SOME FACTORS INVOLVED IN THE COMPARISON
OF RESPONSE SYSTEMS: ACQUISITION, EXTINCTION,
AND TRANSFER OF HEAD-POKE AND LEVER-PRESS
SIDMAN AVOIDANCE¹

JOHN J. B. AYRES, JAMES O. BENEDICT,²
RICHARD GLACKENMEYER, AND WILLIAM MATTHEWS

UNIVERSITY OF MASSACHUSETTS, AMHERST

Head poking, a suggested natural escape reaction to shock for the rat, was compared to lever pressing in a Sidman avoidance study. Both responses could be emitted at any time, but only one was effective in a given session. Acquisition and extinction of the two responses were compared under both signalled and unsignalled avoidance. Then, a test for transfer was conducted in which acquisition conditions were re-instated, but the effectiveness of the responses was reversed. Three differences between responses were noted: (a) head poking was superior in reducing shock rates under signalled conditions; (b) head poking was more resistant to extinction, especially under signalled conditions; (c) under unsignalled conditions, animals were unable to learn to head poke if they had previously learned to lever press. Findings *a* and *c* were pursued in later experiments. Finding *a* depended on the location of the warning signal with respect to the response system. When the lever press required approach to the warning signal, the head poke was superior. But when the head poke required approach to the warning signal, the two responses were equally effective. Finding *c* depended on the absence of feedback for head poke during transfer. Two conclusions are offered: first, the two responses appear to obey the same laws when their topographical differences are taken into account. Second, response feedback appears to be more critical in transfer than in original acquisition.

Recent writers have suggested that laws of learning established using arbitrary operants such as the lever press may not generalize to less arbitrary, more biologically significant responses (*e.g.*, Seligman and Hager, 1972). The present research compared two responses in a free-operant avoidance paradigm (Sidman, 1953). The first was the lever press, the operant used for many years in Sidman avoidance; the second was a head-poke response described only recently (Carrigan, Benedict, and Ayres, 1972).

In a signalled avoidance procedure, Carrigan *et al.* (1972) found that head poking was readily learned and that it reduced shock rates far below the values reported for animals lever pressing under otherwise identical conditions (Forgione, 1970). As one account of this finding Carrigan *et al.* (1972) suggested that "... the

head poke may be a more natural defense reaction to shock or a more natural reaction to the warning stimulus than the lever press. . . . [p. 303]." Indeed, animals shocked for the first time often lunge into the head-poke hole as if trying to escape from the chamber, and this observation in turn fits in with more naturalistic descriptions of *Rattus norvegicus* as a burrowing animal that uses burrows and crevices as a defense against predation (see, *e.g.*, Owings, 1972).

The present research focused on two issues: (a) the extent to which laws of lever-press avoidance generalize to the head poke and (b) the extent to which differences in responding on the two systems are consistent with the idea that the head poke is more closely related to the rat's innate species-specific defense reaction (Bolles, 1970) than is the lever press. Accordingly, acquisition, extinction, and transfer of avoidance across response systems were examined under both signalled and unsignalled conditions. Transfer of avoidance was of special interest, since, logically, it would seem very difficult for an animal to abandon a previously successful "natural" reaction in favor of a less-natural reaction, whereas transfer in the opposite direction would seem relatively easy.

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²Now at Emory and Henry College, Emory, Virginia.

EXPERIMENT 1

METHOD

Subjects

Sixteen experimentally naive male albino rats from Holtzman Co., Madison, Wisc., ranging in age from three to four months were housed individually. Food and water were always available in the home cages.

Apparatus

Two Gerbrands model B conditioning chambers, 19.5 by 23.5 by 22 cm, with left-side dipper feeders, were housed in ventilated 0.61-m cubes of 12.7-mm plywood lined with acoustical tile. Head pokes into the 5.5 by 5.0 by 5.0 cm dipper receptacle, located at floor level in the left corner of the front panel, were recorded using a photocell system described elsewhere (Carrigan *et al.*, 1972). Projection of an object about 2 cm into the dipper receptacle was sufficient to break the photocell beam and be counted as a response. (In actual practice animals almost always broke the beam with their heads and never with their paws. Infrequently, an untrained animal broke it with its tail.) A standard Gerbrands lever was mounted 8 cm above the grid floor 7 cm to the right of the dipper receptacle (measured center to center). Lever presses had no scheduled consequences for rats trained to head poke, and head pokes were ineffective for rats trained to lever press. An 81-dB white noise presented through a 10-cm speaker mounted on the chamber lid preceded shock under signalled conditions. Scrambled grid shocks were provided by two Grason Stadler E1064GS shock sources. Chamber illumination was provided by a 28-V cue light mounted above the dipper opening 9.5 cm above the grid floor. A Lehigh Valley Interact Computer System in a nearby room controlled and recorded stimulus and response events.

