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An experimental note on Tversky's "features of similarity"

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Tversky has related degree of judged similarity between (among) objects to the degree of overlap of matching features. It is shown here that the extent to which mentally retarded children judge planometric figures to be alike is related positively to the number of matching cues.

Tversky (1977) has presented a powerful set-theoretical model designed to account for perceived similarity between objects. He refers to this as a contrast model, and similarity is held to be a linear combination of the values representing common and distinctive features of the objects. The present investigators were impressed with the close fit of Tversky's theory to a set of data gathered for another purpose and in another theoretical context, specifically, data gathered in a doctoral project designed to evaluate a procedure for training mentally retarded children to attend to various dimensions (features) of a visual display (Crawford, 1980). The present note will describe only that part of the original procedure that generated the data relating to Tversky's argument. A full account of the project may, of course, be found in Crawford (1980).

METHOD

Subjects

The study employed 82 mentally retarded children drawn from special educable and trainable classes in Caldwell, Franklin, and LaSalle parishes, Louisiana. IQs ranged from 34 to 69, chronological ages (CAs) from 6 to 18 years, and mental ages (MAs) from 38 to 120 months, with a mean of 81 months (Peabody Picture Vocabulary Test, Form A).

Apparatus

The apparatus consisted of a black screen, 78 cm in width and 60 cm in height, that contained a one-way mirror and a rectangular slot at the bottom through which the stimulus objects were passed to the subject. The screen served to conceal the investigator.

Procedure

To qualify, each subject was required to: (1) correctly identify by name the four colors, red, green, blue, and yellow, (2) correctly name the letters, S, N, C, and Z, and (3) succeed at a practice test designed to insure task understanding. The practice test presented a series of four small stimulus plates (Masonite) differing in thickness (thick or thin) and size (small or large). The total of four exhausted the number of possible unique combinations. All stimulus plates were brown in color and T-shaped.

Five practice series were given, a series consisting of four trials in which, one at a time, the four stimulus plates were presented for comparison with a standard (sample) plate drawn randomly from a matching set of four. Each time, the child was asked to say if "it is just like yours." An affirmative answer will be referred to hereafter as a "yes" response. A different standard was presented for each of the five practice series, and a modest toy prize (or a quarter in cash), exhibited on a nearby table, was promised for "doing well."

A correction procedure was followed. The child was always told when he was wrong, and the cue differences were pointed out. The child was also told when he was correct, and the cue similarities were pointed out.

Thirteen subjects failed to yield two successive correct judgments (choice of the single exact match within two of the five series) and were discarded as unable to grasp the task instructions. Two subjects failed earlier at the color-naming or letter-naming stage. Thus, the original sample of 82 was reduced to the 67 who qualified for the experiment and yielded the data of interest.

The experiment proper followed immediately. Each child was asked to make 32 successive judgments in a series composed of all possible unique combinations of one cue each from five binary-valued dimensions. Specifically, the dimensions represented were: form, color, type of black outline, black central figure, and number of central figures. For half the subjects, the binary values were: circle or cross (form), green or yellow (color), dots or xs (outline), C or Z (central figure), and two or four Cs or Zs (number). For the other half, the values were: square or triangle (form), red or blue (color), solid or dashed line (outline), S or N (central figure), and one or three Ss or Ns (number). Again, the stimulus series was fashioned from small Masonite plates (8.2 cm in both dimensions), and again, the single standard against which each plate in the series was compared was randomly selected from a matching set. The standard varied for each subject, and the order of presentation of the comparison stimuli was random. No feedback was provided. The child was asked each time to "tell me if it [the variable] is just like yours [the standard]." Thus, a "yes" response indexed perceived similarity.

RESULTS AND DISCUSSION

Each "yes" response of the subject was scored for number of cues contained in the variable that did in fact match a cue or cues of the standard. This could vary from zero (no matching cues) to five (the single exact match, all five cues). There resulted for each child

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a frequency distribution relating number of matching cues to number of "yes" responses. Perhaps an example is invited. Let us assume that the child yielded 16 "yes" responses in making the 32 comparisons with the standard. When examined for an actual match with cues contained in the standard, the 16 "yes" responses were distributed as follows: zero matching cues, 0 "yeses"; one matching cue, 1 "yes"; two matching cues, 4 "yeses"; three matching cues, 6 "yeses"; four matching cues, 4 "yeses"; and five matching cues, 1 "yes"; total, 16 "yeses." It can be shown for this subject that the probability of judging the pair to be alike (saying "yes") is a monotonically increasing function of the number of matching cues (or its inverse, the number of distinct cues). The number of matching cues is binomially distributed: In the series of 32 cue combinations, there is 1 instance of zero matches, 1 instance in which all five cues match, 5 instances in which one cue matches, 5 instances in which four cues match, 10 instances in which two cues match, and 10 instances in which three cues match (2^5). Thus, the subject yielding the zero, one, four, six, four, one distribution described above has given us: zero "yeses" for 0 no-cue matches ($p = .00$), one "yes" for 5 one-cue matches ($p = .20$), four "yeses" for 10 two-cue matches ($p = .40$), six "yeses" for 10 three-cue matches ($p = .60$), four "yeses" for 5 four-cue matches ($p = .80$), and one "yes" for 1 five-cue match ($p = 1.00$). And this defines a positive linear relationship between the probability of responding "yes" and the number of matching cues.

Figure 1 presents the outcome when the records of all 67 subjects are averaged. The results convince the eyeballs. However, as a conservative test of statistical significance, the linear regression coefficient was computed and found to be +.179. This value represents an unlikely chance departure from a true zero ($p < .0001$ by t test).

Tversky's (1977) contrast model rests upon five assumptions: matching, monotonicity, independence, invariance, and solvability. The first two define a matching function, one that gauges the extent to which the feature sets of two or more objects overlap. In the present task, the visual cues of form, color, outline, central figure, and number represent the dominant feature set, and the extent of overlap is measured by the number of matching cues. It follows that the probability of judging the variable to be similar to the standard should vary directly with the number of matching cues. And this is what we have found.

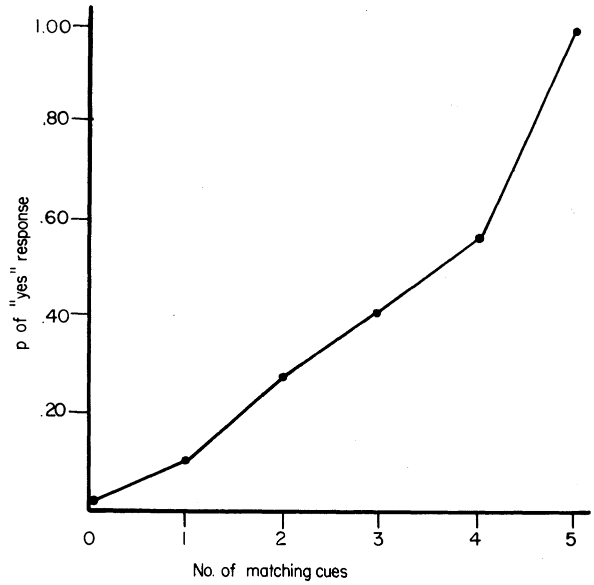

Figure 1. Probability of judged sameness as a function of number of matching cues.

Tversky (1977) has presented supportive experimental evidence from widely diverse areas. The present note extends the boundaries a bit.

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