DOCUMENT RESUME

ED 287 238 EC 200 543

AUTHOR	Bryant, Jeffrey T.; And Others
TITLE	Oddity Learning in Developmentally Delayed Children: Facilitation by Means of a Stimulus Familiarity Intervention.
INSTITUTION	George Peabody Coll. for Teachers, Nashville Tenn. John F. Kennedy Center for Research on Education and Human Development.
SPONS AGENCY	National Inst. of Child Health and Human Development (NIH), Bethesda, Md.
PUB DATE	Apr 87
GRANT	HD15051; HD18754
NOTE	26p.; Paper presented at the Biennial Meetings of the Society for Research and Development in Children (Baltimore, MD, April 23-26, 1987).
AVAILABLE FROM	George Peabody College, Vanderbilt University, Box 40, Nashville, TN 37203.
PUB TYPE	Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Cognitive Development; *Concept Formation; *Developmental Disabilities; *Discrimination Learning; *Perceptual Development; Preschool Education; *Training Methods

ABSTRACT

The study examined the effectiveness of enhancing perceptual differentiation in the training of four developmentally delayed preschool children who were so low-functioning that they did not demonstrate oddity responding (ability to choose one distinct stimulus from a group of identical stimuli). Instead of the Arabic numerals used in the original study, subjects were provided with a specific line drawing surrounded by eight other identical line drawings. Drawings were of common objects. Under these conditions the previously unsuccessful children demonstrated statistically significant increases in percentage of correct oddity responses immediately upon introduction of the arrays of familiar stimuli. Results suggest that enhancement of perceptual differentiation can facilitate relational learning of the type required by the oddity task. (Author/DB)

(Manuscript submitted for publication)

Oddity Learning in Developmentally Delayed Children: Facilitation by Means of a Stimulus Familiarity Intervention

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This research was supported by the National Institute of Child Health and Human Development Research Program Project Grant # HD15051, awarded to the John F. Kennedy Center for Research on Education and Human Development at Vanderbilt University and Grant # HD18754, awarded to Dr. Sal A. Soraci, Jr.

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Running head: STIMULUS FAMILIARITY INTERVENTION

Abstract

The focus of this study is on developmentally delayed children who are sufficiently low-functioning that they do not demonstrate oddity responding in a training context that has been effective in other studies with ostensibly similar children (e.g., the study of Soraci, Alpher, Deckner & Blanton, 1983). Eight children were studied, and it was found that four demonstrated oddity learning with arrays consisting of a specific arabic numeral surrounded by eight other arabic numerals that were identical, the intervention used by Soraci et al. (1983). In accordance with the requirements of a multiple baseline across subjects design, the remaining four children, who had been unsuccessful up to that point, were provided with a specific line drawing surrounded by eight other line drawings that were identical. The line drawings were of common objects (e.g., the depiction of a chair surrounded by eight depictions of a spoon). It was found that each of the four, previously unsuccessful children demonstrated statistically significant increases in percentage of correct oddity responses immediately upon introduction of the arrays of familiar stimuli. The present results were interpreted to indicate that, when perceptual differentiation can be enhanced, relational learning of the type required by the oddity task can be facilitated.

Oddity Learning in Developmentally Delayed Children: Facilitation by Means of a Stimulus Familiarity Intervention

Oddity learning is a form of conditional discrimination learning that requires the subject to choose one distinct (odd) stimulus from a group of identical (nonodd) stimuli. In most applications of the task, the stimuli are presented in a visual array. Identification of the odd stimulus is based upon its variation in one important dimension (e.g. color, form, size) from other stimuli that are identical on that dimension. Thus, a prerequisite for correct performance on the oddity task is the ability to utilize relational information (Stoddard, 1968; Sugimura, 1981). Correct performance on the oddity task has been said to involve attentional (Zeaman & House, 1963; House, Brown & Scott, 1974; Scott & House, 1978), perceptual (Zentall, Hogan, Edwards, & Hearst, 1980), and conceptual (Gollin & Schadler, 1972) factors.

