Bidimensional solution shifts in children and adults

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Eight-, 10-, and 12-year-old children, and adults solved postshift problems based on both (intradimensional), one (partial-dimensional), or neither (interdimensional) of two dimensions relevant in a preshift problem. Performance in the intradimensional shift condition was superior to performance in the other two shift conditions for all age groups. Ss within each age group found the partial-dimensional and interdimensional shifts to be of equal difficulty.

The present experiment was designed to explore the effects of dimension retention or change on the shift performance of children and adults in bidimensional concept problems.

SUBJECTS AND DESIGN

Ninety children and 30 adults were administered postshift problems based on both, one, or neither of two dimensions relevant in a preshift problem. A 2 by 3 by 4 factorial design included two problems (both disjunctive concepts based on different pairs of relevant attributes), three kinds of solution shifts, and four age levels. The shifts were: (1) intradimensional, in which the same two dimensions were relevant in the original and test problems; (2) partial-dimensional in which only one of the dimensions originally relevant was relevant during the test; and (3) interdimensional, in which both of the originally relevant dimensions became irrelevant on the test problem. Five Ss were assigned at random to each of the 24 experimental groups.

Mean ages of the children were 8.4, 10.3, and 12.2 years, respectively; adults were college students approximately 20 years of age. All Ss were white and female.

TASK AND PROCEDURE

Stimuli were geometric figures with three levels on each of four dimensions: color (red, yellow, blue); size (small, medium, large); shape (triangle, circle, square); and number (one, two, three). The figures were presented on 3 x 5 cards during a

practice problem and on slides projected onto a screen during experimental problems. In addition to the specifications required by the shifts, stimulus sequences were restricted in two ways: equal numbers of positive and negative instances were included, and no more than three consecutive instances had the same attribute value. Each sequence contained 40 randomly ordered stimuli and was repeated if more than 40 trials were necessary for S to solve the problem.

The Ss solved two disjunctive problems. Every problem had two relevant attributes, one on each of two of the four dimensions (e.g., small/yellow), with the remaining two dimensions irrelevant. It was considered desirable that Ss administered all shifts receive postshift problems involving the same relevant attributes. Thus, four different Problem 1 sequences were constructed so that Ss in every shift condition could be given one of two transfer problems. The exact attributes relevant to solution on Problems 1 and 2 for the three shift conditions are presented in Table 1.

An attribute identification procedure similar to that of Haygood & Bourne (1965) was used. The S categorized the series of visually presented stimuli into two classes by giving verbal responses, "yes" and "no," to indicate whether or not she thought each stimulus was an example of the concept. The E delivered

feedback verbally after each response.

Before the first problem, Ss were oriented to the experimental situation. They were seated before a screen in an experimental room. A display board containing all stimulus attributes (patches of color, outlines of shapes, size, and number indicators) was kept on a table before the S throughout the experiment. Ss were familiarized with stimulus dimensions and levels shown on the display board and were given practice in using the disjunctive rule. A criterion of eight correct responses was required on a practice problem in order to demonstrate an understanding of the disjunctive rule. In the practice problem, Ss were told the relevant attributes (three/red) and were required to classify stimuli as exemplars or nonexemplars; verbal feedback was given. Relevant attributes in the practice problem were selected so that they did not represent attribute values relevant in any of the experimental problems. In all problems of the experiment, Ss were allowed as much time as they needed to respond to each stimulus. Successive stimuli were presented immediately after feedback was delivered.

When Ss had reached criterion on the practice problem, the first experimental problem was begun. In the experimental problems, Ss were not told the relevant attributes. Ss were told that stimuli like those of the practice problem would appear on the screen and that any of the attributes on the display board might be relevant. To minimize transfer effects from the practice problem, E explained that neither the attributes nor the dimensions relevant in the practice problem necessarily would be relevant in the experimental task. To aid in this, Ss were required to watch while E pointed out several possible combinations of relevant attributes (e.g., two/large, triangle/blue), representing values on all dimensions. The E continued to point out possible combinations until S gave indication that she understood that any two attributes might be relevant on the succeeding task.

