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CONTEXTUAL DISCRIMINATION AFTER NONREINFORCED PREEXPOSURE TO THE CONTEXT

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ABSTRACT: Rats were trained on a contextual discrimination after nonreinforced preexposure to both contexts. In Experiment 1, where contexts differed in terms of tactile and visual stimuli, preexposure retarded subsequent discrimination by comparison with non preexposed controls (latent inhibition). In Experiment 2, where contexts differed only in terms of visual cue, discrimination was facilitated in preexposed animals (perceptual learning). Food was used as reinforcer and anticipatory activity as dependent measure. These results suggest that contextual similarity influences the outcome of nonreinforced preexposure.

RÉSUMÊ: Se entrenaron ratas en una discriminación contextual apetitiva después de preexposiciones no reforzadas a ambos contextos. En el Experimento 1, en el cual los contextos diferían en características visuales y táctiles, la preexposición produjo un retraso en la discriminación, comparada con un grupo no preexpuesto (inhibición latente). En el Experimento 2, en que los contextos eran diferentes en claves visuales, la preexposición facilitó la discriminación (aprendizaje latente). Se utilizó alimento sólido como reforzador y la ambulación anticipatoria como medida dependiente. Estos experimentos sugieren que la similitud de los contextos preexpuestos producen mayor facilidad o retraso en su discriminación posterior.

INTRODUCTION

Nonreinforced preexposure to a stimulus can affect its subsequent conditioning either retarding acquisition (i.e. latent inhibition; Lubow & Moore, 1959, Lubow, 1989), or facilitating acquisition (i.e. perceptual learning; Gibson & Walk, 1956; Fanselow, 1990; Kiernan &

Westbrook, 1993). Chamizo and Mackintosh (1989) and Trobalon, Sansa, Chamizo and Mackintosh (1991) have demonstrated that one training variable determining whether preexposure leads to retardation or facilitation of discriminative learning is the proportion of features or elements S+ and S- share in common. In one of their experiments, rats were preexposed to a T-maze in which the arms were differentiated by the type of floor (either rough or smooth) and were subsequently trained in a tactile discrimination task based on those stimuli. The preexposed rats learned the discrimination faster than non preexposed controls. By contrast, when the arms of the maze differed in terms of the floor and also in terms of brightness of the walls (white or black), preexposure led to retardation, relative to nonpreexposed controls.

These results favoured an interpretation based on a model developed by McLaren, Kaye, and Mackintosh (1989), specifically designed to explain perceptual learning. According to this model, the greater the similarity between two stimuli, the more likely it is that their common elements will be sampled in each trial. Because nonreinforced sampling decreases the associability of the sampled elements, relatively similar stimuli will become more discriminable thus yielding perceptual learning. When the stimuli are more different from each other, then their common elements will be less likely to be sampled and thus subsequent conditioning will be retarded yielding latent inhibition. There is a second mechanism that could be responsible for this differential outcome. According to McLaren *et al.* (1989) the early trials of preexposure will produce some tendency to generalization between two stimuli caused by the formation of excitatory associations between their common and unique elements. Further trials will cancel this generalization establishing inhibitory connections between the unique elements of the stimuli. The greater the similarity between two stimuli, the greater the inhibitory learning that will be formed between them. Thus, preexposure will produce facilitation of discriminative learning if stimuli are very similar, but not if stimuli are more different from each other. Both of the mentioned processes are based on the degree of similarity of the stimuli.

The present experiments were designed to test the same hypothesis as it applies to classical contextual conditioning rather than to spatial instrumental conditioning. Unlike discrete stimuli, which have a clear onset and offset and precede the presentation of the reinforcer closely, contextual stimuli are constantly present characterizing the location where conditioning takes place, rather than the point in time when the reinforcer will be presented. According to most contemporary theories of conditioning, contextual and discrete stimuli follow the same

learning principles (i.e., Rescorla & Wagner, 1972; Pearce, 1987; McLaren *et al.*, 1989). Moreover, McLaren *et al.* (1989) model does not explicitly differentiate between discrete and contextual stimuli. It was therefore expected that the acquisition of a contextual discrimination would be retarded by preexposure, when the contexts were markedly different from each other, but facilitated when the contexts were relatively more similar to each other. In the two experiments, similarity was manipulated by increasing the number of elements that are common to the signals for reward and non-reward.