Procedure

General. Each rat was handled for 15 to 30 min before receiving a 1-hr adaptation exposure to the operant chamber. Beginning the next day, each rat received eight 2-hr sessions at about the same time on eight successive days. The first three were acquisition sessions in which responding on the appropriate response system postponed shock. The

next two were extinction sessions in which the shock sources were turned off. However, the first of these extinction sessions began with a 30-min warm-up under acquisition conditions, so extinction prevailed only in the last 90 min. The last three sessions were "reversal" or "transfer" sessions. Acquisition conditions were reinstated but rats could avoid shock only by responding on the previously ineffective response system. Note that both effective and ineffective response systems were always available throughout the study.

Design. Four acquisition conditions were studied: signalled head poke, signalled lever press, unsignalled head poke, and unsignalled lever press. Four rats were assigned to each treatment. In extinction and reversal sessions, each rat received the same signalling condition experienced in acquisition.

Parameters. For all rats, shocks of 0.24-sec duration and 0.8-mA intensity were delivered every 3.24 sec unless a response occurred (S-S interval = 3.24 sec). Each response delayed the onset of the next scheduled shock for 20 sec (R-S interval = 20 sec). For rats in signalled conditions, an 81-dB white-noise signal was presented in the last 5 sec of the R-S interval and could be terminated only by a response. If a response did not occur, the noise persisted into successive S-S intervals. Responses before noise onset postponed the noise as well as shock. Responses maintained throughout an R-S interval (*i.e.*, holds into shock) were not effective in recycling the next R-S interval. Thus, a response "make" could delay shock for up to 20 sec, but then a "break" and a "re-make" were required to produce the next 20-sec R-S interval.

Recording. Responses during S-S and R-S intervals were tallied separately, and records were kept of the number of shocks each rat received. During extinction, the shock sources were turned off but data were recorded exactly as if shocks were presented. Following previous practice (Carrigan *et al.*, 1972; Forgione, 1970), only the data from the last 90 min of each session are reported, and only responses occurring in the R-S interval are called "avoidance" responses.

Treatment of data. Results were analyzed using multifactor analyses of variance (Winer, 1962, p. 337) with two between-groups factors (response system and signalling condition) and one within-groups factor (sessions). Acqui-

sition, extinction, and reversal data were analyzed separately. When appropriate, the results of *t*-tests are reported. The error term for these tests was derived from the between-groups error term in the analysis of variance, and *t*-tables were entered using the degrees of freedom associated with that error term. Unless noted otherwise, all *p* values are two-tailed.

RESULTS

Table 1 shows that during acquisition, signalled head-poke subjects received fewer shocks than signalled lever-press subjects ($t = 2.50$, $df = 12$, $p < 0.05$). These data thus replicate in a within-laboratory comparison the previous between-laboratory comparison presented by Carrigan *et al.* (1972). However, the finding could not be extended to the unsignalled condition. Table 1 shows that under the unsignalled procedure, head-poke and lever-press subjects received about the same number of shocks ($t = 1.17$, $df = 12$, $p > 0.20$).

Previous work on free-operant avoidance (*e.g.*, Keehn, 1959; Ulrich, Holz, and Azrin,

1964) has usually found that subjects receive fewer shocks when the end of the R-S interval is preceded by a signal than when it is not. This was true here only for the head-poke condition. Why it was not also true for the lever-press condition will be examined later.

As shown in Table 2, signalled head-poke subjects made more avoidance responses in acquisition than did signalled lever-press subjects ($t = 2.63$, $df = 12$, $p < 0.05$). Under the unsignalled condition, avoidance rates did not differ between response systems. Consistent with previous reports using comparable signal durations and R-S intervals (Keehn, 1959; Shnidman, 1968; Sidman, 1955; Stretch and Skinner, 1967), animals made more avoidance responses in unsignalled than in signalled conditions ($F = 54.33$, $df = 1, 12$, $p < 0.01$), and this was true for both head-poking and lever-pressing.

