrim, Jackson, & Galizio, 2000; Schilmoeller, Schilmoeller, Etzel, & LeBlanc, 1979; Zygmont, Lazar, Dube, & McIlvane, 1992; but see Devany, Hayes, & Nelson, 1986). These data suggest that instructions can play an important facilitative role in the development of conditional discrimination performances. The development of conditional discrimination performances then allows us to ask questions about the role of such performances in the development of equivalence relations.

Pilgrim et al. (2000), for example, investigated the effects of instructions as well as sample naming with children ranging in age from 3.25 years to 6.75 years. In Experiment 1 of their study, children were initially exposed to differential reinforcement contingencies only – no verbal instructions or models were presented. After extended exposure to simple

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differential contingencies with no improvement in accuracy, participants were presented with general or specific instructions as well as opportunities to name the stimuli. For example, participants receiving general instructions were shown the sample stimulus and told to "[l]ook at this one. This one will tell you where the prize is." Participants receiving specific instructions were shown the sample stimulus and told "[w]hen this one is in the middle, pick this one". Seven of the 8 participants in Experiment 1 eventually acquired the first (AB) conditional discrimination – four after receiving specific instructions relating particular sample and comparison stimuli and three after generating and using names for the sample stimuli within trials. The results showed that the general instructions (see above) were not effective in facilitating the acquisition of conditional discriminations. Rather the data suggest that some combination of specific instructions and naming facilitated the acquisition of conditional discriminations. Of these 7 participants, however, only 4 went on to show rapid acquisition of the second (AC) conditional discrimination. These data suggest that the effects of the instructions were generalized for some of the participants but not for others. The factors that may promote generalization remain less than well understood.

One factor that may influence the effectiveness of instructions is the timing of their delivery. For example, instructions presented at the beginning, when the participant is unfamiliar with many aspects of the task, may be less effective than instructions delivered after the participant has become familiar with the basic requirements of the task such as orienting to stimuli, scanning the stimulus array, using a mouse or another device to select and respond to a stimulus, etc. Another factor may be the content of the instruction itself. For some participants, for example, the use of specific instructions may have served to narrow the range of the instructions' effectiveness to only the task in which the instruction was delivered and thus inhibited generalized effectiveness. In contrast, general instructions (ones that do not implicate particular stimuli) may be more effective in establishing a rule which allows the subject to respond effectively with novel exemplars. The main purpose of this report is to describe the effects of general instructions presented by the experimenter after participants had demonstrated a failure to acquire a conditional discrimination (AB) under typically programmed differential reinforcement contingencies.

## METHOD

### *Participants*

Fourteen experimentally naive children, ranging in age from 5 years and 3 months to 11 years, served as participants. The age and gender of each participant is presented in Table 1. None of the participants had any familiarity with the stimuli used in the experiment, and all relations were arbitrary at the beginning of the experiment. Prior to the first session, the parents were told that the task involved using a mouse to choose stimuli presented on a computer screen. They were further told that no computer skills were necessary, that the study could last up to two hours, and that the children were free to leave at any time. Parents signed an informed consent form prior to the beginning of the study. All participants were debriefed and received a small gift such as a comic book or a set of stickers at the end of their participation.

### *Apparatus*

Two personal computers, Hewlett Packard nc6320, with an Intel® Celeron® M processor presented all stimuli and recorded all responses. A press on the left button of a two-button mouse was used as a response option in the current experiment.

### *Stimulus materials*

As shown in Figure 1, syllabus, pictures, non-figurative stimuli, and Arabic and Cyrillic letters were used as stimuli. The stimuli were presented on the screen with the sample stimulus always presented in the vertical and horizontal middle of the screen and three comparison stimuli presented in the three corners, leaving one randomly determined corner blank.

### *Procedure*

The procedure taught the children conditional relations that were expected to promote the development of three 3-member classes. A simple-to-complex training protocol was employed in which the children first learned one conditional discrimination (e.g., AB)

Table 1

Children, gender, age (years; months), and stimuli in the experiment. For all children the stimuli were unfamiliar and the relations between them were arbitrary.

