GENERALIZATION PEAK SHIFT IN RATS UNDER CONDITIONS OF POSITIVE REINFORCEMENT AND AVOIDANCE

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Rats were trained to discriminate between two click frequencies. One frequency was associated with either variable-interval food reinforcement (Experiment 1) or free-operant avoidance (Experiment 2). The other frequency was associated with the absence of food in Experiment 1 and the absence of shock in Experiment 2. On a click frequency generalization test, the rats in both experiments showed positive peak shift with the shape of the relative gradients being very similar. This is the first reported instance of peak shift in rats when responding was maintained by an avoidance contingency. Nondifferentially trained controls showed that this shift was due exclusively to associative processes, with nonassociative stimulus factors in themselves apparently making no contribution to increased rates at particular stimulus values. These results show the comparability of appetitive and aversive control and support the position that gradient differences do not result from approach versus avoidance per se.

Key words: peak shift, stimulus generalization, positive reinforcement, avoidance, bar pressing, rats

Much of the research literature on stimulus control is concerned with the influence of intradimensional discrimination training on the shape of generalization gradients (Rilling, 1977; Terrace, 1966; Weiss, 1978). Hanson (1959) was among the first to investigate this influence. In his study, pigeons' key pecks were reinforced at 550 nm in a procedure that included brief periods of darkness during which responding was ineffective. On a subsequent generalization test, a roughly symmetrical gradient was produced with maximum responding controlled by 550 nm (S+). In comparison, when responding was reinforced at 550 nm and extinguished at 555 nm (S−), the gradient's peak was displaced from S+ in a direction away from S−. This peak shift was profound, with approximately four times as many responses emitted at 540 nm as at 550 nm. Although peak shift has been reported many times since then, responding was maintained in almost all of these studies by positive reinforcement, often under training conditions

very similar to Hanson's (Weiss, 1978, Table 3). The present study is concerned with investigating this perceptual phenomenon under conditions where responding is maintained by shock avoidance.

Klein and Rilling (1974) were the first to report an attempt at demonstrating peak shift when shock avoidance was used to maintain responding. Their experiment was modeled after those of Hearst (1968, 1969). Hearst's aim was to predict peak shift in the appetitive situation from gradients of excitation and inhibition separately produced after interdimensional training. In Klein and Rilling's intradimensional group, pigeons were trained to postpone shocks by treadle pressing in the presence of a 1000-Hz tone and to cease responding during shock-free 1500-Hz periods. In testing, only one of four birds showed peak shift, although there was a good correspondence between the asymmetrical gradient produced by this group and that derived from the summation of the relative gradients produced by the groups given excitatory training at 1000 Hz or inhibitory training at 1500 Hz. Klein and Rilling did support the gradient interaction theory (Spence, 1937) even though their birds didn't shift in training.

Klein and Rilling's (1974) failure to find peak shift could be attributed to the wide (500

Hz) separation between their S+ and S−. This supposition is based on findings that even under appetitive conditions the likelihood of getting peak shift is reduced as the S+:S− separation increases (Purtle, 1973). Since there is no obvious procedural or theoretical reason that peak shift should not occur when responding is maintained by avoidance, Bushnell and Weiss (1980) recently gave pigeons intradimensional avoidance discrimination training under a more optimal S+:S− stimulus separation. Initially they found a stimulus separation wherein all six of their pigeons given intradimensional discrimination training under conditions of positive reinforcement showed peak shift in testing. Subsequently they used the same 8-nm difference when they trained naive pigeons to postpone shocks by treadle pressing in a free-operant avoidance discrimination situation. After this training clear peak shift was obtained in all three pigeons.

The purpose of the present experiment is to determine whether peak shift can also be obtained in rats after intradimensional training on a click frequency dimension wherein responding is maintained by free-operant avoidance. Just as Bushnell and Weiss (1980) did, initially we determined whether peak shift was obtained under specified stimulus-separation conditions when responding was maintained by positive (food) reinforcement. When it was, the same stimulus differences were then employed, in different rats, with responding maintained by free-operant avoidance. Control groups experiencing the same stimuli as the experimental groups under nondifferential positive or negative reinforcement were tested to reveal possible stimulus factors that might influence gradient shape under the different incentive conditions.

EXPERIMENT 1

METHOD

Subjects

Eight experimentally naive adult male hooded rats were trained and tested at 80% of their free-feeding weights (325 to 425 gms). Rats were individually housed, had free access to water, and were fed directly after each session a supplemental ration of Tekland rat diet in an amount necessary to maintain their 80% weights.

Apparatus

The experimental chamber measured 23 by 20.5 by 19 cm. The front and rear walls were aluminum, the side walls were white translucent Plexiglas and the ceiling was transparent Plexiglas with ventilation holes. The floor was made up of 15, .4-cm diameter, stainless steel grids spaced 1.4 cm apart (center to center).