Previous studies that have screened prospective subjects who were not functioning at a predetermined minimal level (Ellis & Sloan, 1959; Gollin & Schadler, 1972; Greenfield, 1985; Soraci, Alpher, Deckner, & Blanton, 1983; Soraci, Deckner, Haenlein, Baumeister, Murata-Soraci, & Blanton, 1987a) may have inadvertently excluded subjects who in fact were capable of performing the oddity task. While such studies have demonstrated oddity acquisition in moderately low functioning children, the potential for oddity learning of still lower functioning subjects has been neglected. It is clear that the inclusion of such lower functioning subjects in oddity research is essential to both the generalization of findings and the development and assessment of more powerful intervention strategies. The focus of the present study was children who were less then 4 1/2 years of age, who are developmentally delayed, and who were unable to acquire the oddity concept when trained with a procedure demonstrated effective with other, ostensibly similar children (Soraci et al., 1983, 1987a).

One effective method of facilitating oddity performance consists of increasing the number of identical, nonodd choices presented in the visual array (Gollin, Saravo, & Salten, 1967; Gollin & Schadler, 1972; Zentall et al., 1980). Soraci et al. (1983) found that correct oddity responding was rapidly learned by low functioning children when the number of nonodd, homogeneous distractors was increased from three to eight. According to Soraci et al. (1983), increasing the number of nonodd, homogeneous stimuli enhances the perceptual salience of the odd stimulus. In other words, the uniqueness of an odd stimulus presented with many nonodd stimuli is more readily perceived than that of an odd stimulus presented with few nonodd stimuli. The assumption ofthe present investigators was that children who are unsuccessful with an exact replication of the training procedure demonstrated effective by Soraci et al. (1983, 1987a) provide a stringent test of the efficacy of new interventions.

A recent study has shown that manipulations of stimulus familiarity may enhance the performance of low functioning subjects who are initially nonlearners in a specific experimental context. In a study not concerned with oddity learning, Soraci, Deckner, Blanton, & Baumeister (1987b) trained developmentally delayed children to associate novel geometric forms with unfamiliar auditory cues. To meet the demands of this task, subjects had to learn to pair the auditory presentations of two esoteric words (fulsome and confect) with two novel geometric forms, and utilize the former as cues in choosing between the latter. After a subject failed to associate the auditory and visual stimuli, Soraci et al. (1987b) introduced an intervention that consisted of having the subject associate two familiar geometric forms (a square and a circle) with auditory stimuli whose correspondence was known preexperimentally ("box" and "ball," respectively). The experimenters hypothesized that this familiarity intervention would enhance the saliency of the task demands. As anticipated, the intervention resulted in subsequent utilization of the esoteric words as cues in choosing between the novel geometric forms.

The present investigation is designed to provide evidence as to whether the effects of such stimulus familiarity interventions are robust and not paradigm specific. In the present study, it was hypothesized that a familiarity intervention would promote correct oddity performance in subjects who were functioning at a sufficiently low level as to be unsuccessful even with the arrays consisting of nine arabic numerals found to be facilitative by Soraci et al. (1983, 1987a).

Several studies with young and moderately low functioning children have tested oddity acquisition by means of reversal shift assessments (Gollin & Schadler, 1972; House, Brown, & Scott, 1974; Soraci et al., 1983, 1987a). This test of oddity acquisition consists of changing the elements of a stimulus array such that the previously odd stimulus (correct choice) becomes the configuration for the multiple nonodd stimuli (incorrect choice), and the previously nonodd configuration becomes the (now singular) "odd" element that is the correct choice. Exposure to reversal shift trials thus may constitute a training experience which is itself inductive of oddity learning. A secondary objective of the present study was to demonstrate that oddity responding can be induced in young, low functioning children not exposed to reversal shifts.

Method

Subjects

Subjects were selected from classes of preschool children at the John F. Kennedy Center at Vanderbilt University. Based upon data from the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984), parental reports, and professional observations, the children had been placed at the Center on the basis of their being identified as persons at risk for mental retardation. Table 1 shows the social quotients, chronological ages, Peabody Picture Vocabulary Test-Revised (PPVT-R) scores (Dunn & Dunn, 1981), and gender of the subjects.

