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Contextual Factors in Neophobia and its Habituation: The Role of Absolute and Relative Novelty

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In four experiments we investigated the role of contextual cues in the habituation of neophobia in rats. Experiment 1 showed that the consumption of a novel flavour increased across a series of presentations in one context (A) but fell when the flavour was subsequently presented in a second, novel, context (B). In Experiments 2 and 3, subjects again received exposure to a flavour in context A, but also were familiarized with the test context, B. These subjects consumed the flavour with equal readiness, whether it was presented in Context A or in Context B at test. Experiment 4 replicated the results of Experiment 1 and also showed that the consumption of a novel flavour was not influenced by whether it was presented in a novel or a familiar context. Several mechanisms by which the novelty or familiarity of the context might interact with the novelty or familiarity of the flavour were discussed.

A novel stimulus will usually elicit a characteristic unconditioned response (UR) that declines with repeated presentation of the stimulus. Theories of habituation explain this effect in a range of different ways: as being the consequence of a decline in the efficiency of the stimulus–response (S–R) pathway (Groves & Thompson, 1970), as being a product of associative learning (Wagner, 1976), or in terms of the formation of a neuronal model of the stimulus (Sokolov, 1963). These various accounts are unified, however, by their assumption that habituation is a direct function of the number

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of occasions on which the target stimulus has been encountered. That is, they hold that the effectiveness of a stimulus in evoking its UR is determined by its *absolute novelty*.

An alternative view, that the effectiveness of a stimulus might depend on its *relative novelty*, has been less well developed, but versions of this suggestion have been offered by, among others, Berlyne (1960), Lubow, Rifkin, and Alek (1976), and Mitchell, Kirschbaum, and Perry (1975). Although they differ in many respects, these theorists agree that the ability of a given stimulus to command processing will depend, at least in part, on its novelty relative to the novelty of the contextual cues with which it is presented. Thus, according to the version offered by Lubow et al. (1976), a stimulus will elicit its response not only when it possesses absolute novelty (i.e. has never been encountered before) but also (or even especially) when it has relative novelty—when it is a familiar event presented in an unfamiliar context or a novel event presented in a familiar context.

The aim of the experiments presented here was to examine the role of contextual cues in determining the vigour of a UR and in doing so to evaluate the theories just outlined. In each of the experiments we monitored the readiness of rats to consume a flavoured solution across a series of exposures. On the basis of previous work we anticipated that initially the rats would consume rather little, but that with repeated presentation they would come to consume the solution readily—a change that we shall argue reflects, at least in part, the habituation of a UR of neophobia (see below; see also Domjan, 1977). Of primary interest in our experiments, however, was the effect of presenting the flavour in a different context after habituation training. The principle of relative novelty implies that a change of context will restore the habituated UR, provided that the change introduces a contrast between the novelty of the context and the target stimulus. Experiment 1 was intended to provide a demonstration of this basic effect by presenting the pre-exposed flavour in a quite novel test context. Later experiments were designed to allow investigation of other cases (in particular that in which the familiar stimulus is presented in a familiar test context) and also to evaluate the explanations for contextual effects that can be offered by those theories that find no place for the notion of relative novelty.

EXPERIMENT 1

The effects of presenting a familiar stimulus in a quite novel test context have been investigated in a range of experimental procedures. Even if we restrict consideration to experiments using rats as subjects, the results have been varied. Some have produced the restoration of the UR predicted by the relative novelty account. Hall and Channell (1985) found such an effect

in rats, the behaviour under study being that of orienting toward a briefly presented light. Evans and Hammond (1983) monitored the extent to which the squeal of a rat disrupted the behaviour of licking at a water spout and found that the habituated response (of suppression) will reappear when the squeal is heard in a new context. Similarly, Archer and Sjödén (1979; see also Archer, Sjödén, & Nilsson, 1985) observed the return of the rat's neophobic response to a saccharin solution when the fluid was presented in a new context.

We may contrast these results with those reported by Baker and Mercier (1982), by Leaton (1974), and by Marlin and Miller (1981) who found no restoration of the UR evoked by an auditory cue when that stimulus was presented in a novel test chamber. Although not what the theory predicts, these failures to find an effect pose no real threat to the suggestion that relative novelty determines the likelihood of a UR, as it is always possible for proponents of this suggestion to argue that the difference between training and test context was not readily discriminable by the subjects. Clearly, therefore, as a first step it is necessary to provide a demonstration that with our stimuli, contexts, and training procedures, a simple change of context is indeed capable of restoring the habituated response to a familiar stimulus.

Each of the subjects in this experiment received a series of presentations of a sucrose solution in a distinctive cage (Context A), such training being continued until their initial neophobia had habituated. During the test phase subjects in Group S (for Same) received another presentation of sucrose in Context A, whereas subjects in Group D (for different) were given sucrose for the first time in a different distinctive cage (Context B).