On the front wall a 5- by 1-cm lever extended 1.5 cm into the chamber. It was located 6 cm above the floor and 1.5 cm from the right side wall. A minimum force of .3 N depressed the lever (Gerbands G6312). A food trough (4 by 5 by 2.5 cm) was located 7 cm to the left of the lever and .3 cm above the grid floor.

The experimental chamber was enclosed in an Industrial Acoustics Company sound attenuation chamber Model AC-1. The 60-W ceiling light in this chamber provided continuous diffuse illumination. A 15-cm diameter speaker was located in the upper-left-rear corner of the acoustical chamber. The auditory stimuli were produced by a Foringer Model 1293 click generator. The ambient noise level, taken from inside the experimental chamber with the exhaust fan running, was 78.5 dB (General Radio 1565-A sound level meter, scale Cs). The click stimuli used in the experiment were, in terms of clicks-per-sec/dB: 8/82.5, 12/84.1, 16/85.3, 20/86.0, 24/86.6, 28/87.2, 32/88.2, 37/88.8, 42/89.2, 47/89.7.

All experimental events were controlled by electromechanical equipment located in a room adjacent to that containing the training chamber. Reinforcers were Noyes 45-mg rat pellets.

Procedure

The rats were initially magazine trained and hand-shaped to bar press, after which they were permitted to acquire approximately 50 food pellets on a continuous reinforcement schedule. On the following day they were trained on a variable-interval (VI) 15-sec schedule that was gradually extended to VI 60-sec over the next several sessions. The limits of these schedules were 2 sec to approximately three times the mean value, with intervals sequenced so as to have the probability of any interval following any other interval roughly equal. Half the rats received this preliminary training in the presence of 20 clicks/sec and half in the presence of 32 clicks/sec. (To the

experimenters 20 and 32 clicks/sec appeared fairly similar yet distinguishable.) At this point half the rats were placed in a differential training group and half in a nondifferential training group.

Differential training. The rats in this group were placed on a multiple VI 60-sec extinction schedule. The VI schedule (S+) was signaled by the stimulus used in preliminary training (20 or 32 clicks/sec) and the extinction component (S−) by the other frequency (32 or 20 clicks/sec). Variable interval and extinction components averaged 3 min each (range 2-8 min) unless a bar press during the final 60 sec of an extinction component extended that component by 60 sec. A 1.5-sec interclick-stimulus interval (ISI), during which only the ambient background noise was present and food could *not* be earned, separated components. The probability was 50% that the ISI would be followed by a component the same as that which preceded it and 50% that the following component would be different. The rats were trained under this schedule until response rate in the VI component was 10 times that in the extinction component over four consecutive sessions, with no systematic trend in rate in either component. Sessions lasted approximately 4 hr or until 135 food pellets were received, whichever occurred first. On the day following criterion, a generalization test was administered.

Nondifferential training. For subjects in this group the 20 and 32 clicks/sec stimulus components were sequenced and timed identically as for the differentially trained rats. However, the VI 60-sec schedule operated *continuously* during the session in the presence of both frequencies as well as during the 1.5 sec ISI periods that separated them. Sessions lasted approximately 2.5 hr, during which approximately 135 pellets were earned. After responding had stabilized and was comparable in the two components for four consecutive sessions, a generalization test was administered.

Generalization test. Each rat was trained on its terminal training schedule for approximately 1 hr immediately prior to this test. The test consisted of eight block-randomized replications of nine stimuli each. If S+ had been 20 clicks/sec, these stimuli ranged from 8 to 42 click/sec; whereas if S+ had been 32 clicks/sec these stimuli ranged from 12 to 47 clicks/sec. For the rats nondifferentially trained, two were

tested with the 8 to 42 range and two with the 12 to 47 range. Each stimulus was presented for 1 min within each block, with the 1.5 sec ISI period separating stimuli. Reinforcement was discontinued during the test.

RESULTS AND DISCUSSION

Performance on the criterion sessions presented in Table 1 shows a clear discrimination between S+ and S− by the differentially trained rats. The generally small standard deviations indicate little between-session variability in response rates during S+ or S−. Response rates in the presence of 20 and 32 clicks/sec are quite similar for each of the nondifferentially trained rats.

On the generalization test all four rats in the differentially trained group showed positive peak shift, responding at a higher rate to stimuli displaced from S+ in a direction away from S− than to the S+ training stimulus. This is shown for each of the subjects in the lower frame of Figure 1. In comparison, for the nondifferentially trained control subjects there was no systematic increase in rate to the left of 20 clicks/sec or to the right of 32 clicks/sec (see upper frame of Fig. 1), whereas the mean test response outputs in 20 and 32 clicks/sec were almost identical—12.7 and 12.5% respectively.

