Does context influence the shape of a perceptual scale?¹

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Effects of background reflectance on the shapes of scales of lightness were investigated in two experiments. In Experiment 1, 25 Ss compared similarities of pairs of gray chips that were viewed against black, gray, or white backgrounds. In Experiment 2, 33 Ss positioned a series of gray chips, viewed against a white, gray, or black background, so that the distances between successive chips represented the perceived differences in lightness between them. The results of both studies indicated that scale shape was influenced by background. The nature of the effect was that interstimulus differences in the region of a background were enhanced relative to interstimulus differences far from a background.

The effects of contextual stimuli upon the perception of focal stimuli have been studied extensively for many years (see, e.g., Helson, 1964; Corso, 1967, pp. 514-536). However, despite the considerable amount of research that has been done on this topic, the fundamental question of whether or not context appreciably influences the *shape* of a perceptual scale remains essentially unresolved.

The answer to this question would appear to be most easily obtained by means of one of the conventional scaling procedures such as category judgment or magnitude estimation. For example, with the former technique, gray chips varying in reflectance might be viewed within controlled contexts (e.g., displayed against backgrounds of different reflectances) and judged in terms of a category scale ranging from very dark through medium to very light. The conclusion invited by scales of lightness which varied systematically from one background to the next would be that context was a determinant of scale shape. Direct estimation of lightness under similar circumstances by the method of magnitude estimation would presumably result in ratio scales (Stevens, 1957), and a systematic relationship between background reflectances and the exponents of these various scales would suggest the same conclusion.

However, conclusions about perceptual systems drawn from such complex judgmental tasks are tenuous. Poulton (1968) has recently pointed out that, with the magnitude estimation procedure, an overt response reflects an interaction between sensory magnitude and a variety of response sets. Similarly for category judgment, Parducci (1965) has observed that scales derived by the use of this method are influenced by a tendency to use all categories equally often and by a tendency to equate the stimulus ranges covered by the category labels.

In the present series of two experiments the intent was to examine the shapes of perceptual scales by means of methods designed to minimize response biases and complex judgmental effects. To investigate the visual dimension of lightness, two techniques were employed which required Ss to neither categorize nor assign numbers to stimuli. In Experiment 1, a variant of the method of cartwheels was used (Coombs, 1964). In Experiment 2, Ss used a direct scaling procedure, devised by Richardson (1929), to construct an interval scale of lightness. Both procedures require Ss to respond only to magnitudes of difference between stimuli rather than to the absolute magnitude of individual stimuli.

EXPERIMENT 1

Method

Subjects. Twenty-five paid volunteers from The Johns Hopkins summer session served as Ss. Approximately equal numbers of males and females were tested individually.

Materials. Both focal and contextual stimuli were grays selected from the Color-Aid series of colored papers. Per cent reflectance of each gray was determined by matching with Munsell standards.

Three 8 in. x 14 in. sheets with reflectances of 90, 17, or 3% were used as backgrounds; these backgrounds are referred to as white, gray, and black, respectively, in this report. Focal stimuli were eight 1 in. square gray chips with reflectances of 55, 43, 30, 20, 15, 12, 9, or 5%.

Procedure. All stimuli were viewed under fluorescent ceiling lamps on a table in front of S. On each trial S was presented two identical pairs of chips, one pair on each of two contiguous background sheets. The two backgrounds always differed in reflectance, and the placement of the lighter background to the right or left of the darker one was determined randomly for each trial. The chips of each pair of focal stimuli were always adjacent members of the stimulus series (i.e., a pair could consist of chips with 55 and 43% reflectance, but not 55 and 20%). On every trial the two chips of each focal pair were displayed, with the lighter one above the darker, about 1 in. apart with the pair centered on its background. The S's task was to indicate the pair in which the chips were more alike.

From a series of eight chips, seven pairs with adjacent reflectances can be formed. Similarly, with the contextual stimuli, three pairs of backgrounds with differing reflectances are possible. Each S received six blocks of seven trials each. In each block a single pair of backgrounds was used (e.g., white-gray). The order of presentation of the seven pairs of focal stimuli was randomized within blocks for each S. For each S different random orders of the three background combinations were used for Blocks 1-3 and Blocks 4-6.

Fig. 1. Percentage of responses on which each pair of focal stimuli was judged more similar when it appeared on the darker of two backgrounds. Plotted functions refer to the three combinations of backgrounds used; B = black, G = gray, and W = white.

Results

The Ss' choices were tabulated to give the proportion of judgments in which each pair of focal chips was seen as more similar when it appeared on the darker of the two backgrounds. Figure 1 presents these proportions for successive pairs of focal stimuli. Plotted functions reflect judgments made against the three combinations of backgrounds (G/B, W/B, and G/W).