Method

Subjects. The subjects were 16 male hooded (Lister) rats with a mean free-feeding weight of 390 g (range: 350–420 g). They had previously served as subjects in a study of appetitive conditioning, but were naive with respect to the stimuli and procedures employed in the present study. They were housed in pairs in a large colony room that was brightly lit between 0800 and 2000 and was dark for the remainder of the day. In their home cages, the rats received continuous access to food and to water from large glass bottles.

Apparatus. Two sets of cages served as the two contexts. One set, consisting of large cages, 42 cm × 35 cm × 16 cm, was located in the colony room. The walls and floor of these cages were made of translucent white plastic, and the wire-mesh roof included a section through which a water tube could be inserted. The cages in the second set were smaller,

measuring 35 cm × 22 cm × 19 cm, and were located in a separate small room. This room was dimly illuminated by a 60-W table lamp, and a background of white noise was presented at 82 dB. The walls and floor of the smaller cages were constructed from transparent plastic, and the floor was covered with wood-shavings. In the wire-mesh roof of these cages there was also a section through which a water tube could be inserted. Inverted plastic tubes were used to present measured amounts of tap water or of a 1.32 *M* sucrose solution. These calibrated plastic tubes were equipped with stainless-steel ball-bearing-tipped spouts. Consumption was measured to the nearest 0.5 ml.

Procedure. On each of the first seven days of the study the subjects were taken from their home cages at 1100, given a 30-min presentation of a fluid in Context A, and then returned to their home cages. In an attempt to increase the sensitivity of our measure, we arranged to measure consumption separately for the first and second halves of the 30-min period. In order to achieve this, the tube was removed after 15 min and replaced immediately by a second, full, but otherwise identical tube. It turned out, however, that the amount consumed in the second half of each trial was negligible, and accordingly our data are derived from the first 15 min of each trial.

For half of the subjects the large cages served as Context A; for the remainder the small cages served as Context A. All received free access to tap water on the first day of the study; on the subsequent six days sucrose was presented. On the final day of the experiment half of the subjects that had experienced the large cages and half of those that had experienced the small cages received training identical to that given on the previous six days. For these subjects, Group S, sucrose was presented in the same context as that in which habituation training had taken place. The remaining subjects, those in Group D, received sucrose for the first time in the novel, B, context. Thus, subjects for which sucrose had been presented in the large cages were given sucrose in the small cages, and those that had been given sucrose in the small cages received test presentations of sucrose in the large cages.

Results

The mean amount of sucrose consumed during the first 15 min of each of the training sessions (in two-session blocks) and that consumed during the single test session is presented in Figure 1. It is clear that during the initial days of training subjects consumed relatively little sucrose but subsequently came to consume it quite readily. An analysis of variance (ANOVA) with group (S or D), context (large or small), and block as factors confirmed

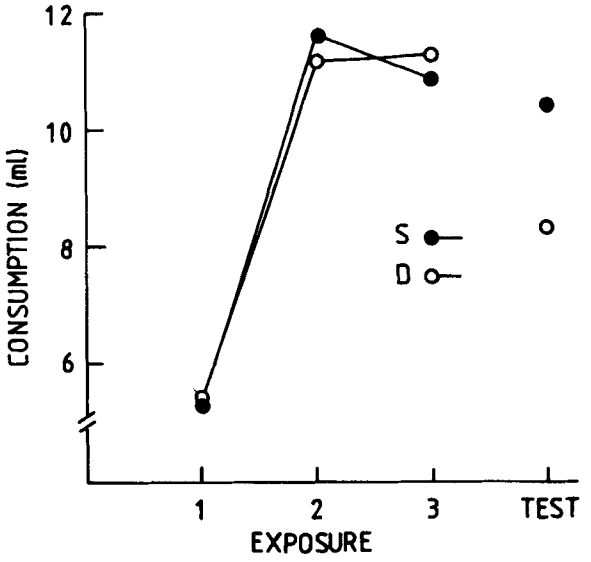

FIG. 1. Experiment 1: Group mean consumption of a sucrose solution during exposure (2-session blocks) and a single test session occurring in the same context as was used for exposure (Group S) or in a different context (Group D).

this description of the results. There was an effect of session block, $F(2, 24) = 224.15$, $p < 0.01$, no effect of group or of context, and no interactions among these factors [largest $F(2, 24) = 1.09$].

