SOCIAL FACILITATION OF RESPONSES DURING A STIMULUS PAIRED WITH ELECTRIC SHOCK¹

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Key-pecking responses of a pigeon were maintained by a variable-interval schedule of food reinforcement. The responses were suppressed during the occasional presentation of a warning stimulus paired with electric shock. The presence of a second pigeon emitting the same response for food reinforcement reduced the suppression that otherwise occurred during the warning stimulus when the second pigeon was absent. These results reveal that the social facilitation phenomenon can be used to restore behavior that is suppressed by a conditioned aversive stimulus.

One method of increasing the frequency of a response is to deliver reinforcement after that response. Another method is designated as "social facilitation". As stated in a review of the phenomenon, "the general term social facilitation may refer to any increment of individual activity which results from the presence of another individual, and can be regarded as one of the most basic forms of social interaction," (Crawford, 1939, pp. 410-411). In practice, the term has been used to include increases in behavior that result from either the activity or the presence of the second individual (see reviews by Crawford, 1939; Smith and Ross, 1952; Zajonc, 1965). When facilitation occurs in the presence of a second non-behaving individual, it has been termed an "audience effect"; when the second individual is engaging in the same behavior, it has been termed a "co-action effect" (Zajonc, 1965). The phenomenon differs from imitation in that it does not deal with the acquisition of a new response and does not require that the facilitated behavior be topographically similar to that of the model.

Feeding behavior has been the most frequently investigated response in studies of social facilitation. Feeding has been found to be

socially facilitated in a variety of animals including fish (Welty, 1934), birds (Bayer, 1929; Tolman, 1964, 1965; Tolman and Wilson, 1965), rats (Harlow, 1932), dogs (Ross and Ross, 1949a, 1949b; James, 1953, 1960; James and Gilbert, 1955; James and Cannon, 1955), and monkeys (Harlow and Yudin, 1933; Yerkes, 1934). The method usually employed in such studies is to give a large quantity of food to a food-deprived subject and to measure feeding behavior either in terms of the amount of food consumed or the change in body weight. The measurement is taken both in the presence and absence of a second feeding animal. The extent of the difference between these two measurements constitutes the extent of the social facilitation; only rarely (*e.g.*, Tolman and Wilson, 1965) have investigators attempted to determine the extent to which the facilitation has resulted from the co-action effect as differentiated from the audience effect.

Social facilitation is sufficiently important if it can increase the frequency of a response that normally occurs fairly often. Its importance as a means of behavioral control increases if it can restore behavior that is otherwise absent. Possibly for this reason some investigators have first eliminated the normal feeding behavior by satiating the subject and then tested to determine if social facilitation would again initiate feeding (Bayer, 1929; Harlow and Yudin, 1933; Tolman and Wilson, 1965; Ross and Ross, 1949b; James, 1953; James and Cannon, 1955). The restoration of feeding in satiated subjects raises the question

¹This investigation was supported by grants from the Mental Health Fund of the Illinois Department of Mental Health, NSF Grant 1987, and NIMH Grant 4925. The authors gratefully acknowledge the assistance of Drs. L. K. Miller, H. B. Rubin and, particularly, N. H. Azrin in the preparation of this manuscript. Reprints may be obtained from D. F. Hake, Behavior Research Laboratory, Anna State Hospital, Anna, Illinois 62906.

of whether behavior reduced through aversive stimuli could be similarly increased by social facilitation. If so, the types of behavioral phenomena subject to control through social facilitation would be much greater. The conditioned suppression procedure (Estes and Skinner, 1941), which conveniently produces suppression while simultaneously providing a measure of the non-suppressed level of responding, was used to answer this question in the present study.

METHOD

Subjects

Four experimentally naive White Carneaux pigeons about three years of age were maintained at 80% of free-feeding body weight. They were housed in individual home cages but there was no attempt to prevent visual observation of other pigeons. Two served as subjects and the other two served as second birds in the chamber.

Apparatus

The experimental chamber consisted of two, 7-in. wide by 14-in. long, compartments separated by a transparent partition. This clear divider allowed each pigeon visual and auditory observation of the other compartment; each compartment was separately and continuously illuminated. The response key and feeding mechanism in each compartment were located on the front wall so that the two separated animals worked "side by side". A key peck of 10 g or more constituted a response. Reinforcement was a 3-sec access to a grain mixture which could be obtained when the bird inserted its head into the wall aperture. During reinforcement, when the tray was elevated into an accessible position at the lower rear of the aperture, 2-w lights illuminated the food tray. This method of delivering food prevented the other bird from directly viewing it from the other side of the dividing partition. The electric shock was a brief (100 msec) ac shock delivered through a 10K series resistor to electrodes implanted in the tail region of the subjects (Azrin, 1959). The second animals did not receive shock. The warning stimulus was a 350-cps tone combined with a simultaneous change from white to red illumination of the response key. White noise continuously masked sounds outside the cham-

ber. The warning stimulus raised the sound level from 82 to 90 db.