Although all experimental subjects showed peak shift, the gradients of those with 20 clicks/sec as S+ (Rats 387 and 412) ultimately began to decline to the left of S+. In comparison, when 32 clicks/sec was S+, the gradient had a positive slope up to 47 clicks/ sec, the highest frequency. One can only speculate on the reasons for this asymmetry, but examination of the training procedure and the control group's gradients does suggest some potential contributing factors.

Reinforcements weren't available during the 1.5 sec ISI period separating components, and all differentially trained rats responded at rates 50 to 93% lower in this period than in S+ (see Table 1). Therefore, when 20 clicks/sec was S+ the dimension was anchored with extinction periods both above (32 clicks/sec) and below (0 clicks/sec) S+—conditions that should produce a steep excitatory gradient on both sides of 20 clicks/sec (Jenkins & Harrison, 1960). In comparison, the 32 clicks/sec S+ group experienced no extinction above S+.

The control gradient was flat to the right of 32 clicks/sec. Therefore, we would hesitate to
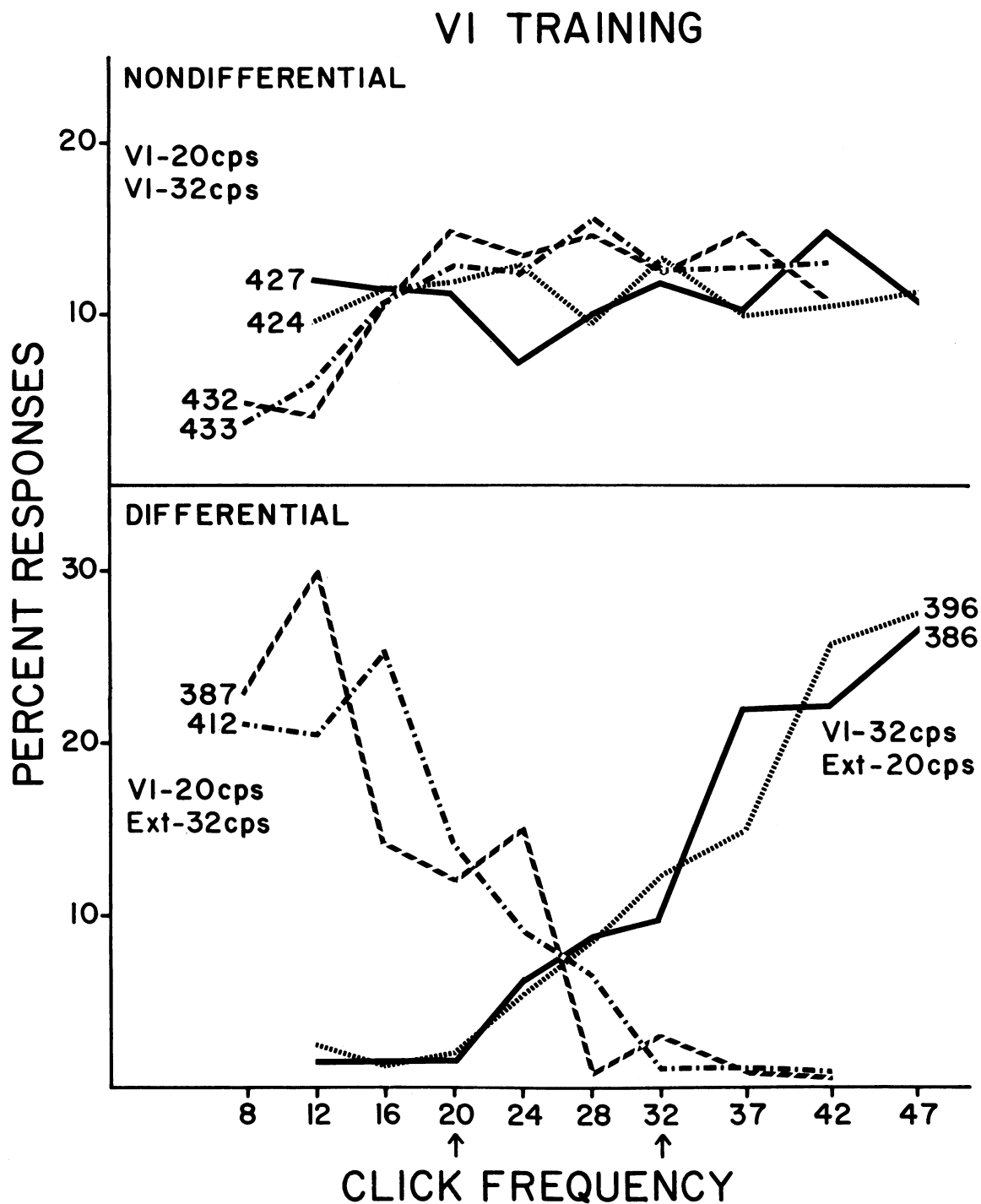
Fig. 1. Click frequency generalization gradients for nondifferentially (upper frame) and differentially (lower frame) variable-interval trained subjects of Experiment 1. To generate these response percentage gradients a rat's responses at each test value were divided by that rat's total test responses and multiplied by 100. Total test responses emitted by nondifferential Rats 424, 427, 432, 433 were 1,075, 608, 1,380, and 1,636 respectively. Total test responses emitted by differential Rats 386, 387, 396, and 412 were 564, 372, 249, and 2,557 respectively.