The data were interpreted with respect to the following argument. If the shapes of scales of lightness are not influenced by context, the similarity of one gray chip to another should be unaffected by the lightness of the particular backgrounds against which they are seen. Thus, the members of any pair of chips should appear no more similar on one background than on another. This reasoning leads to the prediction, for the measure plotted in Fig. 1, of three horizontal functions, all at a proportion of .50.

Examination of Fig. 1 dictates the rejection of the preceding argument. The three functions are neither identical nor horizontal. The differential influence of context is perhaps clearest when comparisons are made, for a single combination of backgrounds, between extreme pairs of focal stimuli. For example, with the white-black background combination, a light pair of chips (e.g., 43 - 55%) was judged more similar on the darker background, while a dark pair of chips (e.g., 5 - 9%) was judged more similar on the lighter background. The stability of these functions is indicated by the fact that when the judgments from the first three blocks and the last three blocks of trials were plotted separately, the resulting functions were virtually identical.

EXPERIMENT 2

The results of Experiment 1 clearly indicate that the form of the scale of lightness is influenced by the lightness of the background against which focal stimuli are viewed. Experiment 2 was designed to provide some quantitative index of the degree to which backgrounds influenced scale shapes.

Method

Subjects. Thirty-three volunteers from the Experimental Psychology course at Towson State College, Towson, Maryland served as Ss. Approximately equal numbers of males and females were tested individually.

Materials. As in Experiment 1, focal and background stimuli were selected from the Color-Aid series of gray papers. The backgrounds, black, gray, and white, were each 18 in. x 24 in. Seven chips with the following percent reflectances were selected as focal stimuli: 3 (black), 5, 12, 15, 20, 55, and 90 (white).

Procedure. On each of the three background sheets a black and a white chip were placed at opposite ends of the longer horizontal axis. The Ss' task was to position the five free chips along this axis in such a way that the distance between successive chips represented the perceived difference in lightness between them. Each S positioned the focal series once on each of the three backgrounds, and the order in which the backgrounds were used was randomized over Ss.

Results

One edge of the fixed black chip was taken as a reference point, and the distance to the comparable edge of each succeeding chip was measured. From these data the mean distance of each chip from the referent was calculated for each background. These data are presented in Fig. 2. The separations between the lines representing the three different backgrounds are proportional to the differences in reflectance between them. These data thus indicate that perceived differences between lighter focal stimuli are larger on a light background than on a dark background, while, conversely, perceived differences between dark stimuli are relatively smaller on a lighter background. Furthermore, for dark chips, the scale differences are small between the white and gray backgrounds but large between the gray and black backgrounds. The reverse relationships hold for light chips.

A statistical evaluation of these data is rendered difficult by the fact that the responses (i.e., the settings of successive chips) are

not independent. However, an analysis based on a single setting per background is valid. The setting of the middlemost chip (reflectance = 15%) was selected for further examination. An analysis of variance indicated that the position of this chip was significantly affected by differences among backgrounds ($F = 25.56$, $df = 2/64$, $p < .01$). Further examination indicated that while mean positions on the white and gray backgrounds differed reliably ($F = 29.88$, $df = 1/64$, $p < .01$) the difference in positions on the gray and black backgrounds failed to reach an acceptable level of significance ($F = 1.56$, $df = 1/64$, $p > .10$).

DISCUSSION

The results of these experiments lead to the conclusion that context can, in fact, influence the shapes of perceptual scales. Furthermore, they indicate that the nature of the influence is one of relative enhancement of interstimulus differences for stimulus magnitudes near in value to a background as compared with differences between stimuli that are far from a background.

These results are consistent with data reported some years ago by the Optical Society of America's subcommittee on the spacing of the Munsell colors (Newhall, Nickerson, & Judd, 1943, pp. 416-417). These investigators used the Richardson (1929) scaling technique and concluded that Munsell value was significantly affected by background reflectance. However, the concern of the O.S.A. subcommittee was the practical utility of the Munsell system, and the evaluation of their data excluded detailed analysis of background effects. It is precisely these neglected effects of context that the current experiments were designed to explore.

A study by Dinnerstein (1965), although not specifically concerned with perceptual scaling, provides some evidence which lends generality to the results of the present experiments. In her experiment, Ss performed the classical task of weight discrimination using the method of constant stimuli. Ss lifted the comparison and standard weights with the right hand and, simultaneously, lifted anchor weights (the contextual stimuli) with the left hand. Depending on the condition of the experiment, the left-hand anchor weights were much heavier or much lighter than the

Fig. 2. Mean distance (cm) from black reference chip to each focal stimulus for three different backgrounds. Parameter gives the per cent reflectance of each focal stimulus.

right-hand test weights. The data, analyzed in terms of accuracy or sensitivity of discrimination, indicated that the zone of maximal sensitivity shifted within the test series as a function of anchor weight. A heavy anchor shifted the zone of maximal sensitivity toward heavier comparison weights while a light anchor had the opposite effect.

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NOTES

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