SOME EFFECTS OF INTRODUCING AND WITHDRAWING KNOWLEDGE OF RESULTS EARLY AND LATE IN PRACTICE [1]

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An earlier study by Bilodeau and Bilodeau (1958) reported the effect of providing schedules of knowledge of results (KR) according to fixed ratio. It was shown that learning depended upon the absolute frequency of KR, but not upon the relative frequency. That is, whatever the distribution of KR, non-KR trials neither hindered nor facilitated the learning produced by KR trials. The present study also deals with the relevance of KR for learning, but here KR and non-KR trials were administered in blocks. Such blocks were introduced either early or late in practice.

Because of the results of the previous study, it was expected that performance would improve with KR and deteriorate after the withdrawal of KR. The major expectation, however, was that non-KR trials would have no effect on learning when KR was eventually introduced. Actually, the issues involved here are analogous to those of the latent learning, reward context, and the experimental design was structured accordingly. In the latter part of the experiment all *Ss* were tested with KR. Prior to this, one group practiced without KR, another with KR, and two others with a different number of KR trials followed by trials without KR.

A secondary purpose of the experiment was to provide observations on the rate and level of response deterioration as KR was withdrawn from *Ss* of diverse proficiency.

[1] The data were collected at the Air Force Personnel and Training Research Center, San Antonio, Texas. The costs of preparing and publishing the manuscript were borne by the Graduate Research Council of Tulane University.

METHOD

Subjects and apparatus.—One hundred and sixty naive male *Ss* were assigned in equal number and without known bias to each of four conditions of practice on the Manual Lever apparatus. A complete description of the device was published by Bilodeau and Ferguson (1953).

The *S*'s task was to learn to displace the lever by a certain amount. Unknown to *S*, a displacement of 33° of arc constituted a perfect pull of the lever. Whenever KR was given, it followed the pull by about 5 sec., "10 units high" and "8 units low" are examples of KR. The task, then, was to learn to pull the lever by an amount which would minimize the error reported verbally by *E*.

A 20-lb. pull was required to move the lever. Thus, proprioceptive cues were strong as compared with a line drawing task.

Procedure.—For each of four groups, 24 pulls were required. The last five pulls were always followed by KR. For Groups 0, 2, 6, and 19, the first 0, 2, 6, and 19 trials, respectively, were also with KR. The remaining trials were not.

All 24 trials were run with a 20-sec. trial cycle. A "ready" signal preceded the "pull" signal by 3 sec. The response was made within 3–4 sec., and KR was given 5 sec. after response completion. About 8 sec. remained until the next warning signal. The *S* released the lever on completion of the pull, returned his arm to his side and waited for the next ready signal.

RESULTS [2]

The mean absolute errors (actual response less 33°) are plotted in Fig. 1.

[2] Two tables of data have been deposited with the American Documentation Institute. Copies may be secured by citing Document Number 5957 and by remitting $1.25 for photoprints, or $1.25 for 35 mm. microfilm. Make checks or money orders payable to: Chief, Photoduplication Service, Library of Congress, Washington 25, D. C.

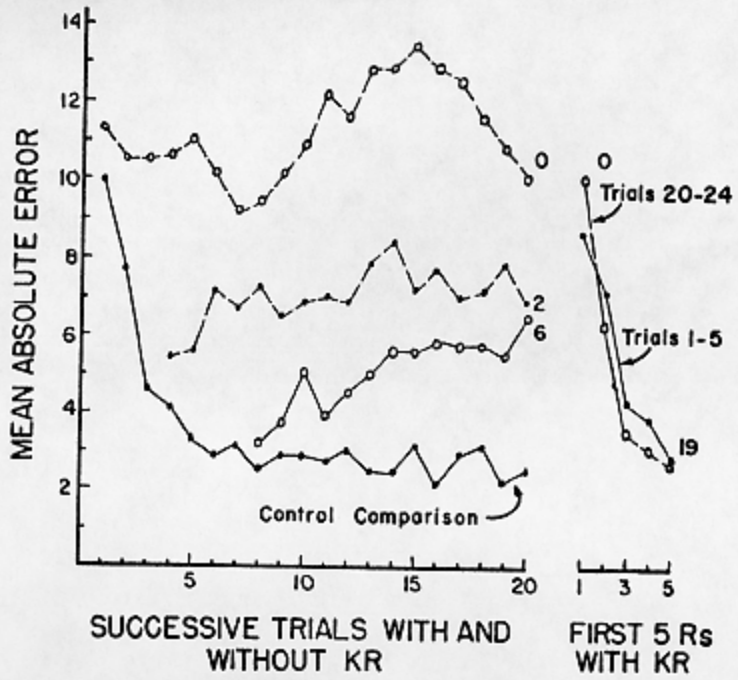

FIG. 1. Mean absolute error in positioning a Manual Lever to 33° on successive trials with and without KR (see text).

The figure is divided into two independent parts. In the first of these parts, the curve labeled Control Comparison shows the effects of 19 successive KRs. The Control Comparison represents the errors of three groups (2, 6, and 19) averaged whenever KR was in effect. The other curves on the left side of Fig. 1 show no particular trend in the error when KR is entirely absent (see 0), and increasing error trends after KR is withdrawn (see 2 and 6). The increasing error trends of Groups 2 and 6 are marked, though they do not suggest an imminent regression to the level of the initial error. The performance of Group 6 certainly deteriorates no more slowly than that of Group 2 despite the fact that Group 6 has had four more KRs. Groups 2 and 6 do not appear sufficient for a firm conclusion on deterioration as a function of the number of previous KRs. A group with KR withdrawn after 20 or so trials would have been a useful addition to the experimental design.