Insert Table 1 about here

Apparatus

An Apple II-E computer with 64K memory was used for stimulus presentation and response recording. The output device for stimulus presentation was a 13-inch diagonal screen television monitor (Apple, model AZM2010), positioned at eye level in front of the child. The children were seated directly in front of the monitor, within comfortable reach of the screen (i.e., approximately 20 inches from the screen). [For further information about the apparatus and computer program, see Deckner, Soraci, Blanton, and Tapp (1984).]

Stimuli

The stimuli were of two types: (a) arabic numerals and (b) line drawings of common objects (e.g., comb, fork, chair). All stimuli were displayed in a 9-inch square matrix projected onto the monitor. The tic-tac-toe like matrix was divided evenly into 3-inch square cells. A stimulus could be projected onto any one of the nine cells of the matrix, and as many as nine stimuli could be presented simultaneously.

All subjects were shown nine-element arrays in each phase of the study. Within these arrays, eight nonodd (S-s) and one odd (S+) were positioned randomly over trials such that the S+ appeared in a different cell from trial to trial and approximately an equal number of times in each cell. The eight S-s were positioned in the remaining cells of the matrix. The location of the S+ was varied in an attempt to discourage positional responding.

The particular S+ and S-s presented on a given trial were randomly selected from among all possible combinations of either arabic numerals or line drawings. Thus all arabic numerals and all line drawings appeared approximately an equal number of times. The format of random display of stimuli was used throughout the entire study and no reversal shift trials were administered.

Procedure

Prior to the first experimental session, individual subjects were presented with an array containing a line drawing of a single common object, projected onto a randomly selected cell of the computer-generated matrix. The subject was seated so that he or she could view the entire visual array and easily touch any cell in the matrix. By means of prompting and differential verbal feedback, the child was trained to touch the cell in the matrix that contained the figure. Most of the subjects were able to master this task within 10 training trials.

During the formal experiment, each child was brought individually into the experimental room by the experimenter. The child was seated relative to the display screen as in the preexperimental session. Upon presentation of each matrix, the experimenter said to the subject, "Which one is it?" or "Touch the right one." Each child's response was followed by differential verbal feedback: e.g., "Yes, that's it"; "No, that's not it."

Because of the ages of the children, the experimenter remained present with them during the testing sessions, rather than leaving them alone in the experimental room. The experimenter controlled the computer as he sat next to the child. A stimulus array was presented for 20 seconds or until the child responded. Responses were observed and recorded on the computer by the experimenter.

Experimental sessions were limited to one per day. Occasionally, sessions were separated by more than one day. Each session consisted of approximately 25-30 trials. A session was never ended when a subject had several consecutive correct responses and was consequently nearing criterion.

Experimental Design

All subjects were initially presented with nine-stimulus arrays of arabic numerals, the arrays found to evoke correct oddity responding in the studies by Soraci et al. (1983; 1987a). Depending on their performance with this array, subjects were then divided into two groups: (a) those who met criterion, 9 correct responses in a block of 10 trials, within 200 trials, and (b) those who failed to meet the criterion within 200 trials. These groups will hereafter be referred to respectively as the performers and nonperformers. Differentiating among the children on this basis defined 4 nonperformers in the original group of 8 subjects.

After failing to exhibit oddity responding with nine-element numeral arrays, the nonperformer group was presented with nine-element arrays of line drawings of common objects. Presentation of the arrays of drawings was consistent with the requirements of a multiple baseline across subjects design; i.e., subjects were exposed to the intervention after receiving different numbers of trials with the numeral arrays.

Results

Figure 1 shows the percent of correct responses for the 4 subjects who met the specified criterion with the arabic numeral arrays. As can be seen, 3 of the 4 performers met the criterion of 9 correct responses in a block 10 trials within three test sessions. The remaining subject achieved criterion in six test sessions. Thus, 4 of the 8 subjects were able to succeed with the nine-element array used in the Soraci et al. (1983, 1987a) studies.

