Effects of overtraining and irrelevant stimuli on successive position reversals in rats¹

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Three groups of rats were given a series of 15 successive position reversals: one group without irrelevant stimuli; one, with one irrelevant dimension; and one, with two irrelevant dimensions. Half of the Ss in each group received 100 overtraining trials before each reversal and the remaining, zero trials. There was a large learning set effect. Overtraining retarded the early and facilitated the later reversals. The effects of irrelevant stimuli were to increase both the interfering and facilitating effects of overtraining, although not significantly in the case of the latter.

The study here reported investigated the effects of overtraining and irrelevant stimuli on successive position reversals. Mackintosh (1965) and Sperling (1965a, b), in their reviews of the effects of overtraining on reversal and discrimination learning, noted that in a majority of cases overtraining produced either no effect or retarded reversal learning when position was the relevant dimension. However, all of the data reviewed were from single habit reversals, and to date there have been no reports on the effects of overtraining on a series of reversals when overtraining followed each reversal. The effect of irrelevant stimuli has been less consistent. With visual discriminations Mackintosh (1963) found that additional irrelevant stimuli enhanced the facilitating effects of overtraining, the overtraining reversal effect (ORE), while North & Clayton (1959) found no effect. Eimas (1967, Experiment 1) found that, in the absence of the ORE, increasing the number of irrelevant dimensions from one to two retarded visual discriminations and had no effect upon position discriminations. Again, the effects of irrelevant stimuli on an extended series of reversal problems are not known.

Method

Subjects. The Ss were 30 male albino rats approximately 90 days old at the beginning of training. They were assigned randomly and in equal numbers to six treatment groups formed from the combination of two levels of overtraining (0 and 100 trials) and three levels of variable irrelevant dimensions (0, 1, and 2 dimensions). Throughout the experiment, Ss were fed 12 gm of lab chow per day approximately 15 min. after testing.

Apparatus. A Wisconsin General Test Apparatus, modified for the rat and described by Rollin, Shepp, & Thaller (1963), was used. The irrelevant stimuli were wooden rectangles and circles, approximately equated for area, onto which black and white cardboard cutouts could be attached.

Procedure. The handling, pretraining, and daily training procedure have been described elsewhere (Eimas, 1967). Essentially each S was trained on a position discrimination. Twenty-five trials per day, five days per week, were given until a criterion of 20/25 correct responses in a daily session was attained. A noncorrection procedure was used and each correct response was reinforced with a single 45-mg pellet. On the day after criterion on the original problem and each reversal, half of the Ss began training on the next reversal, while the remaining Ss received 100 overtraining trials, at the rate of 25 per day, prior to the next reversal. This training procedure was continued until each S reached criterion on 15 successive reversals.

The Ss in the zero irrelevant dimensions groups were trained with two identical stimuli covering the foodwells, e.g., two black circles. The one-dimension irrelevant groups were trained with either form or brightness irrelevant and variable, e.g., black square and black circle. Each stimulus was reinforced equally often, and on a particular trial was determined by a random series. The two-dimension irrelevant groups were trained with both form and brightness irrelevant and variable; that is, there were two pairs of stimuli, black square—white circle and white square—black circle. The two pairs of stimuli were randomly alternated from trial to trial as was the selection of one stimulus within a pair to be reinforced.

Results and Discussion

Figure 1 depicts the mean total errors for the original problem and for the 15 reversals in blocks of three reversals. All of the functions reveal the typical learning set curves for successive reversals:

Fig. 1. Mean total errors for blocks of three reversals as a function of amount of overtraining (0 and 100 trials) and number of variable irrelevant dimensions (zero, one, and two). OR. refers to the original problem.

an increase in errors in comparison to the original problem during the early reversals followed by a relatively rapid decline toward asymptote.

An analysis of variance, Overtraining by Number of irrelevant dimensions, performed on the error data from the original problem, revealed a significant Dimensions effect ($F=3.58$, $df=2/24$, $p<.05$): more errors were made with variable irrelevant stimuli present.² In order to be able to compare the results of the initial reversal with previous single-reversal studies, an analysis of variance was performed on the error data of the first reversal only. Significant effects at the .05 level or better were found for Overtraining ($F=20.48$, $df=1/24$), Dimensions ($F=3.93$, $df=2/24$), and the Overtraining by Dimensions interaction ($F=3.43$, $df=2/24$). Reversal learning was retarded by overtraining, a reverse ORE effect, and about equally by one or two irrelevant dimensions. In addition, the interfering effect of overtraining was enhanced by increasing the number of irrelevant dimensions. These results are similar to those of other studies using position discriminations and small rewards, but are in marked contrast to the results obtained by Mackintosh (1963) with visual discriminations.