EXPERIMENT 1

The two contexts used in the present experiment differed in terms of visual and tactile cues, thus presumably having relatively few elements in common. Therefore, it was expected that, after nonreinforced preexposure, the rats would find their discrimination to be relatively more difficult than control rats not preexposed to the contexts. Previous experiments have shown that contextual conditioning based on the presentation of food can be measured in terms of general activity. Mustaca, Gabelli, Papini & Balsam, (1991, Experiment 1) measured a wide range of behaviours after a differential contextual training using rats as subjects and found that activity was the only behaviour that yielded a consistent pattern across sessions and contexts. Subjects exhibit significantly more activity (walking, running, circling, or jumping) in the presence of a context paired with food than they did in the presence of a different context in which food was never presented. The increase in general activity in anticipation of food presentation is similar to the behavioural changes that have been observed in pigeons (Durlach, 1982, 1983) and ringdoves (Balsam, 1982 1985) under similar circumstances. Consequently, these same features were used in the experiments reported here.

METHOD

Subjects

The subjects were 12 adult Wistar rats, all female and experimentally naive. They were approximately 90 days old at the start of the experiment. Ten days before the experiment, the subjects were transferred to individual cages with water freely available. During 10

days, the daily amount of food was gradually reduced until their weights were lowered to an 80-85% of the individual ad libitum weights. The colony was under a 12:12 cycle of light and darkness, with light from 7:00 to 19:00 hr.

Apparatus

Subjects received training in 2 similar conditioning boxes measuring 52 x 31 x 35 cm (length, width, height). The wall facing the observer, as well as one of the lateral walls and the ceiling, were made of translucent Plexiglas. The other walls and the floor were painted black. One of the black walls contained a tube through which the reinforcer (0.15 g pieces of commercial cookies) was manually administered. The tube protruded 1.5 cm within the box, and was located at 5 cm above the floor and in the middle of the wall. The reinforcer fell directly on the floor. A speaker located in the upper right corner of the same wall provided masking white noise. A light (60 W) located 40cm above the floor of the laboratory provided diffuse illumination.

The preceding description applies to context A. Several elements were added to produce context B. A piece of cardboard was placed in the wall containing the reinforcer tube. This cardboard had vertical red and white stripes, 1.5 cm wide. A rough grid was placed on the floor. A diet Pepsi can, filled with sand, was located 10 cm. away from the reinforcer tube and directly in front of it. Finally, an orange bulb (12 W) was placed in the upper left corner of the same wall containing reinforcer tube. (This bulb was turned off for context A.)

Previous experiments run in our laboratory show that pieces of commercial cookies (Lincoln, Nabisco-Terrabusi. Main ingredients: vanilla and lemon flavour, flow, sugar, fat, starch, glucose extract, and salt) can be used as appetitive reinforcers and that contexts A and B are easily discriminated by rats (see Pellegrini, 1997; Mustaca & Pellegrini, 1996).

Procedure

Subjects were randomly assigned to 2 groups (n=6) according to whether or not they received preexposure. Group PE received 10 sessions in each of the two contexts, at a rate of 2 sessions per day, separated by an interval of 20 min. These sessions lasted 5 min, and no food was presented. The subjects in group C were similarly handled but were not exposed to the contexts.

During acquisition, all subjects received 10 sessions of training in each of the contexts. Context A was always reinforced whereas context B was always nonreinforced. In each of the reinforced sessions, food was delivered according to a variable time 30 s schedule. Although the first session was reinforced for all subjects, the rest of the sessions in contexts A and B were alternated at random with the only restriction that one exposure to each context was administered per day.

Behavioural observations were carried out in sessions 1-2, 9-10 and 19-20 (one session in each context for any given pair) of the preexposure phase, and in each session of the acquisition phase. These observations lasted for 2 min and thus session length was 7 min during the 6 sessions of preexposure listed above, · and during all the acquisition sessions. An observer recorded every 5 s whether or not (1/0 sampling) the rat was active. "Activity" was defined as any movement of the limbs (e.g., walking, running, circling, or isolated movements of any number of limbs). This observation technique is frequently used in our laboratory. Reliability has been estimated against naive observers (agreement above 95%; Mustaca & Pellegrini, 1996) and against an automatic device (Pearson's coefficient of correlation $r=0.81$, $p<.0001$; Pellegrini, 1997). In view of the relatively high level of agreement, reliability was not explicitly estimated in the present experiments. No food was delivered during the 2 min of behavioural observations.