Insert Figure 1 about here

The percent of correct responses for the remaining 4 subjects is shown in Figure 2. Note the lengthy baselines of failure performance for this group (typically below 30% correct) on the arabic numeral arrays. As is evident from inspection of the figure, introduction of the arrays of familiar forms evoked immediate increases in percentages of correct responses in all 4 subjects. The results of an Rn analysis (Revusky, 1967), shown in Table 2, revealed that the nonperformers' level of correct responding was significantly higher in the treatment condition than in the baseline condition ($p < .05$). Furthermore, 3 of the 4 subjects met the original criterion of 9 of 10 correct responses. The remaining subject went from an average of 17% correct responses per session during baseline to 47% correct during intervention, with a high of 64% correct.

Insert Figure 2 and Table 2 about here

Discussion

In examining the performances of children at two levels of functioning with respect to oddity acquisition, the present study obtained results indicative of the following: First, the performance of the 4 subjects in the performer group replicates the findings of the Soraci et al. (1983, 1987a) studies and is consistent with the interpretation of Soraci et al. that the perceptual salience of the odd stimulus in nine-element numeral arrays is sufficient to induce oddity performance in some subjects. Second, an intervention, presentation of line drawings of common objects, was found effective in establishing correct responding in subjects who had failed with the Soraci et al. (1983) intervention. Third, the fact that both performing and initially nonperforming subjects achieved correct oddity responding in the absence of reversal shifts indicates that reversal shift experience is not a requisite of oddity acquisition for young and low functioning children.

The results of the present study, when considered with those obtained by Soraci et al. (1987b), indicate that stimulus familiarity interventions may be useful in various training contexts. The findings that familiarity interventions enhance both oddity and paired associate learning suggest that this type of intervention is robust. Its facilitative effect is not limited to a single type of training objective.

While further research is necessary to set forth a definitive theoretical rationale for the efficacy of the familiarity manipulation, some hypotheses can be ruled out and others posed as explanations for the current findings. It could be postulated that the drawings of familiar objects facilitated the performance of the originally nonperforming subjects because they are more discriminable than the arabic numerals. Data from the recently completed Soraci et al. (1987a) study suggest, however, that the efficacy of the familiar line drawings is not based upon mere differential discriminability between the line drawings and the arabic numerals. Soraci et al. (1987a) found that three-element arrays of novel geometric forms and arabic numerals were discriminated equally poorly by young, developmentally delayed children who were approximately the same age as the subjects used in the current study. Both novel geometric forms and drawings of common objects have a greater number of discriminable features than arabic numerals (see Figure 3). If discriminability per se explained the superiority of the drawings in enhancing subjects' performances, one would expect performance with more discriminable geometric forms to be superior to performance with less discriminable arabic numerals. As noted above, Soraci et al. (1987a) found no evidence for such a claim, and, in fact, found evidence to the contrary--i.e., the arabic numerals facilitated the performance of subjects who had failed with the geometric forms.

Insert Figure 3 about here

The results of the present study are consonant with those obtained by Soraci et al. (1987a) in an additional respect. In that study, 3 of the 5 subjects were unable to respond successfully on reversal shift trials that involved the use of nine-element arrays of novel geometric forms. As noted, Soraci et al. (1987a) used nine-element arrays of arabic numerals to facilitate the performance of those subjects. Although in all likelihood the arabic numerals were more familiar to the children than the novel geometric forms used by Soraci et al. (1987), it is reasonable to assume that they are less familiar than the drawings of common objects used in the current study. The results of these two studies thus are consistent in that the subjects in both studies who failed with less familiar stimuli (i.e., novel geometric forms and arabic numerals, respectively) later succeeded when trained with more familiar stimuli (i.e., arabic numerals and drawings of common objects, respectively).

In comparing the stimuli that were presented in the Soraci et al. (1987a) study and the current study, one might infer the existence of a "familiarity hierarchy" in which novel geometric forms represent the least familiar, arabic numerals represent moderately familiar, and drawings of common objects represent the most familiar stimuli. Considering this possible hierarchy, our interpretation is that the highest functioning subjects are able to perform the oddity task with the least familiar stimuli (i.e., the novel geometric forms), lower functioning subjects require presentation of moderately familiar stimuli (e.g., arabic numerals), and performance by the lowest functioning subjects requires presentation of even more familiar stimuli, drawings of common objects.

