Counterconditioning with and without response prevention in deconditioning persisting avoidance*

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Thirty-six rats were each fixed with a chronically indwelling electrode to provide intracranial stimulation (ICS) of the lateral hypothalamus-medial forebrain bundle. They were trained in an automated one-way avoidance apparatus to avoid footshock. After footshock was turned off, they were given one of six treatments and then tested for effectiveness of treatment by being allowed to respond again to extinction criteria. Treatments included response prevention and programming positive ICS under different circumstances. Results showed that those treatments which were most effective provided some form of counterconditioning with ICS while the rat was on the footshock grid; however, it was not necessary to prevent responding for the ICS to countercondition.

There are a number of animal laboratory studies attempting to specify the conditions for efficient elimination of avoidance responding following footshock termination (Baum, 1970; Wilson & Davison, 1971). Recently, intracranial stimulation (ICS) has been used as a tool to manipulate affective states of rats in these paradigms (e.g., Gordon & Baum, 1971; Hunsicker, Nelson, & Reid, 1973). The outcomes of these studies have demonstrated that programming positive ICS during response prevention (flooding) is remarkably efficient in eliminating persisting avoidance (Reid, 1973). This study examined the effects of giving positive ICS without response prevention; that is, some groups of rats were given potential counterconditioning ICS while the avoidance response was possible and compared to groups prevented from making the response.

METHOD

Subjects

Ss were 36 adult male Sprague-Dawley rats, all fixed with chronically indwelling bipolar electrodes aimed for the medial forebrain bundle of the lateral hypothalamus. The commercially made electrodes (Plastic Products Ms 303) were bipolar, stainless steel, and insulated except at the cross section of the stimulating tips.

Apparatus

ICS was 60-Hz sine waves of 0.25 sec, with intensity individually determined for each rat, but always between 20 and 60 microA. Footshock of 1.3 mA was generated by a Grason-Stadler shock source and scrambler. When ICS and footshock were programmed in the same chamber, the electrode leads for the two kinds of stimulation were never connected at the same time, preventing interaction between the two stimulations.

The avoidance apparatus was modeled after the one described

in detail by Baum (1965) and was a square box with an electrifiable grid floor and retractable shelf (7 cm wide) extending through the width (30.5 cm) of one side. The shelf remained out of the chamber for a period of 2 sec after each retraction.

Procedure

The procedure resembled that of Gordon and Baum (1971). After surgery for implanting electrodes and after at least 4 days for recovery from surgery, responsiveness for ICS was measured in a box with a lever, the depression of which yielded a single ICS. The intensity of ICS was varied and an intensity which supported high rates of pressing was selected. Those 24 rats that pressed the most (always greater than once every 2 sec) were selected to get ICS as part of their procedure.

All rats got the same avoidance training. Without habituation to the chamber, S was placed on the grid. Ten seconds later, footshock came on and remained on until S jumped to the ledge. After 30 sec on the ledge, the ledge retracted, returning S to the grid and beginning a new trial. S avoided footshock by climbing to the ledge within 10 sec. Training continued until S made 10 consecutive avoidances. On the following day, S was given another training session which allowed it to respond until 10 consecutive avoidances were made. A 1-sec unavoidable shock was then programmed and followed by additional avoidance training until 10 consecutive avoidances were again attained; then one of six treatments were programmed.

To begin treatments, footshock was disconnected, S was picked up, and electrode leads were connected. The treatments, which were always 10 min, included: (a) a group which was placed in a pail next to the chamber, a no-treatment control group; (b) a group which was placed on the grid with the shelf removed, a response prevention, (flooding) group; and (c) a group which received periodic ICS every 2.25 sec while S was on the grid and the shelf was removed. The other three groups received ICS during their 10 min in the chamber with the apparatus programmed to operate as in training, except footshock was no longer programmed. One group (d) was given ICS only when S was on the shelf; another group (e) received half the number of ICS on the shelf and half the number on the grid; the last group (f) received ICS only when on the grid. Each rat scheduled for ICS received 302 ICS. A summary of treatments appears in Table 1.

At the end of the treatment time, electrodes were disconnected, and S was placed on the returned shelf. Thirty seconds later the shelf retracted, beginning the first trial of tests for perseveration of responding which continued until 5 consecutive minutes were spent on the grid, or 250 responses.

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Table 1
Treatments and Outcomes

	Group					
	a	b	c	d	e	f
	Treatments					
Response Prevention	No	Yes	Yes	No	No	No
ICS Distribution	None	None	Grid Only	Shelf Only	Grid & Shelf	Grid Only
	Trials to Criteria					
Mean	239.3	160.3	84.0	211.7	62.5	122.4
Median	249+	157	49.5	249+	3	129
Highest	250+	250+	250+	250+	250+	250+
Lowest	215	5	0	20	0	0
S/n at 250+	4/6	2/6	1/6	5/6	1/6	1/5

Pretreatment measures were total trials and total seconds of shock across all training. Posttreatment data were trials and avoidances to extinction criteria.

