Choice response times as functions of inter-item similarity, anchor level, and stimulus type¹

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Stimuli drawn from response-defined interval scales of size dimension, lightness dimension, and the two dimensions combined were used to investigate effects of visual similarity, stimulus type, anchor level, and practice upon two-choice response time (RT). Results indicated the following: (a) Mean RT was independent of the physical dimension(s) upon which alternative stimuli differed; and (b) although mean RT decreased 130 msec (19%) across the range of similarities investigated, error rate never approached the 10% limit considered tolerable in choice RT research.

Several investigators (e.g., Crossman, 1955; Henmon, 1906; Johnson, 1939; Sternberg, 1967) have obtained results indicating that choice response time (RT) decreases with increases in physical dissimilarity of stimulus alternatives. Henmon (1906), for example, reported average RT decreased monotonically as colors of two circular light patches or lengths of two lines were made more dissimilar. Wilson (1957), using as stimuli geometric objects differing in either size or shape, found similar results; but he obtained no corresponding decrease for stimulus alternatives differing simultaneously in both size and shape. He suggested, consistent with some earlier work (Bricker, 1955; Eriksen, 1952), that increasing stimulus dissimilarity by increasing the number of dimensions upon which items differ may actually increase RT.

In an attempt to quantify the RT-similarity function, Thurmond & Alluisi (1963) used stimuli scaled via the equal-discriminability (ED) method. Stimuli were circles scaled on the size dimension. The smallest of 11 circles was paired with each of the other 10, and the dissimilarity value for each pair was obtained by taking the difference, in units of the ED scale, between the two items. Average latencies decreased considerably (900 to 600 msec), as did error rate, when dissimilarity was increased from 1.0 to 3.0 units of the ED scale, while the drop was smaller (600 to 420 msec) and error rate constant as dissimilarity increased from 3.0 to 12.0 units.

The present study investigated the generality of findings described above. Thurmond & Alluisi (1963) used circles scaled on the size dimension, while in the present research, stimuli were drawn from ED scales of the lightness dimension (shades of gray), size dimension (circle sizes), and from the two dimensions combined (cf. Wilson, 1957). Thurmond and Alluisi paired their smallest circle with each of several larger ones to obtain different dissimilarity values. In the present study, anchor stimuli were selected from both the high and low ends of each scaled dimension.

METHOD

Twenty-four female Ss (paid volunteers), 15 to 18 years old, were randomly assigned to three groups of eight each. Each S was presented with four two-item lists, each at a different dissimilarity value.

Stimuli, chosen from previously constructed response-defined interval scales (Gholson & Hohle, in press), were grays (differing in lightness) obtained by combining Liquitex Polymer Emulsion artists' colors (Permanent Pigments, Inc., Cincinnati, Ohio), Mars black with Titanium white, and circles (differing in size) obtained via a calibrated adjustable diaphragm. Items were presented via two fields of a tachistoscope. Trials began with a 5.0-sec presentation of Field 2. At the end of this interval, Field 1, containing the reaction stimulus, was switched on, and a clock started simultaneously. The S's verbal response terminated the stimulus

(i.e., returned the tachistoscope to Field 2) and stopped the clock. The apparatus was programmed to record latencies (in milliseconds) and stimulus information on paper tape.

Each S was presented with four different two-item lists in which dissimilarity values of items varied from list to list (2-, 4-, 6-, and 8-ED units). For a given S, one item (anchor) was identical in all four lists, while the second number varied among pairs as necessary to obtain desired dissimilarity values. For one group, stimuli differed on the lightness dimension (Group L); for a second, they differed on the size dimension (Group S); and for a third (Group LS), the dimensions were combined to produce stimuli differing in both size and lightness. Within each stimulus-type group, there were two anchor-level subgroups. For one subgroup, the anchor was selected from the low end of the scaled dimension (i.e., smallest circle, lightest gray, or both smallest circle and lightest gray), while for the other subgroup, the anchor was drawn from the other end of the scale. Specific stimuli assigned the four Ss in each subgroup can be seen in Table 1. The numbers in the rows of the table labeled "ED scale values" denote stimuli as defined by the ED scaling procedure.² The dissimilarity value of any pair is obtained by subtracting the smaller member from the larger. The method used to produce stimuli for Group LS can also be seen in this table. The two scaled dimensions were combined orthogonally so the smallest, lightest stimulus served as anchor for one LS subgroup. The second member of, for example, the 2-ED list for this subgroup differed from the anchor by 2-ED units in size and by 2-ED units in lightness.

Table 1
The Specific Stimuli (as Defined by the ED Scaling Procedure) Composing the Stimulus-Pairs Assigned to Each of the Six Groups. Included in the table are the specific ED scale values and corresponding physical values.