In extinction, responding declined so rapidly under the unsignalled condition that by the second extinction session both head-poke and lever-press rates had fallen below their respective operant levels of 0.9 and 0.1 re-

Table 1
Median number^a and range of shocks received in last 90 min of each experimental session.

Group ^b	Measure	Acquisition Sessions			Extinction Sessions		Reversal Sessions		
		1	2	3	1	2	1	2	3
EXPERIMENT 1									
(1) SHP→SLP	MDN	6	4	6	—	—	88	35	13
	R	4-63	3-18	0-9	—	—	45-181	8-128	7-80
(2) SLP→SHP	MDN	236	213	157	—	—	208	106	76
	R	84-312	6-360	4-246	—	—	5-1631*	2-525	2-167
(3) USHP→USLP	MDN	300	40	35	—	—	232	225	218
	R	187-906	16-109	30-292	—	—	98-344	95-269	110-271
(4) USLP→USHP	MDN	142	86	114	—	—	1404	1541	1612
	R	71-194	29-143	13-172	—	—	1263-1602	702-1660	377-1648
EXPERIMENT 2									
(5) SHP→SLP (Sp Sw)	MDN	76	17	18	—	—	320	179	128
	R	28-91	11-27	5-25	—	—	64-1662*	14-1656*	19-1662*
(6) SLP→SHP (Sp Sw)	MDN	73	23	36	—	—	296	30	44
	R	36-107	2-145	9-82	—	—	101-593	5-138	4-86
EXPERIMENT 3									
(7) USHP→USLP (Fd bk)	MDN	459	30	20	—	—	98	107	62
	R	174-1003	18-66	18-23	—	—	55-1656*	48-1651*	39-1662*
(8) USLP→USHP (Fd bk)	MDN	152	99	88	—	—	397	208	48
	R	107-157	45-129	38-173	—	—	117-1651*	39-430	30-115

^aWith four subjects, the mean of the middlemost scores.

^bS = signalled; US = unsignalled; HP = head poke; LP = lever press; Sp Sw = condition in which speaker was switched to location near head-poke hole; Fd bk = feedback; → = shifted to.

*The data from one rat in each starred condition were atypical. These cases are discussed with the results of Experiment 3.

Table 2

Median number^a and range of avoidance responses made in last 90 min of each experimental session.

Group ^b	Measure	Acquisition Sessions			Extinction Sessions		Reversal Sessions		
		1	2	3	1	2	1	2	3
EXPERIMENT 1									
(1) SHP→SLP	MDN	480	424	429	276	150	322	304	318
	R	348-524	366-444	296-524	126-398	78-165	252-489	233-375	298-325
(2) SLP→SHP	MDN	209	241	253	110	36	370	316	310
	R	110-302	73-367	115-405	38-137	0-70	2*-384	90-460	243-515
(3) USHP→USLP	MDN	552	822	549	35	2	600	550	382
	R	251-761	707-966	381-824	1-215	1-4	420-800	330-739	271-538
(4) USLP→USHP	MDN	670	807	769	24	0	26	11	4
	R	627-947	680-1214	652-1079	11-94	0-2	19-58	0-250	0-477
EXPERIMENT 2									
(5) SHP→SLP (Sp Sw)	MDN	501	495	474	397	86	392	204	217
	R	432-611	460-745	406-907	167-623	53-209	0*-960	0*-507	0*-411
(6) SLP→SHP (Sp Sw)	MDN	448	447	366	72	5	373	397	338
	R	333-636	251-629	288-465	41-154	1-15	271-584	348-462	283-405
EXPERIMENT 3									
(7) USHP→USLP (Fd Bk)	MDN	338	870	932	229	11	778	783	926
	R	153-659	855-1199	857-1353	124-520	0-41	0*-1386	0*-1289	0*-1359
(8) USLP→USHP (Fd Bk)	MDN	668	997	827	43	0	562	610	891
	R	618-1071	655-1388	532-1305	21-199	0-2	1*-659	518-897	859-980

^aWith four subjects, the mean of the middlemost scores.