When a criterion of 12 correct

Table 1
Dimensions and Attributes Relevant in Intradimensional, Partial-Dimensional, and Interdimensional Shifts on Problems 1 and 2*

Shift	Problem 1		Problem 2	
	Dimensions	Attributes	Dimensions	Attributes
Intra-dimensional	Size, Color Number, Shape	Small, Yellow One, Square	Size, Color Number, Shape	Large, Blue Two, Circle
Partial-Dimensional	Number, Color Size, Shape	One, Yellow Small, Square	Size, Color Number, Shape	Large, Blue Two, Circle
Inter-dimensional	Number, Shape Size, Color	One, Square Small, Yellow	Size, Color Number, Shape	Large, Blue Two, Circle

*Dimensions and attributes irrelevant for each specific problem are not presented.

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responses had been reached on Problem 1, S was informed that "two different things" would now be relevant and Problem 2 was begun. This information concerning the change in relevant attributes was accompanied, again, with instructions that any of the values on the display board might be relevant, with the exception of the two specific attribute values relevant prior to the break in procedure. No clues as to dimensions or attributes to be relevant were given. When S had given 12 consecutive correct responses in Problem 2, the experiment was ended.

RESULTS AND DISCUSSION

All Ss were successful in reaching criterion on Problems 1 and 2. An analysis of variance on Problem 1 showed that age and relevant attributes were significant sources of variance [$F(3,96) = 10.72$ for age and $F(5,96) = 4.33$ for attributes, $p < .01$]. Mean trials were 67.3, 52.5, 54.9, and 27.9 for 8-, 10-, 12-year olds, and college students, respectively. The exact effect of the attribute variable could not be assessed because of the partial crossing of the attributes in Problem 1 with the shift variable. An inspection of the average number of trials to criterion on Problem 1 over the two Problem 1 cells assigned to each shift condition showed no systematic variation in difficulty, however, and an analysis of variance on these scores revealed no significance for the shift variable.

The analysis of variance performed on trials to criterion on Problem 2 indicated again that age was a significant factor [$F(3,96) = 17.07$, $p < .01$]. Performance on all shifts improved with age. An application of Scheffé's test for group comparisons showed that most of the difference attributable to age was between the performance of the 8-year-olds and that of the other three ages [$F(1,96) = 47.7$, $p < .01$]. Performance of neither the 10- nor the 12-year-olds was reliably different from that of adults.

Fig. 1.

Mean trials to solution in Problem 2 for each of the three shift conditions are plotted as a function of age in Fig. 1. The intradimensional shift was performed with less difficulty than both the partial and interdimensional shifts by Ss of all age levels. The analysis showed significant effects due to shift [$F(2,96) = 19.51$, $p < .01$]. Orthogonal comparisons showed the intradimensional shift reliably different from the other two shifts [$F(1,96) = 38.62$, $p < .01$].

The only other significant effect was the interaction between age and attributes [$F(3,96) = 3.06$, $p < .05$]. This finding suggests that attribute saliency may have influenced performance of some of the children. The critical result of the study, however, is the ease of the intradimensional shift and the equality of the partial and interdimensional shifts for all relevant attributes.

These results indicate, as other experiments have shown (Bourne & O'Banion, in press), that Ss of increasing age levels are generally more efficient at solving concept problems. No Ss of any age level in the present experiment, however, benefited from

the transfer of a single relevant dimension from a first to a second problem when the problems involved two dimensions. The finding suggests that when one member of a pair of dimensions is found irrelevant by either children or adults solving disjunctive problems, both components of a working hypothesis involving the inappropriate dimension may be discarded. A recent study by Nahinsky, Penrod, & Slaymaker (1970) in which adults were found to sample attributes of conjunctive hypotheses as units supports such an interpretation.

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