RESULTS

The level of activity observed in each of the two contexts in Group PE, during preexposure sessions, decreased as preexposure progressed, but there were no appreciable differences between contexts. A Context x Session analysis of variance yielded only a significant effect of Session [$F(2,10)=25.27$; $p<.001$]. The effects were not significant for Context ($F<1$) or for the Context x Session interaction [$F(2,10)=1.75$].

All animals ate the food delivered during training sessions. Figure 1 shows the main results of the acquisition phase for each group and session. The dependent variable was a discrimination index (DI) obtained by subtracting the activity score in context B (nonreinforced) from that obtained in context A (reinforced). As the DI becomes more positive, the frequency of activity in the reinforced context increases relative to the activity observed in the nonreinforced context. As Figure 1 shows, discrimination was retarded in Group PE, relative to Group C. A Group x Session analysis provided support for this conclusion in the form of a significant Group effect [$F(1,10)=17.34$; $p<.002$]. There was also a significant Session effect [$F(9,90)=10.20$; $p<.0001$]. The Group x Session interaction was not statistically reliable [$F(9,90)=1.78$; $p<.08$].
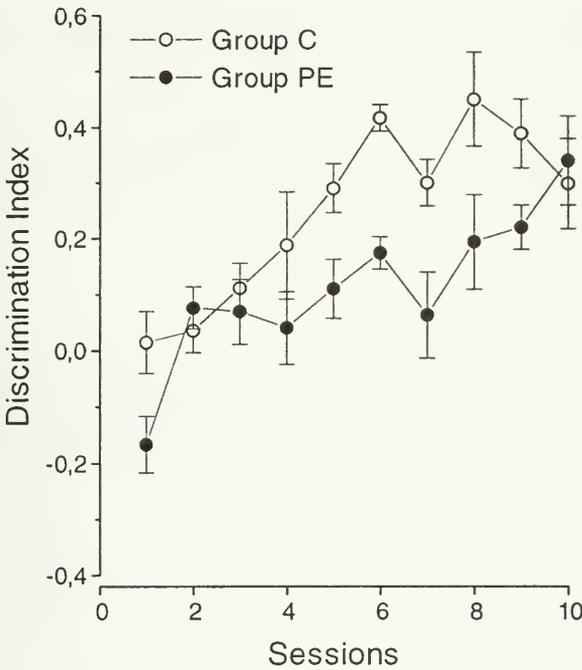
Figure 1. Contextual discrimination in groups preexposed (PE) or not (C) to the context during a prior phase. Training contexts differed in terms of visual and tactile cues. See text for a definition of the discrimination index.

EXPERIMENT 2

The contexts to be discriminated in the present experiment were made more similar by removing elements from context A in the previous experiment. As already noted, McLaren *et al.* (1989) hypothesis assumes that greater contextual similarity implies a larger proportion of common elements. Preexposure should then serve to reduce the associability of these common elements to a greater extent than that of the unique elements. In turn, this should lead to perceptual learning, that is, the discrimination of the stimuli should be subsequently facilitated.

METHOD

Subjects and Apparatus

The subjects were 14 rats of the same characteristics as in Experiment 1. Maintenance conditions and deprivation were as already described.

The conditioning boxes were those already described. Context B was created by placing the board with the red and white stripes against the wall with the food-delivery tube. Context A was the same as in the previous experiment.

Procedure

Rats were randomly assigned to two groups (n=7). There were two procedural differences with respect to Experiment 1. First, the assignment of subjects to context A and B was counterbalanced. In each group, 4 rats were trained in an A+/B- discrimination, and 3 rats were trained in a B+/A- discrimination. Second, there were a total of 28 discrimination sessions, 14 sessions with each of the two contexts, instead of 20 sessions as in Experiment 1. More training sessions were run because this discrimination was more difficult than the previous one, given the similarity between the two contexts.

RESULTS

For Group PE, the frequency of activity in preexposure sessions 1-2 was higher in the context that was later to become the reinforced one, than in the negative context. However, activity level decreased in preexposure sessions 9-10 and 19-20, in both contexts, and it became nondifferential. A Context x Session analysis indicated a significant interaction [F(2,12)=5.41; p<.001], product of the initial differences across contexts, and also a significant habituation effect across sessions [F(2,12)= 15.31; p<.001]. The simple effect of Context was not significant [F(1,6)=2.76].