^bS = signalled; US = unsignalled; HP = head poke; LP = lever press; Sp Sw = condition in which the speaker was switched to location near the head-poke hole; Fd Bk = feedback; → = shifted to.

*The data from one rat in each starred condition were atypical. These cases are discussed with the results of Experiment 3.

sponses per minute (as determined by Carri-gan *et al.*, 1972). The decline in responding was slower under the unsignalled condition ($F = 24.58$, $df = 1, 12$, $p < 0.01$) as previously reported for lever pressing by Shnidman (1968); and, again this was true for both response systems. Also in extinction, head-poke subjects made more avoidance responses than lever-press subjects ($F = 12.62$, $df = 1, 12$, $p < 0.01$), especially under the signalled condition (see Table 2).

In the reversal sessions, three of the four groups learned to respond on the previously ineffective response system (Table 2). The group that failed to do so had been trained to lever press under unsignalled conditions and then was required to head poke to avoid shock. As shown on the right side of Table 1, this group took close to the maximum number of scheduled shocks (max = 1666 shocks last 90 min) in each of three 2-hr sessions and differed significantly from each of the remaining groups ($ts > 5.5$, $df = 12$, $ps < 0.01$).

DISCUSSION

Regarding the generality of the laws of free-operant avoidance, it is clear that the head poke obeys many laws previously described for the lever press and reconfirmed here. Head poking increases above operant level when its occurrence reduces shock frequency and returns toward operant level when shocks are removed. In acquisition, response rates are lower, yet fewer shocks are received under signalled than under unsignalled conditions; in extinction, responding persists longer under signalled conditions.

Our results did not support the hypothesis that the head poke is a more natural escape reaction to shock than the lever press. As expected, fewer shocks were received by head-poke subjects in acquisition under signalled conditions, but this result could not be extended to the unsignalled condition. Moreover, under the unsignalled condition, the transfer test results were exactly opposite those ex-

pected. Specifically, rats required to shift from lever pressing to the presumably more natural response of head poking failed to do so, while those required to transfer in the opposite direction did so readily. Under signalled conditions, transfer occurred readily in both directions. In general, the acquisition and transfer results of Experiment 1 strongly suggest that those differences between head-poke and lever-press avoidance reported here and elsewhere (Carrigan *et al.*, 1972) are probably due to variables other than the degree to which the two responses relate to the rat's natural defense reaction. The remaining experiments sought to identify some of these variables.

EXPERIMENT 2

The following observation may provide a clue as to why head poking was superior to lever pressing in reducing shock density only under signalled (and not unsignalled) acquisition conditions. Subjects usually receive fewer shocks under signalled than unsignalled conditions, but in Experiment 1 this was true only for the head poke. This observation suggests that the signalled condition in Experiment 1 may have introduced a bias against the lever press. One biasing factor may have been the location of the white-noise speaker on the chamber lid. To press the lever, subjects usually stood on their hind paws and therefore raised their heads near the speaker (within 10 cm). In contrast, by head poking, subjects moved their heads about as far from the speaker as was physically possible (about 22 cm). There have been several studies in the discrete-trials bar-pressing literature (Biederman, D'Amato, and Keller, 1964) and in the shuttle-box literature (McAdam, 1964; Whittleton, Kostanek, and Sawrey, 1965) showing that avoidance is more readily learned when the animal's response takes it away from the warning stimulus rather than toward it. To assess the possibility that a similar variable might be operating here, the speaker was taken off the chamber lid in Experiment 2 and bolted to the side of the chamber about 2 cm from the side of the dipper receptacle. Using this arrangement, acquisition, extinction, and reversal of head-poke and lever-press avoidance were re-examined.

METHOD

The subjects were eight experimentally naive rats similar to those of Experiment 1 and maintained under the same conditions. The apparatus of Experiment 1 was modified as just described. The procedure replicated the signalled lever-press and head-poke conditions of Experiment 1, except that the white-noise speaker was located beside the dipper receptacle.

RESULTS AND DISCUSSION

Rows 5 and 6 of Table 1 show the median number of shocks each group received during each session and rows 5 and 6 of Table 2 show the median number of avoidance responses. Analyses of variance were performed on the data of rows 5 and 6 and 1 and 2; factors included speaker location, response system, and sessions.