PPVT-R data from the Soraci et al. (1987a) study and the present study, shown in Table 3, are consistent with this interpretation. Note the distribution of means for the four groups. As can be seen in Table 3, the 2 subjects who succeeded with the novel geometric forms had higher PPVT-R scores ($M = 105$) than any of the other subjects, while the two groups who succeeded with the arabic numerals had relatively similar scores that were lower ($M = 81$ and 78.5). Finally, the subjects in the current study who were originally nonperformers had by far the lowest mean score of any group ($M = 71$).

Insert Table 3 about here

While data based on such small samples must be interpreted cautiously, the vocabulary scores shown in Table 3 suggest that (a) subjects in the present study had poorer receptive vocabulary skills than the subjects in the Soraci et al. (1987a) study (as measured by the PPVT-R, $M = 74.8$ vs. 90.6), and (b) receptive vocabulary is related to children's abilities to perform the oddity task. Differences in PPVT-R scores are taken to indicate differences in labeling ability among children (Soraci et al., 1987a). When given a relatively unfamiliar set of stimuli to scan (i.e., novel geometric forms or arabic numerals), children with greater vocabulary skills may utilize implicit labeling of stimulus elements to facilitate differentiation of the relevant stimulus relations. This hypothesis is consistent with selective attention theories that assume the effect of labeling is to increase attention to relevant stimulus dimensions (Fisher & Zeaman, 1973). It is also consistent with the finding of Soraci et al. (1987b) that familiar stimuli can be used to evoke adaptive attention to task demands. As noted, in that study, reinforcement was contingent upon utilization of auditory cues as a basis for choosing between visual forms.

In terms of Gibson's (1969, 1979) theory of perception, familiar stimuli are those with which a subject has had experience in discriminating distinctive features. A further point is that a label can serve to direct attention to a distinctive feature. Improved performance with familiar stimuli relative to unfamiliar stimuli is thus predictable from a Gibsonian perspective. Similarly, in terms of operant learning theory, Dinsmoor (1985) postulates that increases in stimulus salience may be used to (a) evoke increases in observing of and attention to stimulus dimensions correlated with reinforcement, (b) enhance discriminative responding, and (c) establish stimulus control. To the extent that the dimensions of familiar stimuli are more salient than those of unfamiliar stimuli, the present results also are consistent with Dinsmoor's position. Drawing upon Fisher and Zeaman's (1973) theory of the effect of labeling in selective attention, we hypothesize that readily labeled familiar stimuli are more salient than unfamiliar stimuli for which there are no ready labels. The present investigators are currently seeking to obtain data pertinent to this hypothesis.

An additional contribution of the present study was the demonstration that the oddity performance of young, low functioning subjects was facilitated without exposure to reversal shift trials. In previous research by Soraci et al. (1983, 1987a), reversal shift trials accompanied successful performance with the nine-element arrays. As previously mentioned, it can be argued that a reversal shift trial, which consists of a previous S+ becoming the S- stimulus configuration, is an instantiation of the oddity rule--i.e., regardless of physical configuration, "choose the one that is different." Thus, although Soraci et al. claimed it was the perceptual enhancement of the odd stimulus via the increase in the number of nonodd stimuli that facilitated oddity performance, the question remained as to whether this perceptual enhancement manipulation in the absence of reversal shift trials is sufficient to induce oddity responding in populations such as the one tested. The results of the present study support the position that interventions such as the present one, designed to promote perceptual differentiation per se, can be effective without concurrent exposure to reversal shift trials.

In summary, it has been suggested that a lack of differentiation characterizes the perceptual mode of retarded children (Kemler, 1983). The present results suggest that perceptual differentiation of low-functioning children can be enhanced to improve discrimination learning of the type required by the oddity task. Enhanced differentiation pertinent to conditional discrimination learning has now been achieved by increasing the number of nonodd, homogeneous stimuli with which an odd stimulus is presented (Gollin, et al., 1987; Gollin & Schadler, 1972; Soraci et al., 1983, 1987a; Zentall et al., 1980); by presenting familiar auditory and visual stimuli whose correspondence was known preexperimentally (Soraci et al., 1987b); and, in the present study, by presenting familiar pictorial stimuli. The present results also tend to confirm theoretical positions which posit that the ability to label stimuli contributes to perceptual differentiation (Fisher & Zeaman, 1973; Gibson, 1969, 1979).

