Children's relative and absolute shape learning: A comparison with size learning¹

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Berman (1963) and Graham, Ernhart, Craft, & Berman (1964) found that it was significantly easier for preschool children to learn to respond to a common size relationship than to a specific size. The generality of this finding was tested in a partial replication of Berman's study using shape stimuli which adults judged to be equal in discriminability to her size stimuli. No significant difference was found between problems involving a response to a common shape relationship (either more or less rectangular) and response to a specific shape.

Since the early 1920's there has been a continuing interest in the perception and learning of relations between stimuli. The problem has frequently been studied with some form of the transposition experiment. Another procedure has been employed to make a direct comparison between relative and absolute discrimination learning. Three stimuli which vary on a dimension (e.g., size) are presented in two pairs (e.g., small with medium, and medium with large). The pairs are presented successively to Ss. Those learning an absolute discrimination are required to choose the middle-size stimulus in each pair. Some Ss learning a relative discrimination are rewarded for choice of the larger stimulus, and other Ss, for choice of the smaller, in each pair.

In 1937 Wolfle found that it was harder for rats to learn an absolute than a relative brightness discrimination. Recently, Graham, Ernhart, Craft, & Berman (1964), and Berman (1963), presented relative size problems to preschool children and used a similar two-pair technique. Children learned the relative size problems significantly more easily than the absolute problem.

To date none of the relative-absolute experiments, and few of the transposition studies, with children have used stimuli other than size; however, there is some suggestion from transposition experiments that the tendency to make relative responses may vary with the dimension studied (McKee & Riley, 1962; Riley & McKee, 1963).

The present experiment tests the generality that preschool children learn relative discriminations more easily than absolute ones, using shape stimuli rather than size. The procedure partially replicated Berman's size study (1963),² and Ss were drawn from the same sources. An attempt was made to equate discriminability of the stimuli on the two dimensions since, in transposition studies, discriminability is an important variable which influences the tendency to make relative responses.

METHOD

Subjects

The Ss were 40 two-year-olds and 40 four-year-olds who lived in University of Wisconsin graduate student and faculty housing, or attended one of two nearby nursery schools. Ss were limited to children of white, English speaking graduate students, faculty members, and other professionals.

Materials

Stimuli were white cardboard rectangles varying in degree of rectangularity, with length of perimeter held constant. They

were constructed to be comparable in discriminability to the 4.0 cm sq, 7.35 cm sq, and 13.5 cm sq, cardboard stimuli used by Berman. The following method was used to construct shape stimuli as discriminable from one another as the size stimuli were from each other.

A graded size series of 12 cardboard squares with an adjacent area ratio of 1:1.5 was placed in a row before 10 adult judges. The squares used by Berman as stimuli were in the third, sixth, and ninth positions in the series. A 40 cm string was taped into the shape of an 11 x 9 cm rectangle and this shape was designated as the least rectangular stimulus to be used. Each judge was asked to construct with another 40 cm string, a rectangle, more rectangular than the 11 x 9 cm stimulus, and as discriminable from it as Berman's middle- and larger-size stimuli were from each other. The dimensions of the median shape constructed were designated as the dimensions of the midrectangular stimulus for the present experiment.

A similar method was used to construct the most rectangular stimulus. Each of the judges constructed a still more rectangular stimulus, as discriminable from the midrectangular stimulus as Berman's middle- and smaller-size stimuli were from each other.

The final three stimuli to be used measured 11 x 9 cm (least rectangular), 15.1 x 4.9 cm (midrectangular), and 17.95 x 2.05 cm (most rectangular). The interquartile range of judges' estimates for the longer side of the midrectangular stimulus, and the most rectangular stimulus, were 1.6 cm, and .6 cm, respectively.

During stimulus construction, and later during stimulus presentation to Ss, the rectangles were oriented with the longer sides in the vertical plane. Positive stimulus cards had colored decals on the back and negative stimuli were left blank.

It should be noted that either area or extent of perimeter must change as shape is systematically varied, and either may serve as an additional cue in discrimination learning. In the present experiment the length of the perimeter was held constant. The result was a small area difference between the least rectangular and midrectangular stimulus pair, and a larger area difference between the midrectangular and the most rectangular stimulus pair. Despite this difference the two pairs appeared to be composed of equally discriminable stimuli and the salient feature for differentiation of stimuli appeared to be the shape of the stimuli.

Procedure

Children were tested individually. They were asked to play a card game and to see how many cards they could win. Pairs of stimuli were presented to S approximately 7.5 in. apart from center to center on a 12 x 19 in. background mat. Each time S picked a card with a picture on the back he had won and could put the card in the "bank," a slotted cardboard box.