Procedure

For the experimental subjects, food reinforcements were scheduled according to a 1-min variable-interval schedule. The warning stimulus was presented at irregular intervals averaging 15 min apart, each presentation lasting 1.5 min. To provide a stable baseline of responding, the animals were exposed to this procedure without shock in daily 45-min sessions for about three months. In subsequent sessions the shock was presented at the end of the warning stimulus. A suppression ratio was calculated for each session: the rate of response during the warning stimulus was divided by the rate in its absence (safe stimulus). A suppression ratio of 1.0 indicated no suppression during the warning stimulus and a suppression ratio of 0.0 indicated complete suppression. The shock intensity was increased gradually until the suppression ratio was consistently less than 0.30 (160 v for Bird 164 and 400 v for Bird 165). When this criterion shock intensity was reached, the second animal was introduced on alternate sessions. The second animal had been conditioned to respond only during the warning stimulus that signaled shock for the subject. For the second animal, each response during the warning stimulus resulted in food reinforcement (fixed ratio 1); responses in the safe stimulus were not reinforced. Since the second bird was present, but did not respond during the safe stimulus, audience effects could be determined by comparing the response rate during the safe stimulus, when the second bird was present, with the response rate when the second bird was absent. Similarly, co-action effects could be evaluated by comparing the response rate during the warning stimulus, when the second bird was present, with the response rate when the second bird was absent.

The apparatus had been designed to block the experimental subject's view of the food delivered to the second bird. Since the stimuli associated with food delivery were still visible to the subject, an additional procedure was used with one subject (Bird 164) to evaluate the effects of the magazine operation *per se*. In this procedure the second bird was absent, but the food magazine was activated automatically at approximately the same rate that

the second bird had produced it. The effects of the magazine operation alone were evaluated by comparing the response rate during this bird-absent-food-present procedure with the response rates when both the second bird and the food stimuli were absent. To evaluate the extent to which the magazine operation alone accounted for the results when the second bird was present and producing food, the response rate during the bird-absent-food-present procedure was compared to the response rate when the second bird was present and producing food. There were eight sessions with the bird-absent-food-present procedure. These were compared with the preceding 16 sessions which alternated between sessions with both the second bird and food stimuli absent and sessions with the second bird present and producing food. Shock intensity was 300 v for all sessions.

RESULTS

Figure 1 shows cumulative response recordings of the experimental subject and illustrates the major finding that the presence of the second bird reduced suppression. Suppression during the warning stimulus is evident in all three records, but the suppression was less severe in the middle record, obtained when the second bird was present. For the three consecutive sessions shown, the suppression ratios were 0.10, 0.41, and 0.07 respectively.

Figure 2 shows the suppression ratios before

Fig. 1. Cumulative response records illustrating the rate and pattern of responding within sessions. The heavy diagonal lines separate three consecutive sessions. The second bird was present during the middle record and absent during the other two sessions. Presentations of the warning stimulus are indicated by a downward displacement of the response pen and a line beneath. The shock intensity was 160 v. Suppression ratios for these three sessions were 0.10, 0.41, and 0.07 respectively.

shock, during the criterion shock intensity (400 v for Bird 165 and 160 v for Bird 164), and after shock was removed. Before pairing the stimulus with shock, the suppression ratios averaged about 1.0, indicating that the stimulus alone had little effect upon responding. When the stimulus was paired with the criterion shock, the suppression ratios decreased, indicating suppression during the stimulus. But there was less suppression when the second animal was present, the suppression ratios being almost two (Bird 165) or three (Bird 164) times as high. The mean suppression ratio of Bird 165 was 0.47 in the presence of the second bird, compared to 0.26 in its absence. For Bird 164 the mean suppression ratio was 0.50 in the presence of the second bird, compared to 0.15 in its absence. The difference between suppression ratios with and without the second bird was not transient; it lasted as long as shock was in effect, 91 sessions for Bird 164 and 68 for Bird 165. When shock was removed, however, the suppression ratios increased and the difference either disappeared (Bird 164) or remained about the same (Bird 165).

Table 1 shows the mean and average deviation of response rates for the safe stimulus and the warning stimulus as well as for the presence and absence of the second bird. An audience effect upon responding in the safe stimulus can be determined by comparing the response rate during the safe stimulus in the presence of the second bird with the rate in its absence. The results show that the mere presence of the second bird produced a slight increase for one subject (Bird 164) and a slight decrease for the other (Bird 165). The effects of the co-action procedure upon responding in the warning stimulus can be evaluated by comparing the response rate during the warning stimulus, when the second bird was present, with the rate when the second bird was absent: the presence and activity of the second bird almost doubled the response rate for one subject (Bird 165) and quadrupled it for the other (Bird 164).