The second part of Fig. 1 presents a test of the latent effect of repeated responding in the absence of KR. Here, the last five trials of Group 0 represent the *first* trials with KR, after a series of 19 trials without KR. Group 19 served as a control, since their first five KR trials provided their first experience with the apparatus. The mean squares of neither Groups nor Groups by Trials reached the .05 level of significance. Thus, introducing KR immediately

or late in practice had no differential effect upon level of performance and rate of learning, i.e., there is no demonstrable latent effect.

The mean *algebraic* errors were also examined. These errors were near zero for Group 19. For the experimental groups, the errors were near zero during KR trials and markedly positive in sign in the absence of KR. Not only did *S*s overshoot when KR was omitted, but they also overshot by amounts that increased steadily the longer KR had been absent.

Discussion

The results were consistent with a previous study where KR was given according to fixed ratios. There was (*a*) no improvement without KR, (*b*) progressive improvement with KR, and (*c*) deterioration of response proficiency after the withdrawal of KR. The curves of Fig. 1 effectively summarized the classical properties of KR. Furthermore, it was shown that an initial series of trials without KR did not serve to acquaint *S* with properties of the lever system that could be gainfully employed (positive transfer) with the introduction of KR after the twentieth response. However, and lamentably so, a failure to produce latent learning is not to say that latent learning cannot be produced (though we may not know how).

A few KR trials (2 or 6) introduced at the very beginning of practice were effective in producing relatively long-term response modification, though response deterioration did set in immediately upon the withdrawal of KR. The deterioration, marked in quantity and positive in sign, nonetheless remained substantially below the level of errors produced when KR was entirely absent. The positive effect of a single KR trial is probably much greater (and more lasting) than the negative effect of a non-KR trial.

Dees and Grindley (1951), and others, have also observed increasing amplitude of response upon withdrawal of KR. A naive application of Hull's I_R theory (1943) to deterioration phenomena would predict *decreasing* amplitude of response, e.g., progressive undershooting would follow the build-up of I_R. Perhaps, it would be better to state that I_R interacts with or damps proprioceptive feedback. Thus, with the accumulation of I_R, responses must progressively lengthen during non-KR trials in order to produce internal feedback sufficient on Trial n to match feedback on Trial $n - 1$. The assumption here is that *S* is matching proprioceptive feedbacks during trials without KR. If this were done without the accumulation of I_R, a series of responses would be of uniform amplitude. With increasing I_R the amplitude of the response might well rise in compensation for a decreasing proprioceptive feedback.

Summary

This experiment deals with the late introduction and removal of knowledge of results. Its purpose was, by showing in a single experiment the effects of basic manipulations, to reassert the powerful relationships between response and the presence or absence of KR. The task was lever-displacing; the stimulus (KR) was the amount and direction of the reported error.

The experiment showed (*a*) no improvement without KR, (*b*) progressive improvement with KR, and (*c*) response deterioration after the withdrawal of KR. Further, an early series of trials without KR had no latent effect on the learning shown when KR was eventually introduced.

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DIFFERENTIAL EFFECTS OF CONTINUOUS EXTINCTION AND DISCRIMINATION TRAINING ON THE GENERALIZATION GRADIENT [1]

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A basic assumption in the traditional stimulus-response analysis of discrimination learning is that excitatory and inhibitory response tendencies are independently developed to the positive (S^+) and negative (S^-) stimuli as a result of the action of reinforcement and nonreinforcement. The only "interaction" occurring between these stimuli results from the generation of gradients of excitation and inhibitation which have S^+ and S^- as their respective maxima, and which summate algebraically on the stimulus dimension on which S^+ and S^- are differentiated. This analysis, first proposed by Spence (1937) to account for transposition, permits the prediction that after discrimination training, the resulting generalization gradient has its maximum not at S^+ but at a previously neutral stimulus value displaced away from the S^-.

To support the assumption of gradients of excitation and inhibition, Spence cites the work of Pavlov (1927) and of Bass and Hull (1934) in the area of classical conditioning. More recently, Guttman and Kalish (1956) have made a reliable determination of generalization gradients along the spectral dimension in an operant conditioning situation. Honig (1956) was able to establish a gradient of extinction after training a response to a number of stimulus values and extinguishing on one value. In unpublished research, Jenkins [3] obtained a gradient of extinction on the dimension of auditory frequency, after training a discrimination where silence served as S^+ and a tone as S^-. These experiments give support to Spence's assumptions about the existence of gradients of excitation and inhibition, although the forms of the gradients are not always similar to those postulated. The question remains whether the achievement of a discrimination is merely an additive combination of the processes of excitation and inhibition at different points on the stimulus continuum, or whether some more complex interaction is involved.

Hanson (1956, 1957) has investigated the spectral generalization gradient after the establishment of a successive discrimination. He did indeed obtain a displacement of the maximal value, or "peak shift," in the direction predicted by Spence. However, he found considerable difficulty in attempting to derive his empirical gradients from the summation of postulated excitatory and inhibitory gradients. His discussion is too complex to be reviewed here, but one point is particularly relevant to the present study: any postulated inhibitory gradients accounting for his data would have to have maxima at the S^+ rather than the S^- value, a determination that is certainly contrary to Spence's analysis. Hanson concludes that the best description of the effect of discrimination training is a "relocation" of the primary generalization gradient along the stimulus continuum. The simple summation of independently generated gradients of excitation and inhibition cannot account for this "relocation"; the development of a discrimination appears to involve additional processes that are *sui generis*, and

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[3] Personal communication from Herbert M. Jenkins, August, 1958.