Forty Ss, 20 at each age, were randomly assigned to the Absolute Condition. They were rewarded for choice of the midrectangular stimulus whether it was paired with the more- or the less-rectangular stimulus. Twenty children, 10 at each age, were randomly assigned to the Relative Less Rectangular Group. They were rewarded for choice of the less rectangular stimulus in each pair. The remaining 10 two-year-olds and 10 four-year-olds were given the Relative More Rectangular Problem, and were rewarded for the choice of the more

Table 1
Mean Transformed Per Cent Possible Errors-to-Criterion Scores for Relative and Absolute Shape Problems Compared with Scores for Size Problems¹

Problem	Age 2	Age 4	Combined Ages
Abs Shape (N = 40)	26.93	24.17	25.55
Abs. Size (N = 48)	34.12	26.08	30.10
Rel. Shape (N = 40)	28.95	16.30	22.63
Rel. Size (N = 48)	23.48	14.51	18.99
All Shape (N = 80)	27.94	20.24	24.09
All Size (N = 96)	28.80	20.30	24.55

¹Size data from Berman, 1963.

rectangular stimulus in each pair.

The presentation order for the two stimulus pairs was determined from a list of 72 pairs. Nine sets of eight stimulus pairs each, were picked from all possible sets in which each pair appeared four times, but never more than three times in succession. Right-left position was balanced across trials within restrictions designed to minimize the possibility of meeting criterion by perseverative position responses. A starting place on the stimulus-pair list was randomly chosen for each S. Ss were run for 31 trials or until a criterion of eight consecutive correct responses had been reached.

A correction procedure was used following the first trial only. All of the Ss' spontaneous references to the shape of the stimuli throughout the experiment were recorded.

RESULTS

Table 1 presents error scores for relative and absolute shape discriminations in comparison with Berman's scores for size discriminations. An arc sine transformation, which eliminated heterogeneity of variance in the size data, was also applied to the shape data to make the two sets of scores comparable.

When relative and absolute discriminations were considered together the difference between shape and size scores was insignificant ($F < 1.0$, $df = 1/164$) and, in fact, the means for shape and size problems were almost identical. Thus, scaling by adults for equal discriminability on the two dimensions, yielded stimuli for shape problems approximately equal in difficulty to size problems for preschool children.

However, the comparative difficulty of relative and absolute problems differed for the two stimulus dimensions. In the size experiment, the absolute problem was more difficult than the relative, with a highly significant difference between the two. In the present experiment with shape stimuli, the difference between relative and absolute was reduced and insignificant ($F < 1.0$, $df = 1/74$).

It can be seen from Table 1 that relative shape problems were more difficult than relative size problems, even though absolute shape was easier than absolute size. The difference was small for the older children, but more pronounced for the two-year-olds, and it accounts for the reduced difference between relative and absolute shape.

Children showed no significant preference for either the more or the less rectangular shapes. In contrast, the size studies had shown a significant preference for smaller stimuli.

Four-year-olds learned shape problems more easily than two-year-olds ($F = 4.53$, $df = 1/74$, $p < .05$), with no interaction between age and type problem ($F < 1.0$, $df = 2/74$). These results paralleled results with size stimuli.

DISCUSSION

Two previous studies with preschool children found relative size discriminations to be significantly easier than absolute size

discriminations. The present experiment fails to replicate these results using a set of shape stimuli constructed to be equal in discriminability to the stimuli used in one of the size experiments, using similar procedures and Ss drawn from the same sources.

It is interesting that the great majority of transposition studies with children have used size stimuli although results of at least two transposition experiments suggest that results may vary with the stimulus dimension used.

There is little previous data comparing children's responses to shape and size. In 1932, Jones and Dunn tested kindergarten children with a series of transposition problems, each with stimuli varied on a different dimension: size, shape, brightness, and hue. The proportion of children who transposed following shape training was very similar to the proportion transposing following size training, but no attempt had been made to equate the four sets of stimuli for discriminability or to control for order effects.

McKee & Riley (1962) have hypothesized that the common response to a metathetic stimulus dimension may be unlike the response to a prothetic dimension, such as size, where the typical response is to relations between stimuli. If so, we should not expect that relative shape discriminations would be easier than absolute shape discriminations, as is the case with size.

The greater difficulty of relative shape, compared with relative size problems, and the resulting decreased difference between relative and absolute shape problems, may be related to the later emergence of verbal concepts of shape. None of the 40 two-year-olds, and only four of the 40 four-year-olds, learning shape problems made spontaneous verbalizations about the shape of the stimuli, e.g., "the skinny one," "the square one." In contrast, two of Berman's 48 two-year-olds, and 15 of her 48 four-year-olds, spontaneously commented about the size of the stimuli. The difference between the frequency of relevant verbalizations with the two types of stimuli was statistically significant (Chi Square = 5.55, $df = 1$, $p < .02$).

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NOTES

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2. Half of Berman's Ss were given pretraining prior to the discrimination task. The present experiment partly replicates the procedure administered to the remaining 96 Ss, and the scores for these Ss, only, were compared with scores for Ss in the present experiment.