The isolated points on the right-hand side of the figure represent the amount of sucrose consumed during the first 15 min of the test session. It is clear that the subjects in Group S consumed a greater quantity of sucrose during this session than those in Group D. In order to attenuate the effects of individual differences in the absolute amount consumed, further analyses are made using the difference score: volume of sucrose consumed during the test minus the volume consumed during the final block of training. The mean difference score for Group S was −0.47 ml, indicating that there was little difference between the consumption during training and test. The mean difference score for Group D was −2.94—a score that indicates that subjects in this group consumed less sucrose during the test than during training. An ANOVA with group (S or D) and test context (large and small) revealed an effect of group, $F(1, 12) = 13.52$, $p < 0.01$, an effect of context, $F(1, 12) = 15.65$, $p < 0.01$, but no interaction between these two factors [$F(1, 12) = 2.65$]. The significant effect of test context appears to reflect the fact that animals tended to consume more sucrose in the small cages than in the large cages at test. This finding does not unduly complicate the interpretation of the difference between Groups

S and D, however, as the effect of context did not interact with the effect of group assignment.

Discussion

The sucrose solution used as the target stimulus in this experiment appears to evoke neophobia in that rats consumed relatively little of it when it was first presented; but with experience consumption increased, suggesting that habituation occurred. This effect was context-specific. Intake of sucrose was reduced when the solution was presented in a novel context. This result is just that expected by those theorists who hold that the ability of a stimulus to evoke its UR will depend on relative novelty. We are not compelled, however, to accept their interpretation, as theories of habituation that find no place for a notion of relative novelty are also capable of dealing with this result.

Thus, Wagner's (1976) theory holds that a stimulus becomes less likely to receive processing (and thus to evoke its UR) as it comes, as a result of experience, to be expected on the basis of its antecedents. In habituation training, repeated presentation of the target stimulus in a given context allows the formation of a context-stimulus association. Contextual cues become able to "prime" a representation of the stimulus and render it less capable of evoking its UR when it actually occurs. But if the context is changed, the representation will not be activated, and the stimulus will be able to evoke the UR again. And the S–R theory of Groves and Thompson (1970) similarly has little difficulty with these results. This theory asserts that the ability of an S to evoke its R depends not only on the state of the direct S–R pathway but also on the animal's general level of arousal. If it is allowed that the presentation of a novel set of contextual cues raises the arousal level, then this could be enough to permit even an habituated S to evoke its UR.

A further possible explanation of the results, open to almost any theory of habituation, is that the increase in sucrose consumption during exposure is not a direct consequence of a change in the rat's response to that flavour but depends on habituation of the response to contextual cues. If the tendency of the rat to explore the (initially novel) context declines with training, then this would reduce the likelihood of a response that might compete with drinking the sucrose solution. Presenting the sucrose in a new context, then, might produce a reduction in the amount consumed simply because the new contextual cues are still capable of evoking competing responses.

Finally, any theory of habituation could explain the context specificity observed in this experiment by appealing to a process of generalization

decrement. Habituation could not be expected to transfer to a new context if the contextual change were to change radically the perceived properties of the target stimulus. Previous results on the effect of contextual change on neophobia are certainly open to explanation in these terms. Thus, the contextual manipulation used by Archer and Sjödén (1979) included presenting the target flavour in bottles having different spouts from those used in preexposure, a procedure likely to change some of the cues that constitute the complex referred to as "a flavour" (see also Holder, 1988; Sjödén & Archer, 1988).

We may conclude from the results of the present experiment only that our procedure is suitable for revealing effects that may be a consequence of relative novelty. To distinguish the relative novelty hypothesis from other possibilities requires further experimental work.

EXPERIMENT 2

In this experiment, as in Experiment 1, all subjects received initial exposure to sucrose in Context A followed by a test trial again in A (Group S), or in Context B (Group D). They also received, however, exposure to Context B prior to the test trial. Thus, although Group D received the test in a context other than that used for training, this test context was not novel. There was, therefore, no contrast in novelty between target and context, and the relative novelty account predicts that the UR will not be evident on this test.

The result expected by the relative novelty theory can also be accommodated by some of the other interpretations considered above. According to the two-process theory, a familiar test context (even if it is not the one in which initial habituation training was given) should not be arousing and a habituated stimulus will remain ineffective. And the suggestion that the animals' tendency to explore a novel context limits the amount of sucrose solution they consume also leads to the conclusion that levels of consumption should be high when the test context is familiar and thus unlikely to evoke competing behaviour. Wagner's (1976) theory, on the other hand, predicts that the UR should be restored for Group D, in this experiment, just as in Experiment 1. There will be no associative link between the test context and the target stimulus, which will thus receive a full measure of processing.

Finally, a straightforward application of the generalization decrement account predicts that the UR will be restored in this experiment as in Experiment 1, provided it is assumed that the physical difference between the training and the test context is what is responsible for changing the way in which the target stimulus is perceived. It is possible, however, that

only when they are novel will the distinctive features of the test context be capable of inducing generalization decrement, and if so, habituation would be maintained.