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Table 1

Social Quotients, Chronological Ages, PPVT-R Scores, and Sexes of Subjects in the Performer and Nonperformer Groups

Group	Subject #	SQ	CA	PPVT-R Standard Score	PPVT-R Age Equivalence	Sex
Performer						
	1	64	3-8	80	2-10	M
	2	75	3-2	82	2-5	F
	3	74	3-11	68	2-6	M
	4	68	4-3	84	3-5	M
Nonperformer						
	5	58	2-11	73	2-1	M
	6	62	3-11	57	2-3	M
	7	73	3-1	93	2-9	M
	8	63	4-0	61	2-5	M

Table 2

Results of Rn Analysis

	Subexperiments				
	1	2	3	4	
Subjects					
1	+1.32I	-	-	-	
2	+0.23B	+1.20I	-	-	
3	+1.05B	-0.23B	+1.62I	-	
4	+0.40B	+0.11B	+0.53B	+0.43I	
Rank	4	3	2	1	Rn = 10

*p < .05

B - Baseline session

I - Intervention session

Table 3

PPVT-R Scores and the type of Stimulus Mastered in the Soraci et al. (1987) Study and the present study.

Study	Subject #	PPVT-R	Group Mean	SD
Soraci et al. 1987				
Geometric Forms (n = 2)	1	102		
	2	108		
			105	3
Arabic Numerals (n = 3)	3	79		
	4	67		
	5	97		
			81	12.3
All Subjects			90.6	15.3
Present Study				
Arabic Numerals (n = 4)	1	80		
	2	82		
	3	68		
	4	84		
			78.5	6.2
Common Objects (n = 4)	5	73		
	6	57		
	7	93		
	8	61		
			71	14
All Subjects			74.8	11.5

Figure Caption

Figure 1. Percent of correct oddity responses per test session (25 - 30 trials) for the performer group.