| Children | Gender | Age | Stimuli |
|---|---|---|---|
| 1201 | Male | 6;5 | Nameable pictures |
| 1202 | Female | 6;0 | Nameable pictures |
| 1203 | Female | 8;5 | Nonsense syllables |
| 1204 | Male | 7;11 | Nonsense syllables |
| 1205 | Male | 5;3 | Nameable pictures |
| 1206 | Male | 10;11 | Nonsense syllables |
| 1207 | Male | 9;6 | Nonsense syllables |
| 1208 | Female | 7;11 | Nonsense syllables |
| 1209 | Male | 10;3 | Non-figurative stimuli |
| 1210 | Female | 8;6 | Non-figurative stimuli |
| 1211 | Female | 11;0 | Non-figurative stimuli |
| 1212 | Female | 8;6 | Cyrillic and Arabic letters |
| 1213 | Male | 6;5 | Nameable pictures |
| 1214 | Male | 6;4 | Nameable pictures |

to mastery before the second overlapping conditional discrimination (AC) was introduced. The first phase consisted of blocks of 18 trials in which six presentations of each of three trial-types were programmed (e.g., A1B1B2B3, A2B1B2B3, and A3B1B2B3). The second phase was identical to the first but trained the second overlapping conditional discrimination. Phase 3 presented 36 trials per block consisting of a mix of the conditional discriminations trained during Phases 1 and 2. The fourth phase was the same as the third except that there was no feedback. During each phase, the children's response accuracy had to exceed 94% to progress to the next phase. Correct responses to comparison stimuli were followed by the word "correct" (Times Roman, 48 point font) presented in the center of the screen and a windows-generated 'chime' sound while incorrect responses to comparison stimuli were followed by the word "incorrect" presented in the center of the screen and a windows-generated 'buzz' sound. The visual feedback remained on the screen for 2 s and was followed by a 1-s inter-trial interval. Because of the age of the children there were a number of small breaks during the experiment, the number and duration of which varied across children. Typically, the children worked for at least 15 min before they had the breaks.

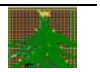
When the experiment started, the experimenter gave the following instruction and pointed to the different positions on the screen:

> "Thank you for participating. This is a sort of a computer game, and the game consists of responding correctly as much as possible. When you mouse click the center stimulus or symbol, more stimuli or symbols will appear in the corners of screen. Mouse clicking on the correct one in the corners will be followed by the text 'CORRECT!' on the screen and a happy sound will be presented. If you mouse click one of the incorrect ones it will be followed by text 'WRONG!' on the screen and a sad sound. After a while there will be no messages of correct or wrong on the screen or any sounds."

Syllables

| | 1 | 2 | 3 |
|---|---|---|---|
| A | LEX | HUM | POV |
| B | CUG | ZID | JOM |
| C | LIB | VEK | REL |

Pictures

| | 1 | 2 | 3 |
|---|---|---|---|
| A |  |  |  |
| B |  |  |  |
| C |  |  |  |

Nonfigurative stimuli

| | 1 | 2 | 3 |
|---|---|---|---|
| A |  |  |  |
| B |  |  |  |
| C |  |  |  |

Abstract letters

| | 1 | 2 | 3 |
|---|---|---|---|
| A |  |  |  |
| B |  |  |  |
| C |  |  |  |

**Figure 1**

If the participants had not acquired the first conditional discrimination (AB) within 40-45 min, the experimenter added the following instruction: "Some of the stimuli belong together and your task is to find out which stimuli go together" in addition to pointing to the sample stimulus and, randomly, to one of the comparison stimuli in the corner to emphasize what was meant by "belong together". After acquisition of the first conditional discrimination, participants were exposed to trials which trained the second, overlapping, conditional discrimination (e.g., AC). After accuracy on the two overlapping conditional discriminations exceeded 94% (without feedback), participants were exposed to test trials designed to assay symmetric and equivalence relations among the stimuli. Tests consisted of 18 symmetry trials and 36 equivalence trials presented alone. There was no retraining or additional testing following a failed test.

## RESULTS

Five of the 14 participants learned the AB relation within 40-45 min and were not exposed to the additional instruction. Their results are not included in the current report. The remaining nine participants failed to meet the mastery criterion after 40-45 minutes (or approximately 580 trials) and were therefore presented with the additional instruction. Figure 2 shows the cumulative correct responses for individual participants as well as the cumulative mean for the group overall for 20 trials immediately preceding and following the delivery of additional instructions. (Note that the group mean graph is scaled in percent units to standardize different absolute number of trials experienced by individual subjects prior to the presentation of supplemental instructions.) The delivery of instructions is marked by the dashed vertical line. This figure shows that the instructions were immediately effective in increasing accuracy of the current set of conditional relations for all children. Specifically, mean accuracy was 39% (range: 20% - 67%) over the 20 trials preceding the instruction but 77% (range: 56% - 85%) over the 20 trials following the delivery of additional instructions.