Table 1

Criterion Sessions Data
(Variable Interval Subjects)

Subject	386			387			396			412		
Stimuli	S+	S−	ISI	S+	S−	ISI	S+	S−	ISI	S+	S−	ISI
Clicks/sec	32	20		20	32		32	20		20	32	
Mean Rate	9.2	.6	.7	18.8	1.4	5.1	8.2	.6	3.3	69.7	7.2	35.0
SD	1.6	.5	.9	1.2	.5	2.7	.6	.2	1.0	7.6	.5	8.6
Sessions (4 hr)		83			57			49			60	

Subject	424			427			432			433		
Stimuli (Clicks/sec)	20	32	ISI	20	32	ISI	20	32	ISI	20	33	ISI
Mean Rate	26.9	25.9	40.1	18.7	20.2	18.4	28.8	31.9	17.4	22.7	21.9	13.0
(SD)	2.4	2.1	7.4	1.3	2.1	4.7	1.9	1.4	2.5	2.1	4.8	2.7
Sessions (2 hr)		30			35			17			32	

Nondifferential Training (header spanning subjects 424–433)

attribute the positive slope of the gradients of Rat 386 and Rat 396 up to 47 clicks/sec to a simple dynamism effect (Gray, 1965; Hull, 1949). At click frequencies higher than 47 clicks/sec, the gradients of the rats should also begin to decline. The tendency for the gradients of the control rats to decline to the left of 20 clicks/sec, even with reinforcement available during the 1.5 sec ISI, must be taken as an indication that nonassociative factors might have operated to reduce responding to the stimuli on that end of the continuum for Rat 387 and Rat 412. The powerful peak shift for the 20 clicks/sec S+ rats indicates the extent to which associative processes were able to overwhelm these stimulus factors[1].

One other characteristic of the differential group's gradients deserves mention. All rats showed negative peak shift to at least some degree. That is, the stimulus removed from S− in a direction away from S+ controlled a lower rate than S−. The percentage of responding to the former stimulus over that to S− was 1.4/

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[1] With regard to this analysis, it should be appreciated that there was a relationship between a control rat's tendency to reduce its responding during the 1.5 sec ISI periods in training and its tendency to produce a gradient with a negative slope to the left of 20 clicks/ sec. Rats 424 and 427 did not decrease their response rates during the ISI period in training, and their gradients to the left of 20 clicks/sec are relatively flat. Rats 432 and 433 did reduce their rates by approximately 59% during the interstimulus period, and their gradients decline precipitously to the left of 20 clicks/sec.

1.5, .8/3.0, 1.2/2.0, and .9/2.2 for Rats 387, 387, 396, and 412 respectively.

The stimulus values used in training were appropriate to reveal both positive and negative peak shift when responding was maintained by positive reinforcement. On that basis we continued our exploration of discrimination training and the peak shift when responding was maintained by avoidance.

EXPERIMENT 2

The same training stimulus conditions that produced peak shift when responding was maintained by positive reinforcement were now used where responding was maintained by free-operant shock avoidance (FOA). Differentially and nondifferentially trained groups again were examined because stimulus factors have been shown to interact with the class of reinforcer maintaining responding in determining attention in both pigeons (Foree & LoLordo, 1973) and rats (Schindler & Weiss, Note 1).

METHOD

Subjects

Eleven experimentally naive adult male rats whose free-feeding weights were approximately 300 to 450 g at the start of training were individually housed with free access to food and water.

Apparatus

The experimental chamber was the same as that used in Experiment 1. Shock delivered to the grid floor as well as to the metal walls and the lever was generated and scrambled by an LVE model 11304 constant current shocker.