RESULTS

A Kruskal-Wallis one-way analysis of variance (ANOVA) of the trials to acquisition criterion, with Ss grouped as they eventually received treatment, yielded $H = 1.3$, $df = 5$, $p > .90$. A Kruskal-Wallis ANOVA of shock taken during acquisition yielded an $H = 1.7$, $df = 5$, $p > .80$. These pretreatment analyses suggest that the groups were roughly equivalent prior to treatment and that analyses of posttreatment scores can be done without taking into account pretreatment performances.

One S in Group f (Table 1) had a seizure during treatment, probably due to an unfortunate massing of ICS at one point. This S's data were not used in posttreatment analyses.

Kruskal-Wallis ANOVA showed that posttreatment differences among groups were reliable: for trials to extinction criterion, corrected for ties, $H = 16.2$, $p < .01$; for avoidance, corrected for ties, $H = 17.9$, $p < .01$, $df = 5$. These analyses of the overall data allow inspection of specific differences among groups.

Embodied within this study is a replication of previous work comparing the three groups of (a) no treatment to (b) response prevention alone to (c) response prevention and periodic ICS. A Kruskal-Wallis ANOVA on the groups of no treatment, response prevention only, and response prevention with periodic ICS yielded, for trials to criteria, corrected for ties, $H = 6.6$, $p < .05$; for avoidances to criteria, corrected for ties, $H = 8.4$, $p < .02$, $df = 2$. The differences among these three groups are highly reliable, not only from analyses of this study, but also because the same ordering of treatments has been found in the studies of Buss and Reid (1973), Gordon and Baum (1971), Hunsicker et al (1973), Prado-Alcala, Bush, Steele, and Reid (1973), and Voss, Mejta, and Reid (1974). Therefore, these three groups may serve as a

standard for comparison of the other three.

An inspection of the data of trials to criteria in Table 1, and the multiple comparisons in Table 2, show Ss receiving no RP but ICS on the shelf (Group d) responding in a manner similar to the no-treatment controls (Group a). Groups receiving ICS on the grid, regardless of whether or not they received response prevention, showed the least responding after treatments. These last three groups are not reliably different from one another, and are reliably different from no treatment (Table 2). These analyses indicate that no treatment and ICS on the shelf are inefficient, response prevention is only moderately efficient, and the treatments providing ICS on the grid are efficient (Fig. 1).

Histological examination of the Ss' brains showed that for the most part the sites of ICS were in the lateral hypothalamus medial forebrain bundle area (MFB), with the exception of one S of Group f, whose electrode placement was in the preoptic area. Although all hypothalamic electrodes probably stimulated the MFB, some electrodes also stimulated adjoining tissue. Those

Table 2
Selected Comparisons

Groups/Treatments				p Value
No treatment	vs	ICS on grid—c		.01
No treatment	vs	ICS on shelf—d		.41
No treatment	vs	ICS on grid—e		.01
No treatment	vs	ICS on grid—f		.06
R prevention	vs	ICS on grid—c		.12
R prevention	vs	ICS on shelf—d		.12
R prevention	vs	ICS on grid—e		.03
R prevention	vs	ICS on grid—f		.21
ICS on grid—c	vs	ICS on shelf—d		.04
ICS on grid—c	vs	ICS on grid—e		.24
ICS on grid—c	vs	ICS on grid—f		.46
ICS on grid—e	vs	ICS on grid—f		.30

Note— p values for deciding reliability of differences were derived from Mann-Whitney U statistics without taking into account that multiple comparisons were made. Group labels are from Table 1.

Fig. 1. Posttreatment trials to extinction criterion for the three reference groups: (a) no treatment, (b) response prevention only, (c) response prevention with periodic ICS, and for the three additional treatments, (d), (e), and (f).

Ss whose electrodes diverged from the MFB the most were also the Ss of Groups c, e, and f that made the most posttreatment responses. Also, the rank-order correlation between posttreatment trials and pressing rates prior to training = $-.43$ across the three ICS grid groups. If Ss of Groups c, e, and f that had electrode sites which diverged the most from the MFB are excluded from analyses, the resultant scores of these groups would all approach zero.

DISCUSSION

The choice of 250 trials as an upper limit for posttreatment trials was too low. Consequently, the apparent conclusion of no difference between giving ICS on the shelf and no treatment is subject to error.

When ICS was given on the grid while S was given the

opportunity to climb to the ledge (Groups/Treatments e and f), ICS probably reinforced staying on the grid. As trials continued during the 10-min period, the rats spent more and more time on the grid. The reinforcement interpretation of the results is compatible with results of Prado-Alcala et al (1973), who found that ICS delivered contingently upon moving away from the shelf during response prevention hastened deconditioning, whereas ICS delivered contingently upon abortive avoidance and movements toward the shelf during response prevention tended to strengthen subsequent avoidance responding.

Interestingly, the results demonstrate that preventing the avoidant was not necessary for efficient deconditioning. Apparently, some ICS given on the grid, however, is necessary for effective counterconditioning. Response prevention ensures that ICS is given on the grid and does not provide fortuitous reinforcement for the avoidant, thus strengthening it. These data, therefore, support the prescription that, to decondition avoidance efficiently, a strong positive stimulus should be provided during response prevention (or fear elicitation) to counter the fear and to reinforce any occurrences of behavior incompatible with avoidance.

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