In Table 1 there is no difference in the number of shocks received by signalled head-poke and lever-press subjects under the *Sp Sw* (speaker switched) conditions (rows 5 and 6). The data are in contrast to those obtained when the speaker was mounted on the roof (rows 1 and 2). Placing the speaker near the head-poke hole in Experiment 2 appears to have improved the lever-press results and brought them into line with the previous literature, for in Experiment 2 the signalled lever-press subjects received about one-half to a third as many shocks as their unsignalled counterparts in Experiment 1. Although placing the speaker near the head-poke hole lowered the shock rates of the signalled-lever-press subjects substantially ($p < 0.02$), it increased the shock rates for the signalled head-poke subjects only slightly. This increase, in fact, was reliable only on the first day of acquisition and only with a one-tailed test ($p = 0.026$).

The response data are shown in Table 2. Comparison of rows 2 and 6 reveals that placing the speaker near the dipper hole in Experiment 2 increased the number of avoidance responses made by lever-press subjects in acquisition ($t = 2.63$, $df = 12$, $p < 0.05$), thus accounting for the lower number of shocks they received. But changing the location of the speaker had little effect on the number of avoidance responses made by head-poke subjects (compare rows 1 and 5).

The middle portion of Table 2 shows that head poking was again more resistant to extinction than lever pressing ($F = 23.41$, $df = 12$, $p < 0.01$) just as it was in Experiment 1 (*cf.* rows 1 and 2).

The right portion of Table 2 shows that all of the signalled groups in both Experiments 1 and 2 readily learned to respond on the previously ineffective response system in the reversal sessions. Rate of avoidance responding and shock rates (Table 1) did not differ significantly among groups.

In summary, the results of Experiment 2 implicate the location of the warning signal as a biasing factor against signalled lever-press avoidance in Experiment 1. When this biasing factor was removed by changing the speaker location (as in Experiment 2) or by removing the signal entirely (unsignalled conditions in Experiment 1), both the avoidance rates and shock rates under the two response systems appeared roughly comparable. It is not clear, however, why placing the speaker near the head-poke hole in Experiment 2 did not exert a stronger bias against head poking.

EXPERIMENT 3

In Experiments 1 and 2, rats studied under signalled conditions quickly learned to make the previously ineffective response when required to in reversal sessions. Only rats in unsignalled conditions in Experiment 1 failed to learn the new response and, then, only when it was the head-poke response. This unexpected finding may make sense when we consider that unsignalled head-poke subjects received relatively little feedback for responding. Breaking the head-poke photocell beam produced no relay click or switch closure that head-poke subjects could detect. In contrast, under the signalled conditions, all responses occurring in the S-S interval were accompanied by the offset of white noise, as were all responses in the last 5 sec of the R-S interval. In addition, all lever presses, even under the unsignalled condition, were accompanied by the click of the microswitch plus the proprioceptive feedback resulting from switch closure and lever movement. To assess the importance of response feedback on transfer of avoidance across response systems, unsignalled head-poke and lever-press conditions were re-examined in

Experiment 3, but with an explicit feedback stimulus added to both systems.

METHOD

The subjects were eight experimentally naive male rats similar to those of Experiment 1 and maintained under the same conditions. The apparatus was modified as described below. The procedure replicated the unsignalled lever-press and head-poke conditions of Experiment 1, except that feedback accompanied responses. Feedback for head poking was created by attaching a relay to the dipper receptacle. The relay was triggered whenever the photocell beam was broken so that it provided a feedback click for each head poke. Like the click of the lever microswitch, the head-poke click occurred whether head poke happened to be the effective response or not. In addition, all responses on the effective response system, whether head poke or lever press, were accompanied by an 81-dB white-noise burst presented for 0.25 sec through the speaker mounted near the head-poke hole.

RESULTS AND DISCUSSION

Rows 7 and 8 of Table 1 show the median number of shocks each group received during each session and rows 7 and 8 of Table 2 show the median number of avoidance responses. Analyses of variance were performed on the data of rows 7 and 8 and 3 and 4; factors included presence *versus* absence of feedback, response system, and sessions.

The right-most portion of Table 2 shows that, when feedback was provided for responding, animals quickly learned to make the previously ineffective head-poke response and responded more than their counterparts without feedback in Experiment 1 ($t = 2.81$, $df = 12$, $p < 0.02$). Table 1 shows that, when a feedback signal was provided, animals required to head poke in reversal sessions received at least 1000 fewer shocks than their head-poke counterparts without feedback in Experiment 1 ($t = 3.21$, $df = 12$, $p < 0.01$).