Table 2 shows the effects of the food magazine operation *per se* upon response rate during the warning stimulus. When the second bird was present and producing the food stimuli, the subject averaged 20.2 responses per min during the warning stimulus. When the second bird was absent and the food magazine

Fig. 2. Daily suppression ratios before shock, during the criterion shock intensity, and after shock was removed. The criterion shock intensity was 400 v for Bird 165 and 160 v for Bird 164. The second bird was present (solid circles) on alternate days. Several sessions have been omitted between the sessions designated as 10 (no shock) and 11 (shock on). During that period, the shock intensity was being gradually increased to the criterion intensity.

was not presented, the response rate during the warning stimulus dropped to an average of 2.9 responses per min. The presentation of the food stimuli alone produced only a negligible increase to 4.1 responses per min.

DISCUSSION

The results show that social stimuli reduced the extent of behavioral suppression during a warning stimulus that ended with

Table 1
Responses per Minute during the Shock Sessions

Subject	Condition	Sessions	Resp/Min during Safe Stimulus			Resp/Min during Warning Stimulus		
			Mean	Avg. Dev.		Mean	Avg. Dev.	
165	Second Bird Present	35	51.3	± 5.9		24.1	± 5.9	
	Second Bird Absent	33	54.3	± 4.6		14.0	± 3.3	
164	Second Bird Present	45	32.9	± 2.1		16.4	± 5.0	
	Second Bird Absent	46	26.7	± 2.7		3.9	± 1.9	

Table 2
The effects of magazine presentations *per se* upon response rate during the warning stimulus.

Subject	Condition	Sessions	Resp/Min during Warning Stimulus		
			Mean	Avg. Dev.	
164	Second Bird Present, Food Stimuli Present	8	20.2	± 4.6	
	Second Bird Absent, Food Stimuli Absent	8	2.9	± 1.4	
	Second Bird Absent, Food Stimuli Present	8	4.1	± 1.4	

electric shock. The results fall within the definition of social facilitation. Most previous studies of social facilitation have not provided the means of determining whether the facilitation was produced by the parallel behavior of the second animal, or its presence, or indeed merely the physical non-social stimuli associated with the second animal's behavior. The fact that activation of the food magazine alone did not produce facilitation revealed that changes in physical stimuli alone were not responsible for the facilitation in the present study. Further, the small and inconsistent facilitation produced in the safe stimulus by the presence of second pigeon suggests that the mere presence of the second pigeon was not the principal determinant of the larger and consistent facilitation effect during the warning stimulus. Rather, it would appear that the total stimulus complex of the second animal engaging in parallel behavior produced most of the facilitation. Additional controls would be needed, however, to make this statement definitive since the audience effect was evaluated during the safe stimulus and not during the warning stimulus. Al-

though the present results should not be construed as a definitive measurement of the relative contribution of the audience and co-action effects, they do demonstrate the feasibility and desirability of attempting this analysis, which has generally been absent in previous demonstrations of social facilitation.

Most studies of social facilitation have not prevented physical competition over food, a factor which might alone increase food-getting behavior. When the possibility of physical competition had been prevented, the social facilitation effect was either reduced (Harlow and Yudin, 1933; Tolman, 1965) or eliminated (Harlow, 1932; Tolman, 1964; Tolman and Wilson, 1965). In the present experiment, a transparent partition between the animals eliminated physical competition and a social effect was obtained. These results indicate that social facilitation of food-getting behavior can occur without physical competition over food.

There have been several previous reports that social factors have reduced emotional effects of aversive stimulation (Liddell, 1964; Harlow and Zimmerman, 1959; Davitz and

Mason, 1955; Masserman, 1943). In Liddell's experiments the presence of a mother goat prevented experimental neurosis in kids subjected to respondent conditioning. Similarly, the findings of Harlow and Zimmerman (1959) revealed that a cloth surrogate mother reduced emotional behaviors of infant monkeys during the presentation of aversive stimuli. Davitz and Mason (1955) found that the activity of rats that had been subjected to electric shock could be increased by the presence of rats that had never been shocked and were moving freely about the chamber. Masserman (1943), using cats as subjects, observed that a learned feeding response that had been eliminated by punishment was reinstated sooner when a normal feeding cat was present. The present results provide objective, quantifiable evidence that the presence of a second animal can reduce behavioral suppression produced by aversive stimulation. Since the pigeons used in the present study were never housed together, the present findings demonstrate that this effect does not require a prior relationship between the animals, as was the case in the previous studies of Liddell (1964) and Harlow and Zimmerman (1959). Observing a second feeding animal as in Masserman's (1943) experiment, or a freely moving animal in the case of the Davitz and Mason (1955) experiment, could indicate to the subject that the situation no longer contained aversive stimuli. Since in the present study shock continued to be delivered even when the second pigeon was present, it cannot be concluded that the experimental subject learned from the behavior of the second animal that shock would no longer be forthcoming. The present findings indicate that behavior suppressed by aversive stimulation can be increased by the presence of a second animal without a special relationship to that animal or any vicarious learning from observation of the second animal's behavior.

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Received November 28, 1966