Procedure

The rats were initially handshaped to escape continuous, approximately .5 ma, electric shock. Then they were placed on a free-operant avoidance (FOA) schedule where each barpress delayed shock for 25 sec (RS 25), and shocks were presented every 2 sec in the absence of a response (SS 2). Shock duration was .4 sec. Over the following four sessions the SS interval was increased to 5 sec and a shock reset contingency instituted whereby a response emitted during a shock reset the shock duration timer, thus prolonging the shock by .4 sec. For half the rats the 20 clicks/sec stimulus was present during this preliminary training and for the other half the 32 clicks/sec stimulus was present. Once a rat's shock rate dropped to .6 shocks per min or less—i.e., at least 75% of the potential RS shocks were avoided—it was placed in either the differential or nondifferential training group. Two rats were removed from the study at this point because they were receiving many shocks and showed little improvement over several sessions.

Differential training. For the rats in this group, the FOA component (S+) was signaled by the stimulus used in preliminary training (20 or 32 clicks/sec) whereas a shock-free period (S−) was signaled by the other frequency (32 or 20 clicks/sec). This could be termed a multiple RS 25-sec SS 5-sec extinction schedule. Component duration and sequencing were similar to that in Experiment 1 with the exception that barpresses during S− had no effect on that component's duration. During the 1.5-sec interclick-stimulus interval (ISI) that separated components, shocks were not presented and the RS clock was reset. Subjects were trained for 8-hr sessions on alternate days. Once response rate during FOA was 10 times that in extinction for four consecutive sessions a generalization test identical to that described in Experiment 1 was administered.

Nondifferential training. For the remaining five rats, the FOA schedule operated during the 20 and 32 clicks/sec stimuli as well as the

1.5 sec ISI period separating components. Stimuli were sequenced as they were for the differential group. All rats were given 4-hr training sessions on alternate days except for Rat 406 who was given 8-hr sessions. Rats were trained until responding had stabilized at a comparable rate for both stimuli for four consecutive sessions where shock rate was .6 per min or less. However, a minimum of 14 sessions were run. Then a generalization test was administered like that given to the nondifferentially trained rats in Experiment 1.

RESULTS AND DISCUSSION

Just as in Experiment 1, performance on the criterion sessions showed that a clear and stable discrimination was established between S+ and S− by the differentially trained rats (see Table 2). In comparison, response rates in 20 and 32 clicks/sec are almost identical for each of the rats in the nondifferentially trained group. In general the response rates of the VI trained rats of Experiment 1 were higher than those of the FOA rats of this experiment, although Rats 386 and 396 of Experiment 1 clearly had rates in the vicinity of the differentially trained rats in Table 2. In comparison, the VI rates of the nondifferential VI rats were 2 to 4 times the rates of the nondifferential FOA rats.

The lower frame of Figure 2 shows that on the generalization test, 3 of the 4 differentially trained rats showed clear peak shift. Even the one rat that did not shift (Rat 397) had identical response rates at S+ (20 clicks/sec), and the stimulus once removed from S+ in a direction away from S− (16 clicks/sec). This produced a pronounced area shift, with 75.4% of the area of this rat's gradient to the left of S+. In comparison, there is no systematic increase in rate for the nondifferentially trained control subjects to the left of 20 clicks/sec or to the right of 32 clicks/sec (see upper frame of Figure 2).

Just as in Experiment 1, on average the control gradient is flat to the right of 32 clicks/sec, with the mean percentage of responses emitted to these stimuli being 10.7, 11.1, 10.5, and 10.3 for 32, 37, 42, and 47 clicks/sec respectively. To the left of 20 clicks/sec responding decreased, with 14.6, 11.9, 8.1, and 9.4% of the test responses emitted to 20, 16, 12, and 8 clicks/sec respectively. This trend represents the behavior of all control rats except Rat 429.

Table 2

Criterion Sessions Data
(Free-Operant Avoidance Subjects)

Subject	389			390			397			399		
	S+	S−	ISI	S+	S−	ISI	S+	S−	ISI	S+	S−	ISI
Stimuli												
Clicks/sec	20	32		32	20		20	32		32	20	
Mean Rate	6.6	.5	4.2	6.4	.6	3.9	5.5	.3	1.4	5.0	.6	1.8
SD	.1	.1	.2	.5	.1	1.4	.6	.2	1.0	.3	.1	.4
Sessions (8 hr)		42			40			31			42	
Shock (ma)		1.6			1.5			1.0			1.8	

Differential Training

Subject	406			409			428			429			446		
Stimuli (Clicks/sec)	20	32	ISI	20	32	ISI	20	32	ISI	20	32	ISI	20	32	ISI
Mean Rate	7.7	7.4	8.8	6.5	6.8	8.3	8.4	8.8	12.1	10.1	10.2	11.3	6.6	6.6	5.9
SD	.4	.3	1.6	.7	.6	5.0	1.1	1.7	2.0	1.2	.9	2.1	.5	.5	1.0
Sessions (4 hr)		17			17			19			16			14	
Shock (ma)		1.0			1.4			1.6			1.8			.8	

Nondifferential Training

even though none of these rats showed any tendency to decrease their response rates during the 1.5 sec ISI in training. Thus, this decrease does not appear to reflect any associative influence, as the comparable decrease might have for the VI controls (see Footnote 1). These control gradients permit the unambiguous conclusion that the enhancement of responding to the right of 32 clicks/sec (Rats 390 and 399), and *especially* the enhancement (Rat 389) and maintenance (Rat 397) of responding to the left of 20 clicks/sec, are a product of the S+:S− discriminations established in training.