The following discussion further illustrates the effects of response feedback and shows that feedback, though important in transfer, is not always sufficient. In this research, the 32 rats studied could be classified as transfer "failures" or "successes" depending on whether they received more than 1200 or fewer than 600 shocks in the last 90 min of the first reversal

session. No subjects fell in between these two categories. Rats could be further subdivided into those receiving good feedback or poor feedback. Of the 32 rats, 28 received good feedback in the transfer tests, including offset of a noise warning stimulus, onset of an explicit feedback signal, and/or microswitch click and proprioceptive feedback from lever pressing. Four rats received poor feedback, namely those required to transfer to head poke under unsignalled conditions. All four of the rats receiving poor feedback failed to transfer; only four of 28 rats receiving good feedback failed. Each of the latter rats (marked with an asterisk in Tables 1 and 2) was from a different group. Two were from groups required to head poke and two were from groups required to lever press. Their failure to transfer did not appear to be related to any experimental variable. The reason feedback did not help these four rats is that they made a total of only 13, 3, 3, and 0 responses in the entire 2-hr session—apparently not enough to contact the feedback contingency. In contrast, the four rats in the poor feedback conditions made 121, 90, 64, and 25 responses, significantly more than the first four subjects ($t = 3.42$, $df = 6$, $p < 0.02$). Presumably, if feedback had been available, the second four subjects would have transferred successfully. A methodological implication of this discussion is that the study of the effects of feedback on avoidance transfer is probably not amenable to single-subject methodology. A failure may not be converted to a success by increasing feedback because the animal may not respond enough to be affected by the new contingency. Similarly, since feedback was not necessary for naive rats learning to head poke, for example, it seems unlikely that a transfer success could be converted to a failure by eliminating feedback after the animal had already learned the new response.

Although feedback affected the transfer of avoidance from lever press to head poke, it had no effect on the original acquisition of either response. Response rates (Table 2) and shock rates (Table 1) were quite comparable for unsignalled subjects with feedback (rows 7 and 8) and without (rows 3 and 4). In the statistical analyses, the effects of feedback in acquisition were not reliable. As in Experiment 1, the unsignalled condition in Experiment 3 produced high response rates and shock rates and no reliable differences among response systems.

Also, as in Experiment 1, there was a tendency in the first acquisition session for rats head poking without a warning signal to receive more shocks than rats lever pressing. When the data from the two experiments were pooled (rows 3 and 7 versus 4 and 8), this tendency was reliable ($t = 2.95$, $df = 14$, $p < 0.02$).

In the extinction sessions too, the same pattern of results emerged as described in Experiment 1. Head poking was more resistant to extinction than lever pressing ($F = 5.18$, $df = 1, 12$, $p < 0.05$); extinction was slower when feedback was provided than when it was not ($F = 5.50$, $df = 1, 12$, $p < 0.05$); and the difference between responses was especially prominent under feedback conditions. Reinspection of the first four rows of Table 2 will reveal that in Experiment 1, head poking was more resistant to extinction than lever pressing; extinction was slower when a signal was provided than when it was not; and the difference between responses was especially prominent under signalled conditions. These differences between head poking and lever pressing during extinction may perhaps be best understood in terms of differences in their topographies—differences that make the head poke less dependent on shock occurrence than the lever press (*cf.* Carrigan *et al.*, 1972). Specifically, during acquisition, the lever-pressing rat tends to lean on the lever throughout the R-S interval. When shock terminates the R-S interval, the animal sometimes lurches and, in so doing, hits the lever and recycles the R-S interval. If the R-S interval exceeds the S-S interval, this behavior may be reinforced by reduction in shock frequency. Indicators of this tendency are "holds into shock" and "short latency responses to shock onset following a hold into shock" (Forgione, 1970). The higher these measures, the more the response can be said to be controlled by shock. Presumably, because the head-poking rat has no manipulum to lean on, the measures of this shock-controlled behavior (under signalled conditions at least) are lower for the head poke than for the lever press (Carrigan *et al.*, 1972). To the extent that responding is controlled by shock, it should extinguish rapidly when shocks are discontinued—hence the more rapid extinction of lever pressing in the present study. To the extent that responding is free of control by shock, it should be more susceptible to control by other stimuli; hence, adding