			Stimulus Types			
			Sizes			
Anchor Subgroup	Low	ED Scale Values	1,3	1,5	1,7	1,9
		Circle Diameters (in 1/32-in.)	14.2,15.6	14.2,18.2	14.2,20.6	14.2,23.8
	High	ED Scale Values	10,8	10,6	10,4	10,2
		Circle Diameters (in 1/32-in.)	24.4,21.8	24.4, 19.3	24.4,17.5	24.4,14.8
			Lightnesses*			
Anchor Subgroup	Low	ED Scale Values	1,3	1,5	1,7	1,9
		Per Cent Titanium White	97.8,91.7	97.8,75.6	97.8,52.9	97.8,31.8
	High	ED Scale Values	10,8	10,6	10,4	10,2
		Per Cent Titanium White	22.7,42.2	22.7,63.8	22.7,86.2	22.7,94.3
			Sizes and Lightnesses Combined			
Anchor Subgroup	Low	ED Scale Values	1,3	1,5	1,7	1,9
		Circle Diameters	14.2,15.6	14.2,18.2	14.2,20.6	14.2,23.8
	Per Cent White	97.8,91.7	97.8,75.6	97.8,52.9	97.8,31.8	
	High	ED Scale Values	10,8	10,6	10,4	10,2
		Circle Diameters	24.4,21.8	24.4,19.3	24.4,17.5	24.4,14.8
		Per Cent White	22.7,42.2	22.7,63.8	22.7,86.2	22.7,94.3

* by weight

Each S served four daily sessions in each of which all four two-item lists were presented. List-presentation order was counterbalanced, for each subgroup, between Ss within sessions and within Ss over days. A unique verbal-recognition response was required upon presentation of each list item. The anchor was always called "one." The second members of the 2-, 4-, 6-, and 8-ED lists were called "two" through "five," respectively.

Each S came individually to the experimental room and was seated facing into the tachistoscope. Instructions emphasized rapid, errorless performance. Ten warmup trials always preceded each list. Each stimulus in a given list appeared 20 times each session.

RESULTS AND DISCUSSION

Four factor analyses of variance were performed on mean RTs and on error data derived from the 20 observations per stimulus per session at each dissimilarity value. Only data for anchor stimuli were included in the analyses. There were two between-Ss treatments: stimulus type (Group L vs S vs LS) and anchor level. Dissimilarity value and daily sessions were within-Ss treatments.

The major findings may be summarized as follows: (a) Mean RT decreased (see Fig. 1) [$F(3,54) = 101.89, p < .05$] as did error rate [$F(3,54) = 39.08, p < .05$], with increases in interitem dissimilarity; (b) neither mean RT [$F(2,18) = 0.25, p > .05$] nor error rate [$F(2,18) = 0.86, p > .05$] were affected by stimulus type; (c) both RT [$F(3,54) = 15.09, p < .05$] and error rate [$F(3,54) = 6.22, p < .05$] decreased across daily sessions. The only other significant result was an Anchor Level by Sessions interaction effect upon error rate [$F(3,54) = 4.40, p < .05$].

The finding of no significant effects involving stimulus type indicated that, while clearly dependent upon dissimilarity value (see Fig. 1), (a) mean RT was independent of the physical dimension(s)

Fig. 1. The effect of dissimilarity value upon choice RT. The parameter is stimulus type, but it did not approach significance in analysis of variance (see text).

upon which alternative stimuli differed and (b) decreased equivalently with increases in dissimilarity for Groups L, S, and LS. The latter result, although inconsistent with related findings (Wilson, 1957) in which no effect of dissimilarity was obtained for stimuli differing simultaneously on two dimensions, suggests that increasing physical dissimilarity by adding an equivalent (response-defined) difference on a second dimension (cf. Group LS vs L or S) may not lead to a corresponding increase in psychological dissimilarity.

The decrease in mean RT and error rate with increases in dissimilarity for Groups L, S, and LS replicated, in detail, related research that used stimuli drawn from an ED-scale of the size dimension (Thurmond & Alluisi, 1963). Although mean RT decreased 130 msec (19%) when dissimilarity increased from 2- to 8-ED units, error rate never exceeded the 10% limit considered tolerable (Rabbitt, 1968; Smith, 1968; Wilson, 1957) in choice RT

research. Error fell from 7.9% at 2-ED units to under 2.0% at all greater dissimilarity values.

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NOTES

1. This research was supported in part by USPHS Research Grant No. HD-2681-01.
2. The unit of the ED scale for both size and lightness is, of course, arbitrary; however, since exactly the same experimental procedures were used to obtain each scale, the same unit was specified for each, with the expectation that given dissimilarity values would have the same significance for each dimension.