Improved recognition with feedback: Discriminability and range-frequency effects*

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Ss ranked the sizes of squares presented, by the method of single stimuli, in sets with skewed spacings of sizes. Thurstone discriminability (the d′ of signal detection) improved when Ss were told the correct rank after each response. The effect of this informational feedback upon the mean ranking of each size is accounted for by a simple decrease in the weighting parameter of the range-frequency model.

Power of discrimination is sharply limited when simple psychophysical stimuli are presented successively (Miller, 1956). Increasing the average difference or spacing of the stimulus values helps very little (Pollack, 1953). However, there is recent evidence that discriminability can be improved by correctly identifying each stimulus after S's response (Braida & Durlach, 1972). Although not surprising, this contrasts with the research on signal detection where feedback appears to have little or no effect upon d′, the conventional measure of discriminability (Green & Swets, 1966).[1]

The present research studies the effects of feedback upon judgments of squares whose spacing, i.e., physical differences between varying sizes, were differentially skewed. The experiment was designed to reveal a possible interaction between the effects of feedback and spacing upon both discriminability and the scale of judgment. Since the scale effects of spacing can themselves be described by a noninteractive range-frequency model (Parducci & Perrett, 1971), a primary concern was whether the same model provides a useful account of the effects of feedback.

METHOD

The positive 1-24 and negative 1-24 sets of squares from Parducci & Perrett (1971) were used as the positively and negatively skewed sets in this experiment. These are each subsets from 24 logarithmically spaced sizes (Stimuli 1-2-3-4-7-10-14-19-24 and 1-7-12-16-19-21-22-23-24, respectively). As in the previous research, projected widths varied from 1.3 to 36.4 cm, black against a white 75 x 107 cm field.

An experimental session consisted of 20 randomly ordered presentations of each of the sizes. The first 18 presentations, 2 of each size, were treated as preview for which responses were not recorded. Each presentation was 4 sec, followed by a 5-sec interval during which the entire field was white. Three different random orders of presentation were used for each combination of feedback and spacing conditions.

All Ss were told there were nine different sizes and that the task was to rank each presentation by placing a plug in one of nine holes of a response box. For the feedback conditions, the correct rank was announced during the interval between successive presentations (after the responses had been recorded).

A total of 108 students in introductory psychology at UCLA served as Ss, in partial fulfillment of a class requirement. Ss were assigned randomly to 1 of 12 experimental subgroups, each receiving a particular order of one of the two stimulus sets either with or without feedback.

RESULTS AND DISCUSSION

Discriminability

The steeper slopes of the psychometric functions for the feedback conditions (solid lines in Fig. 1) indicate that Thurstone discriminability, which is equivalent to the d′ of signal detection (Lee, 1969), is improved by informational feedback. Since the location of the stimuli on the abscissa was determined by a previous Thurstone scaling of equally spaced sizes (Parducci & Perrett, 1971), the parallelism of the functions is further testimony to the independence of the Thurstone scale from contextual effects (see also Tabachnick, 1971).

The slopes were averaged to obtain a single index of discriminability. This is the d′ of signal detection, corresponding to the most restrictive Thurstone model (Torgerson, 1958, pp. 236-240). To estimate error for a statistical evaluation of the observed differences, a separate d′ was calculated for each of the three subgroups in each condition. The effect of feedback was highly significant, $F(1,8) = 38.55$, $p < .001$, reflecting a 75% gain in d′. This suggests a greater effect of feedback than the 20% gain reported by Braida & Durlach (1972); their study employed auditory intensities, somewhat different spacings, and a small number of highly practiced Ss. Neither the interaction of feedback with spacing nor the main effect of spacing approached statistical significance.

Scale of Judgment

The data of Fig. 1 were replotted for Fig. 2, which gives the mean of the ranks assigned the same stimulus by the different Ss in each condition. It is clear that feedback reduces the average error for both spacings, i.e., with feedback the responses more closely approach perfect rank order. The absolute improvement is much greater for the positively skewed spacing, which left more room for improvement.

The nature of the improvement was analyzed using the simplest range-frequency model of spacing effects (Parducci & Perrett, 1971). In this model, the judgment

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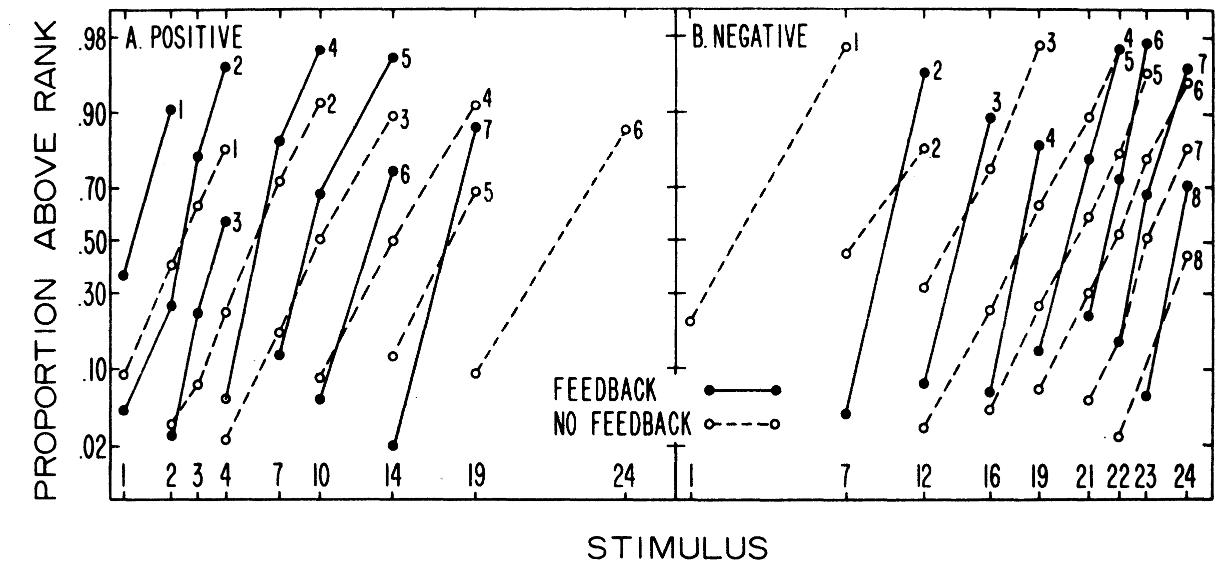