feedback and warning signals enhanced the differences between response systems, that is, it affected the head poke more than the lever press. Independent evidence for control of head poking and lever pressing by shocks can be obtained from the acquisition data of the present experiment. To the extent that responding is shock controlled, a relatively high proportion of responses should occur in the S-S interval. In this study, this proportion was 17% for the 16 lever-pressing rats *versus* 4% for the 16 head-poking rats ($t = 2.79$, $df = 30$, $p < 0.01$). To the extent that responding is free of shock control, it should be more susceptible to control by other stimuli, *e.g.*, the warning signal during acquisition. Thus, a relatively high proportion of responses in the R-S interval should occur during the warning signal. In this study, roughly 50% of the R-S interval responses occurred in the warning signal for the eight signalled head-poke rats *versus* 42% for the eight signalled lever-press rats. This difference is in the expected direction but was not reliable.

GENERAL DISCUSSION

Despite large differences in the topographies of the head poke and lever press, and despite an earlier suggestion that the head poke might be a species-specific defense reaction, there were many behavioral similarities between the systems.

Only two differences between the systems were noted and these did not appear related to the responses *per se*, but seemed due to variables inadvertently confounded with response topography. For example, the head poke was superior to the lever press in reducing shock rates only under a signalled condition in which the lever press brought the animal's head near the source of the warning signal. This superiority was eliminated by removing the warning entirely or by changing its source. Similarly, the inability of animals under unsignalled conditions to transfer from lever pressing to head poking appeared unrelated to response topography or to "biological naturalness" of the responses; instead, it seemed to depend on absence of response feedback. When feedback was provided for head poking, animals transferred to it successfully.

The failure of animals to transfer across response systems was a striking phenomenon

and to the best of our knowledge has not been previously described. It does, however, bear a superficial resemblance to "learned helplessness" (Maier, Seligman, and Solomon, 1969) in that an experience with shock in Stage 1 appears to render animals incapable of learning an avoidance response in Stage 2 that naive animals learn easily. Of course, in the helplessness paradigm the shocks in Stage 1 are given independently of the subject's behavior, while in the transfer paradigm (used here) the subject is given explicit control over these shocks. Seligman and Maier (1967) showed that giving an animal control over shock in Stage 1 can reduce later failure to avoid. The present results show that giving an animal control of shock in Stage 1 can indeed produce later failure, particularly if there is minimal feedback for the Stage 2 response. This demonstration probably requires that the Stage 1 response system be present in Stage 2. It was not in the study by Seligman and Maier.

It was also striking that feedback appeared more important in transfer to head poke than in the original learning of head poke. A speculative account of this phenomenon might be offered as follows: if an animal required to transfer to a previously ineffective response happens to respond appropriately, shock will be delayed. But chances are excellent that soon after responding correctly the animal will return to the highly trained but now ineffective response. (Ineffective responding was not recorded but was often directly observed.) In the absence of salient feedback for the correct response, the incorrect response (now adventitiously) correlated with shock delay will tend to be perpetuated. Two factors then are suggested to be important: (a) the relative salience of the two response systems, where salience is defined in terms of amount of response feedback, and (b) the initial probability of the ineffective response. It is the second factor that presumably causes feedback to be more critical in transfer than in original learning. In the original learning situation, the animal is presumed less likely to have a single highly trained, adventitiously reinforceable, competing response. It is clear, however, that the difference between transfer and original acquisition paradigms is a difference of *degree* rather than *kind*. Therefore, under certain conditions one should be able to demonstrate that feedback is critical in original learning

as well as in transfer. Bolles and Grossen (1969) already provided such a demonstration. They used a rigid lever that moved little and that provided no microswitch click. A force on the lever of 10 g or more was detected by an electromyographic detector and defined as a response. When feedback was explicitly scheduled for pushing the lever, nine of nine rats learned to press to avoid shock in a Sidman procedure. But when no feedback was provided, only three of nine rats learned. Based on the present analysis we would expect an even more dramatic demonstration if Bolles and Grossen's animals had been previously trained to make a now ineffective, but adventitiously reinforceable, competing response such as the head poke.

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