GENERAL DISCUSSION

Experiment 2 of the present study demonstrated for the first time peak shift in the rat when free-operant responding was maintained by shock avoidance. This shows again that appetitive and aversive reinforcement processes are symmetrical and adds species as well as dimensional generality to the Bushnell and Weiss (1980) finding. Thus, we might speculate that it was a procedural rather than a process factor that prevented Klein and Rilling (1974) from obtaining peak shift. Their wide S+:S− stimulus separation was probably to blame. This conjecture could be profitably tested using the Bushnell and Weiss procedure with a tonal dimension and a small S+:S− stimulus separation.

While the findings of Bushnell and Weiss (1980) and those of the present study are the only demonstrations of peak shift in avoidance performance, there have been experiments which have used aversive control, at least in part, to demonstrate peak shift. In one instance discriminated conditioned suppression was used (Hendry, Switalski, & Yarczower, 1969); in a second, noncontingent shocks were presented in S− (Grusec, 1968); and in a third, punishment was programed in one component of a multiple schedule where positive reinforcers were contingent on key pecks in both components (Terrace, 1968). In all three studies, generalization tests revealed a shift in maximum responding from the safety signal in a direction away from the danger signal. In comparison, when aversive stimulation was used in a situation where responding was maintained by shock avoidance (as in the present study and that of Bushnell and Weiss) generalization tests revealed a shift in maximum responding from the danger signal in a direction away from the safety signal. This is a revealing symmetry that supports the notion that an incentive factor contributes to the peak shift (see, Weiss, 1978).

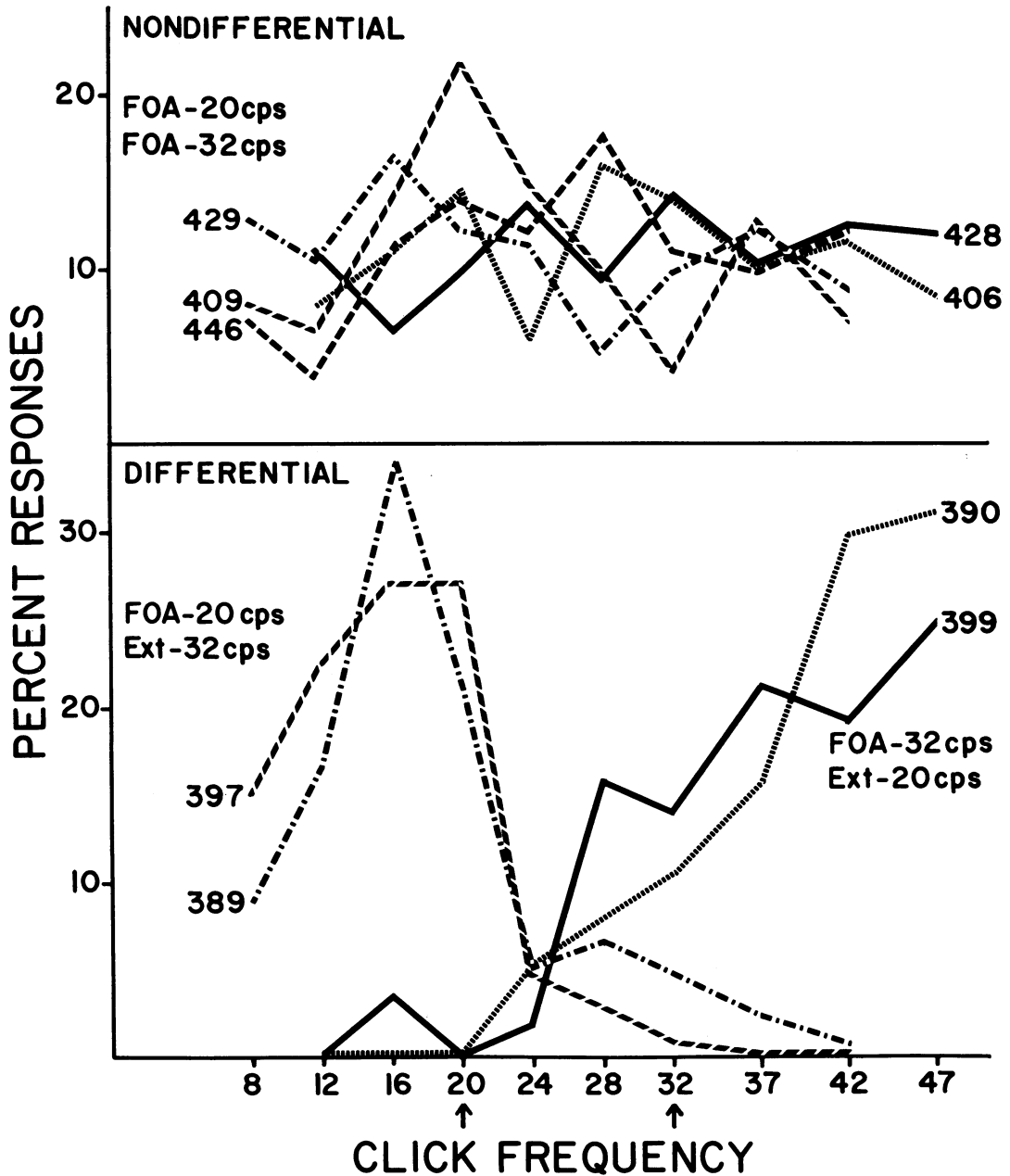Figure 3 compares the mean relative gradi-