By the third session all animals ate the reinforcers immediately after delivery. Figure 2 shows the performance of both groups during the 14 sessions in each context in terms of the DI. As anticipated, discriminative performance progressed faster in Group PE than in Group C, indicating that the nonreinforced preexposure facilitated the subsequent discrimination of these contexts. A Group x Session

analysis of these indices supports this conclusion. There were significant Group [F(1,12)=5.63; $p<.03$] and Session effects [F(13,156)=2.45; $p<.05$], and also a significant Group x Session interaction indicating the faster acquisition by Group PE than Group C [F(13,156)=2.46; $p<.005$].
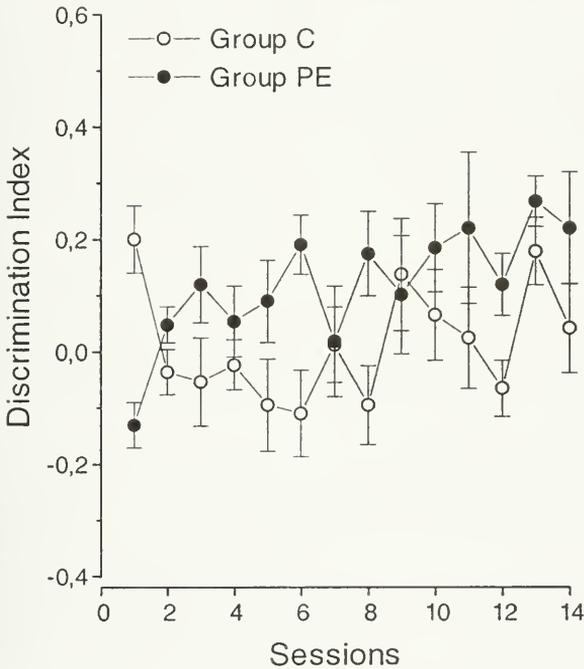

Figure 2. Contextual discrimination in groups preexposed (PE) or not (C) to the context during a prior phase. Training contexts differed in terms of visual cues. See text for a definition of the discrimination index.

DISCUSSION

The main results of the present experiments were that, relative to the non-preexposure treatment, nonreinforced preexposure to the

context had opposite effects depending on the degree of similarity of the contexts. When the contexts were made relatively more dissimilar by the addition of stimuli, the subsequent discrimination was retarded. This effect is akin to latent inhibition (Lubow & Moore, 1959). By contrast, when the contexts were more similar, preexposure facilitated their discrimination, thus yielding a perceptual learning effect.

Because in the present experiments conditioning was assessed in terms of anticipatory activity, and because the level of activity during preexposure habituated in both experiments, it could be argued that these effects could be the simple consequence of differential habituation in Group PE and C. Habituation of ambulation is known to occur in many different situations. This explanation would lead one to predict lower activity levels generally in the groups preexposed to the contexts and could, perhaps, offer an alternative account for the results of Experiment 1. In that experiment, discriminative performance was delayed by the preexposure treatment (see Figure 1). However, this explanation cannot account for the facilitatory effect of preexposure observed in Experiment 2, when the contexts were more similar. In other words, habituation should occur perhaps even faster and to a larger extent, when the contexts are similar because there is the possibility of stimulus generalization (Thompson & Spence, 1966).

Nonetheless, greater contextual similarity actually led to faster acquisition after preexposure than after the control treatment.

Another potential alternative, at least for Experiment 1, is related to the lack of counterbalance of contexts during the acquisition phase. Context A was always reinforced whereas context B was nonreinforced. Perhaps a perceptual bias contributed to the discrimination above and beyond the contribution of preexposure. However, this possibility seems unlikely; previous experiments with these contexts have shown their equivalence (Mustaca & Pellegrini, 1996).

In several studies employing taste aversion (Hall & Channell, 1986), spatial learning (Chamizo & Mackintosh, 1989; Trobalon *et al.*, 1991; Rodrigo *et al.*, 1994) and an appetitive licking procedure (McLaren *et al.*, 1994), it has been strongly suggested that the associations formed within contextual cues during preexposure training are critical for determining whether preexposure will facilitate or retard subsequent conditioning. Furthermore, these investigations are consistent with the idea that one process underlying the effects of preexposure on subsequent discriminative learning is the differential loss of associability by common and unique elements. The results of the present experiments are in agreement with this interpretation and find similar effects using a different training procedure and only contextual

cues as the conditioned stimulus. Therefore, they suggest the generality of this phenomenon.

The emphasis placed by McLaren *et al.* (1989) model on contextual similarity and complexity demands more precise ways of determining these contextual properties. Similarity could be varied more precisely by changing the salience of a single element in independent groups. Such manipulations are needed for a more precise testing of the model's view of contextual conditioning.

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