Table 2

Number of trials during first and second part of training and number of correct responses during tests for symmetry and equivalence.

| Children | Number of trials during first part of training | Number of trials during second part of training | AB/BA and CB/CB | AC and CA |
|---|---|---|---|---|
| 1201 | 940 | 54 | * | 4/18 |
| 1202 | 342 | 54 | 18/18 | 5/18 |
| 1203 | 450 | 54 | 16/18 | 16/18 |
| 1205 | 520 | 90 | 17/18 | 18/18 |
| 1210 | 612 | 54 | 16/18 | 6/18 |
| 1211 | 754 | 54 | 18/18 | 10/18 |
| 1212 | 660 | 54 | 18/18 | 17/18 |
| 1213 | 236 | 36 | 18/18 | 18/18 |
| 1214 | 234 | 36 | 16/18 | 16/18 |

* Due to a programming error symmetry tests were omitted.

Table 2 shows that all 9 children acquired the second conditional discrimination in 54 to 90 trials – a substantial improvement in the rate of acquisition relative to the first conditional discrimination learned. All nine participants were able to proceed to derived-relations testing. Furthermore, Table 2 shows that all 9 participants responded in accord with symmetry and two of nine responded in accord with equivalence.

## DISCUSSION

This study focuses on the performance of nine children who failed to acquire a 3-choice conditional discrimination after extended exposure to typically programmed differential reinforcement contingencies. The results show that instructions specifying that some of the stimuli 'belonged together' were immediately effective in establishing the 3-choice conditional discrimination performance. The results also showed that the participants acquired a second conditional discrimination without any further instructions. All 9 subjects went on to complete emergent-relations testing and passed tests of symmetry. Two of the 9 subjects also passed tests for equivalence. Broadly speaking, these data suggest that instructions can be useful in facilitating the development of conditional discrimination performances when differential reinforcement contingencies are ineffective. Like Pilgrim et al. (2000), these data show that instructions that specified the nature of the relation (e.g., "belong together" or "Given this, touch that") among the stimuli were effective in promoting conditional discrimination acquisition.

Although these results are in general accord with other research examining the role of instructions, there are some important differences. For example, Pilgrim et al. (2000) report that only 4 of the 7 subjects who acquired the first conditional discrimination (with specific instructions) went on to acquire the second conditional discrimination without additional instructions or other supplements. In contrast, the presentation of instructions was effective in promoting the acquisition of conditional discriminations for all 9 subjects in the current study. In addition, all of the subjects went on to acquire the second conditional discrimination without any additional instructions or supplemental stimuli.