Fig. 2. Click frequency generalization gradients for nondifferentially (upper frame) and differentially (lower frame) free-operant avoidance trained rats of Experiment 2. Gradients were generated as in Fig. 1. Total test responses emitted by nondifferential Rats 406, 409, 428, 429, and 446 were 199, 279, 462, 387, and 181 respectively. Total test responses emitted by differential Rats 389, 390, 397, and 399 were 170, 77, 107, and 57 respectively.

ents for the groups given differential (lower frame) and those given nondifferential (upper frame) training where responding was maintained by food (Experiment 1) and when it was maintained by shock avoidance (Experi-

ment 2). The similarity in the shapes of these relative gradients, especially when S+ was 32 clicks/sec, is striking and might be considered in light of the appetitive-aversive gradient comparisons reported by Hearst (1960, 1962,
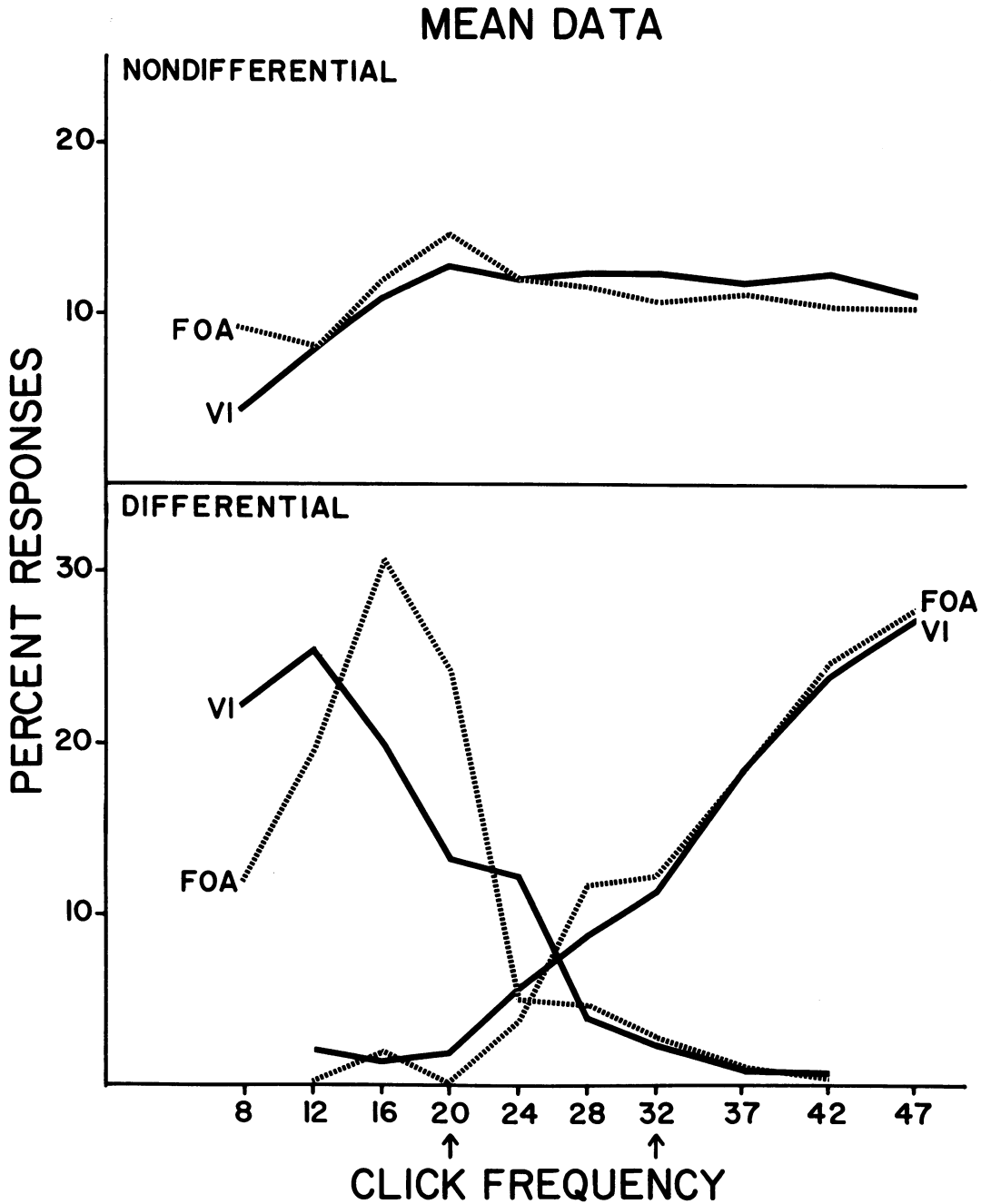
Fig. 3. Mean click frequency generalization gradients for nondifferentially (upper frame) and differentially (lower frame) trained rats of Experiments 1 (VI) and 2 (FOA). To generate these gradients the percentage of responses emitted to each stimulus by those rats comparably trained in each experiment were averaged.