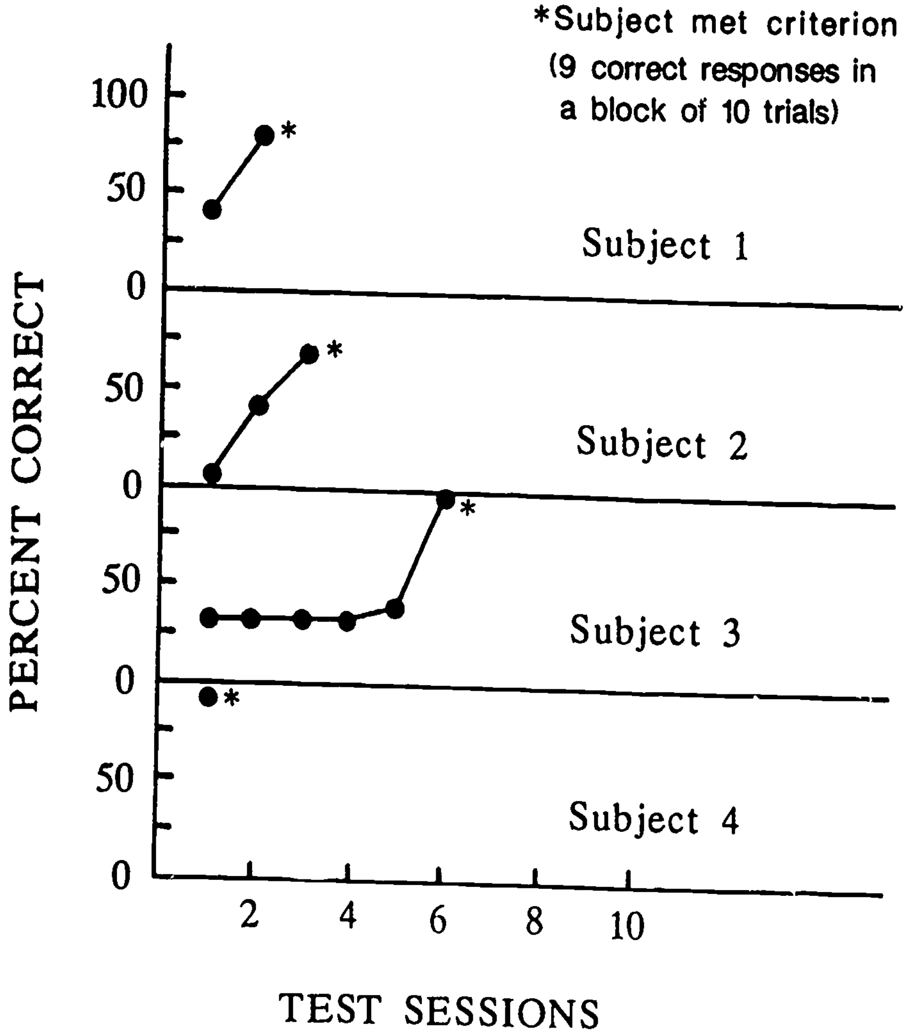
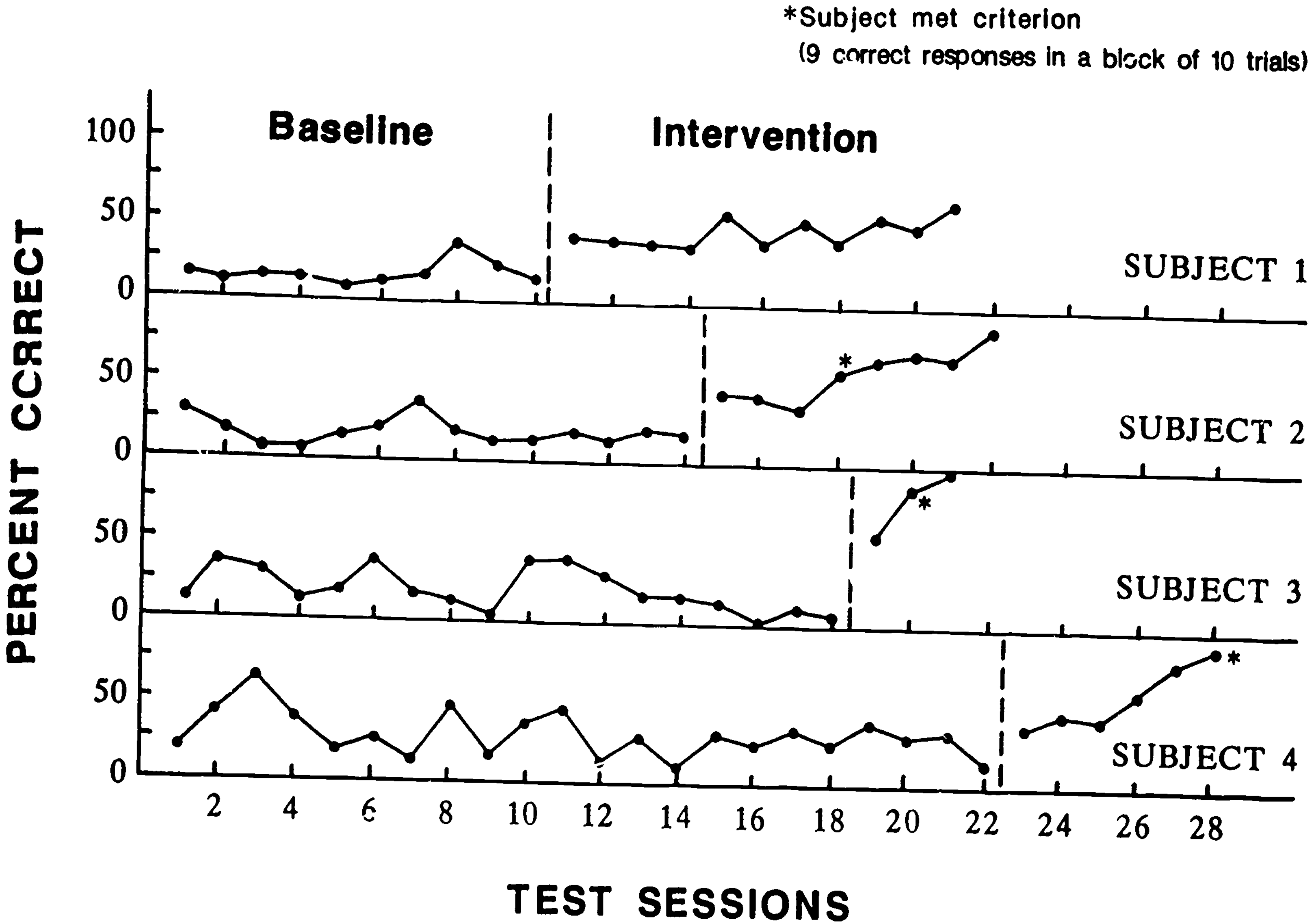