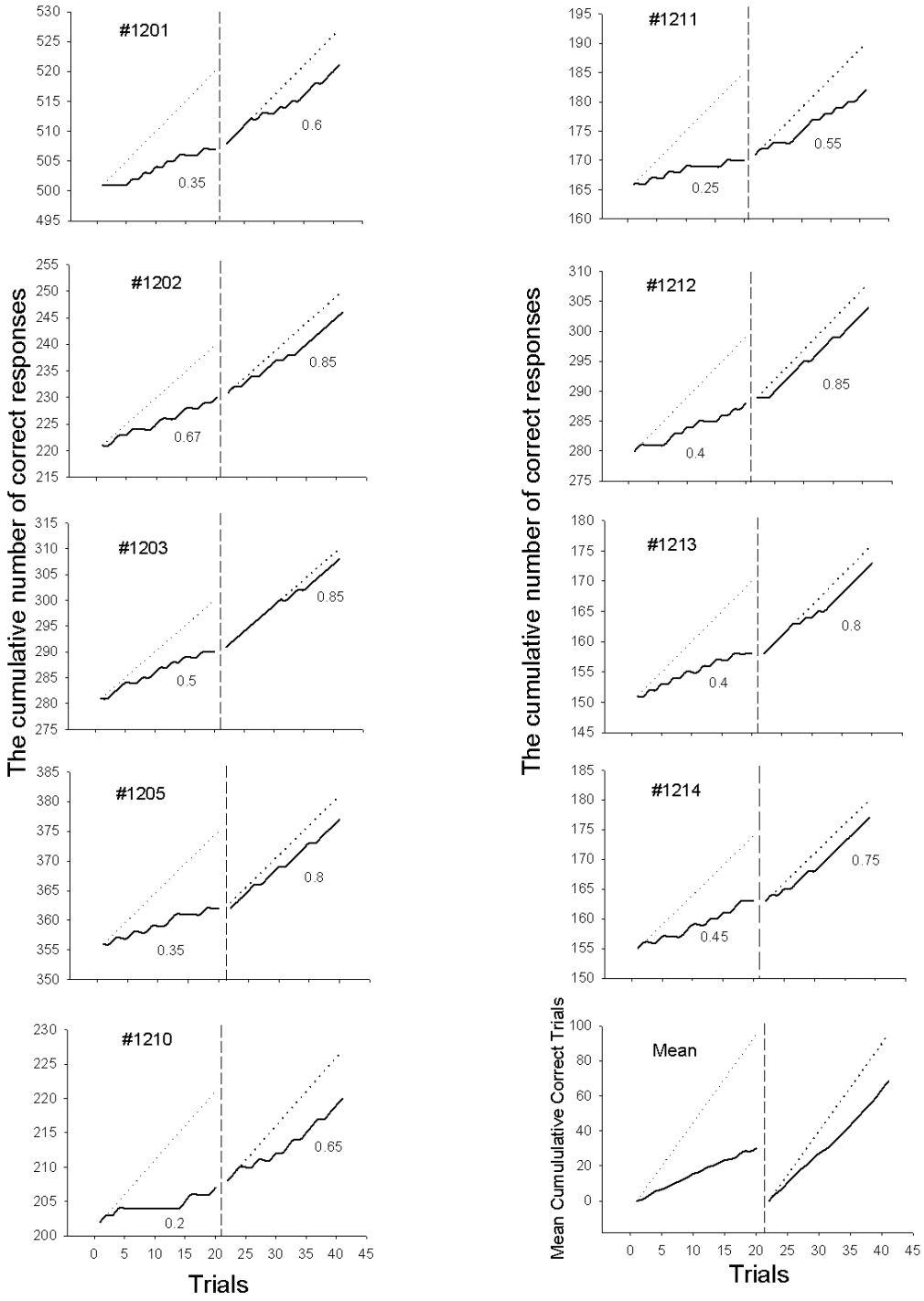



**Figure 2**

One reason for the observed difference may have to do with the nature of the instructions themselves. Specifically, the instructions presented by Pilgrim et al. (2000) specified the particular sample and comparison stimuli involved in the first conditional discrimination. These instructions may have served to narrow the instructions' effectiveness to only the particular conditional relations for which they were presented. In contrast, the current study

presented instructions which may have served as a general rule that could be brought to bear on conditional discrimination trials with novel stimuli. Though speculative with respect to the current set of data, the notion is consistent with empirical results showing highly specific effects of word choices on resulting conditional discrimination performances (e.g., Rosales-Ruiz et al., 2000; Smyth et al., 2008).

One problem with the current study is its failure to unequivocally establish that the presentation of the instructions was responsible for the development of the AB conditional discrimination. Although it is true that the design of the current study cannot rule out history effects as being the actual cause, we feel three features of the data set strongly suggest that the instructions played a functional role in the development of the conditional discrimination. The first is the large number of trials, presented prior to the delivery of the instructions, over which all subjects' performance remained at low levels of accuracy. The second feature is the rapid development of the conditional relations in all subjects following the delivery of instructions. Finally, the number of trials required to meet the training criteria for AB trials (presented prior to the delivery of instructions) was approximately eight times greater than the number of trials required to meet the training criteria for AC trials (presented after the delivery of instructions). Taken together, these three features of the data suggest that the instructions played a functional role in the development of both conditional discriminations. Nonetheless, future studies should attempt to present instructions in a more strategic manner to help elucidate the role of verbal processes in the development of stimulus classes.

In conclusion, these results suggest an interesting method by which the interactions between verbal processes and stimulus class development may be theoretically and empirically dissociated. Specifically, systematic investigations of the role of particular words in instructions may help us identify the ways in which individual subjects' verbal histories interact with the contingencies we may arrange in the laboratory. Accordingly, future research should more systematically study (1) the effects of particular word choices and (2) younger participants with varying levels of verbal sophistication. As difficult as these problems may be to study, their resolution is critical to conceptual progress in understanding the nature and origins of trained and emergent conditional relations and the ways in which they interact with verbal processes.

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