Turning now to consideration of the entire series of reversals, an analysis of variance, Overtraining by Dimensions by Blocks, was performed on the mean total errors in each block of three reversals. Overtraining retarded reversal learning ($F=4.28$, $df=1/24$, $p<.05$) as did irrelevant stimuli, although not significantly ($F=3.16$, $df=2/24$, $p<.10$). There was a reliable learning set effect ($F=152.20$, $df=4/96$, $p<.001$) and Blocks by Dimensions interaction ($F=2.11$, $df=8/96$, $p<.05$), indicating a faster decline in errors as the number of irrelevant dimensions was increased. Most important was the significant Blocks by Overtraining interaction ($F=9.58$, $df=4/96$, $p<.001$) which can be attributed to the initially retarding effect of overtraining followed by a facilitating effect over the final three reversals. The latter was confirmed by a separate analysis of the last block of reversals. Overtraining enhanced reversal learning ($F=4.13$, $df=1/24$, $p<.05$), and there was a tendency for this effect to increase with the number of irrelevant dimensions ($F=2.66$, $df=2/24$, $p<.10$).

In order to determine the manner in which overtraining operated first to retard and then to facilitate reversal learning, the mean total errors were divided into two components, namely, perseverative errors (PEs) and re-acquisition errors (REs). The former was defined as the number of consecutive errors to the previously positive position and the latter as the difference between total errors and perseverative errors. Analyses of variance, Overtraining by Dimensions by Blocks, of these two measures revealed the following effects significant at the .05 level or better: (a) more PEs occurred after overtraining ($F=24.67$,

$df=1/24$); (b) PEs increased with the number of irrelevant dimensions for overtrained Ss only ($F=4.28$, $df=2/24$); (c) PEs declined across reversals ($F=43.05$, $df=4/96$); (d) the decline in PEs was faster for overtrained Ss ($F=13.75$, $df=4/96$); and (e) REs declined sharply across reversals ($F=83.14$, $df=4/96$). On the final three reversals there was no difference in PEs between overtrained and nonovertrained Ss, but there was a reliable difference in REs with overtraining resulting in fewer such errors ($F=8.35$, $df=1/24$, $p<.01$). Thus, the failure to find a facilitating effect of overtraining early in reversal learning was due largely to the excess of PEs after overtraining, as there was no difference in REs. On the other hand, the facilitating effect of overtraining, when it occurred, was primarily a function of faster re-acquisition after overtraining, as the number of PEs did not differ at this stage of reversal learning.

Increasing the number of irrelevant stimuli functioned in two opposing manners, depending upon whether overtraining retarded or facilitated reversal learning. In the case of the former, additional irrelevant stimuli further increased the interfering effect of overtraining, while in the case of the latter they tended to produce an increment in the facilitating effect. Enhancement of the ORE by irrelevant stimuli and the ORE, itself, have been considered consistent with two-stage theories of discriminative learning (e.g., Mackintosh, 1965). However, whether these theories, constructed from the data of single habit reversals and nonreversals, can be modified to account for the present effects of overtraining and irrelevant stimuli in an extended series of reversals is at present an open question.

References

- Eimas, P. D. Overtraining and reversal discrimination learning in rats. *Psychol. Rev.*, 1967, in press.
- Mackintosh, N. J. Selective attention in animal discrimination learning. *Psychol. Bull.*, 1965, 64, 124-150.
- Mackintosh, N. J. The effect of irrelevant cues on reversal learning in the rat. *Brit. J. Psychol.*, 1963, 54, 127-134.
- North, A. J., & Clayton, K. N. Irrelevant stimuli and degree of learning in discrimination learning and reversal. *Psychol. Rep.*, 1959, 5, 405-408.
- Rollin, A. K., Shepp, B. E., & Thaller, K. A. A modified Wisconsin General Test Apparatus for the rat. *Amer. J. Psychol.*, 1963, 76, 500-502.
- Sperling, S. A. Reversal learning and resistance to extinction: A review of the rat literature. *Psychol. Bull.*, 1965a, 63, 281-297.
- Sperling, S. A. Reversal learning and resistance to extinction: A supplementary report. *Psychol. Bull.*, 1965b, 64, 310-312.

Notes

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2. The results from original learning and the first reversal for the 20 Ss trained with one and two irrelevant dimensions have been reported in another article (Eimas, 1967) as part of a larger study on overtraining and reversal learning in rats.