*Subject met criterion
(9 correct responses in
a block of 10 trials)
100
50
0
50
0
50
0
50
0
PERCENT CORRECT
Subject 1
Subject 2
Subject 3
Subject 4
2
4
6
8
10
TEST SESSIONS

Figure Caption

Figure 2. Percent of correct oddity responses per test session (25 - 30 trials) during baseline and intervention for the nonperformer group.


*Subject met criterion
(9 correct responses in a block of 10 trials)
Baseline
Intervention
PERCENT CORRECT
100
50
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SUBJECT 1
SUBJECT 2
SUBJECT 3
SUBJECT 4
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4
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12
14
16
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20
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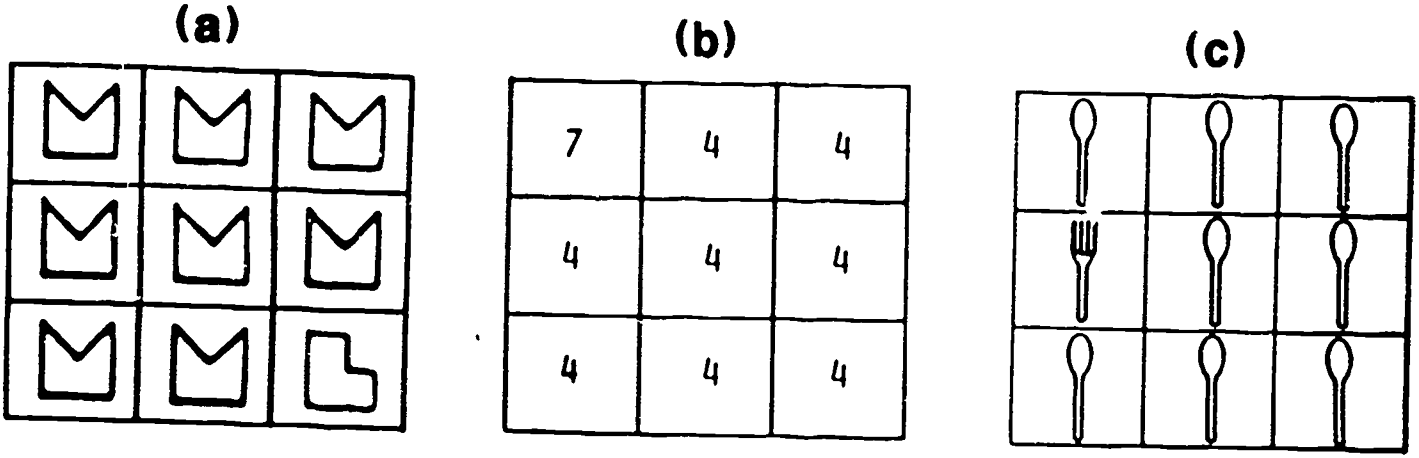
26
28
TEST SESSIONS

24

Figure Caption

Figure 3. Sample arrays of (a) geometric forms used in the Soraci et al. (1987a) study, (b) arabic numerals used in the Soraci et al. (1987a) and the present study, and (c) common objects used in the present study.


(a)
(b)
(c)
7
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4