1965). Miller (1944, 1959) was also concerned with this issue, but his experimental procedures were rather far removed from those being considered here.

Hearst trained monkeys to press a lever to postpone shock on an FOA schedule and to concurrently pull a chain to obtain food on a VI schedule while a houselight was on continuously at its maximum intensity. When an intensity generalization test was administered to

these monkeys, the response controlled by shock avoidance generalized much more widely than the response controlled by food reward. Hearst employed an external vs. internal cues analysis to interpret these results.

The importance of response-produced cues and/or time since the last response have been stressed by many analysts as being particularly important in the control of FOA. In this situation all responses except the avoidance response become dangerous since they can precede shock, and only the avoidance response can terminate this danger signal (Sidman, 1953, 1954). In a related way, Anger (1963) emphasizes the importance of the build-up of "fear" during the response-shock interval. Pointing to this evidence, Hearst (1965) concluded that in his experiments internal cues probably constituted a larger part of the stimulus complex controlling the avoidance response than the appetitive response—accounting for the steeper gradient. But is this difference intrinsic to appetitive vs. avoidance baselines? Hearst thinks not, since even within the appetitive situation one finds steeper gradients when responding is maintained by VI schedules than by schedules that require more precise timing and, by implication, greater internal control (Hearst, Koresko, & Poppen, 1964).

The control gradients in the upper frame of Figure 3 show that the nondifferentially trained VI as well as the nondifferentially trained FOA rats responded at comparable rates to 32 clicks/sec and all higher frequencies. The almost identical relative gradients for the differentially trained VI (Experiment 1) and FOA (Experiment 2) rats who had 32 clicks/sec as S+ should be appreciated in light of this comparability in control VI and FOA gradients above 32 clicks/sec. Over that stimulus range where the relative gradients of the VI and FOA nondifferentially trained rats were comparable, the relative gradients of the differentially trained VI and FOA rats were also comparable.

Unfortunately, the 1.5 sec ISI created some unanticipated stimulus control problems at the lower end of the click frequency continuum. Specifically, the nondifferentially trained VI rats who developed a tendency to reduce their response rates during the ISI in training had much steeper gradients to the left of 20 clicks/ sec than those who did not develop this tendency (see Footnote 1). The same relationship

appeared to hold for the differentially trained VI rats with 20 clicks/sec as S+. In comparison, this relationship was not evident in either FOA group, indicating, perhaps, greater internal control here. Thus, the slight differences existing between the VI and FOA gradients to the left of 20 clicks/sec in the upper and lower frames of Figure 3 are viewed as a reflection of the carryover to testing of the discriminations formed between the ISI and 20 clicks/sec by several VI rats that influenced the average VI gradients.

The results of the present experiments are in basic agreement with those of Hearst (1962) who reported that after extensive discrimination training the differences between his approach and avoidance gradients disappeared. However, it should be remembered that the present experiments report this comparison for the first time in rats where peak shift was obtained. The fact that Hearst's (1965, p. 339) attempt at this extension was inconclusive could be due to the very low rates of click frequency he used and/or the rather poor S+:S− discriminations established in his subjects. In either event, the results of the present experiments demonstrated for the first time peak shift in the rat when responding was maintained by shock avoidance, while adding some generality to Hearst's (1965, 1969) conclusion that positive and negative reinforcement does not in itself account for gradients of different shape.

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