Fig. 1. Proportion of presentations of each stimulus ranked above that rank indicated at top of each psychometric function.

of Stimulus i, J_i, is a weighted average of its range and frequency values:

$$J_i = wR_i + (1 - w)F_i \quad (1)$$

The frequency value, F_i, is what the judgment would have been if the same number of stimuli were assigned to each category; when stimuli are presented with equal frequency and when the number of alternative responses corresponds to the number of stimulus values, as in the present experiment, F_i is simply the rank of Stimulus i. The range value, R_i, represents the position of the stimulus in the range of values with which it was presented. Although range values must be inferred from empirical data (using Eq. 1), the function relating range to physical values is assumed to be constant for different sets with the same end values, as in the present experiment. Extensive tests using these same stimuli without feedback (Parducci & Perrett, 1971) yielded an empirical weighting of w = .5 as the best least-squares fit to the data.

The predicted functions for the no-feedback conditions in Fig. 2A were calculated using the range function inferred from the mean judgments of the equally spaced set in Parducci & Perrett (1971). Equal weighting was again assumed, i.e., w = .5. It is clear that these predictions exaggerate the differences between the empirical data points for the two sets. This may reflect

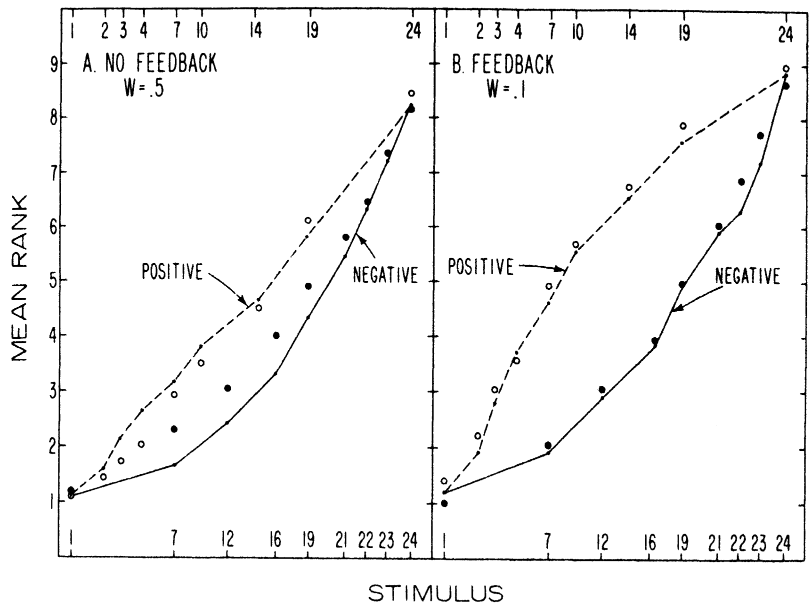

Fig. 2. Predicted (lines) and empirical (points) means of ranks assigned to stimuli presented in either negatively or positively skewed sets, with or without feedback.

the change to a ranking task (Ss had made absolute category ratings in Parducci & Perrett, 1971), the longer temporal intervals between exposures, or the greater amount of practice in the present experiment. For the feedback conditions (Fig. 2B), the best-fit value of w decreases to 0.1. This decrease in w was the only use made of the present data in generating the four sets of predictions for Fig. 2. The interaction between the effects of spacing and feedback upon mean judgment thus disappears when measured in terms of the weighting parameter of the range-frequency model.

If feedback had reflected the spacing rather than the ranks of the stimuli, its effect would presumably have been to increase rather than decrease the weighting of the range value. This, in fact, is what happens with extended practice (up to 36 sessions) in judging different sets of squares without feedback (Parducci & Perrett, 1967). The weighting of range and frequency effects is also affected by the method of presenting the stimuli; judgments of the lengths of simultaneously presented lines are closer to the range values when the layout of the lines emphasizes differences in length (Parducci & Marshall, 1961).

CONCLUSION

The apparent absence of interaction between the effects of feedback and spacing permits a simple description of the results. Feedback improves accuracy of recognition for simple psychophysical stimuli, whether measured by discriminability or average error. The reduction in error can be described as a change in weighting of range and frequency effects.

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NOTE

1. In an apparent exception (Carterette, Friedman, & Wyman, 1966), the direction of the effects of feedback depended upon the signal-noise ratio.

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