Method

The subjects were 16 male hooded (Lister) rats with a mean free-feeding weight of 395 g (range: 335–435 g). The rats had previously taken part in a study of appetitive conditioning but were naive with respect to the procedures of the present experiment. The apparatus was that used in Experiment 1.

On each day of the experiment the subjects received two 30-min sessions, one at 1100 and one at 1500, one in the large cage and one in the small cage. To maintain comparability with Experiment 1, each session again consisted of two 15-min presentations; but again, data from only the first of these presentations will be considered. On the first day of the study subjects were presented with tap water during each of the two sessions. On the subsequent six days they were given access to tap water in one of the contexts and to sucrose in the other. The context in which the subjects received sucrose will be referred to as Context A; that in which they received water will be called Context B. For half the subjects Context A was presented in the morning and Context B in the afternoon; for the remainder the arrangement was reversed. Half experienced the large cages as the A context and half the small cages.

On the final, test, day of the experiment, subjects were given one session in each of the contexts, A and B. The subjects in Group S were given access to sucrose in Context A and tap water in Context B, whereas subjects in Group D received access to water in Context A and sucrose in Context B.

Details of the experimental procedure that have not been specified were identical to those described for Experiment 1.

Results and Discussion

Figure 2 shows the amount of sucrose consumed during the first 15 min of each of the training sessions (in two-session blocks). As in Experiment 1, sucrose consumption increased over the course of training. There was no obvious difference between the groups, which had been treated identically during this stage. An ANOVA conducted with group (S or D), context (large or small), and block as factors substantiated this description of the results. Thus there was an effect of block, $F(2, 24) = 49.63$, $p < 0.01$, no effect of group or of context, and no interactions among these factors [largest $F(2, 24) = 1.62$].

The points on the right-hand side of the figure represent the amount of

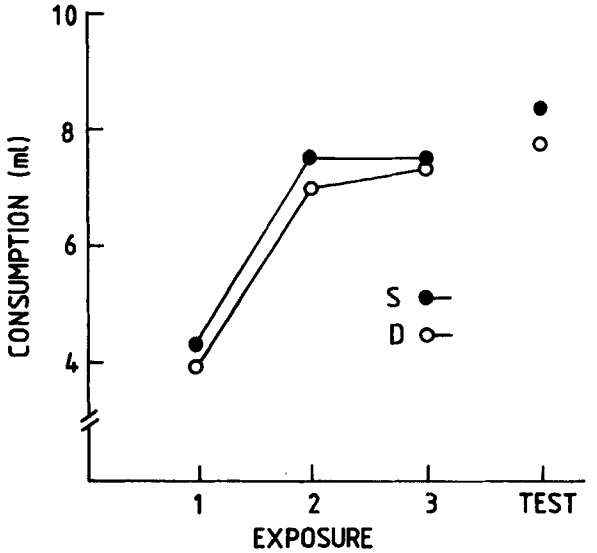

FIG. 2. Experiment 2: Group mean consumption of a sucrose solution during exposure (2-session blocks) and a single test session occurring in the same context as was used for exposure (Group S) or in a different context (Group D). All subjects experienced both contexts during the exposure phase.

sucrose consumed during the first 15 min of the test session. It is clear that Groups S and D did not differ. As in Experiment 1, test consumption was expressed as a difference score with respect to consumption on the final block of training. The mean difference score for Group S was 0.91 ml; that for Group D 0.05 ml. An ANOVA with group (S or D) and test context (large or small) as factors revealed no significant main effect and no interaction between the factors [largest $F(1, 12) = 1.14$].

In Experiment 1 the increase in consumption of sucrose produced by experience of it in one context was eliminated when the sucrose was presented in a different novel context. In Experiment 2, however, the effects of habituation training transferred without loss to a different context. The main difference between Experiments 1 and 2 was that in the former, Group D were tested in a novel context, whereas in the latter the test context had been familiarized during training. This finding is exactly analogous to one reported previously by Hall and Channell (1985). They demonstrated that habituation of the orienting response shown by rats to a light transferred to a different test context when that context was familiar but was restored when the test context was itself novel. It also accords with a result reported by Domjan (1976), who found the return of neophobia to a flavour experienced in a training context when the flavour was

subsequently presented in the home cage. Discussion of the implications of these findings will be postponed until the next experiment has been described.

EXPERIMENT 3

Taken together, Experiments 1 and 2 show that neophobia will return with a change of test context only when the test context is itself novel. Given the potential theoretical significance of this finding, it seemed worthwhile to attempt to confirm its reliability by demonstrating, in a single study, the effects seen separately in Experiments 1 and 2. Accordingly, this experiment included four groups of subjects: S1 and D1 experienced just one context during pre-exposure (as in Experiment 1); Groups S2 and D2 had experience of both contexts (as in Experiment 2). In addition, some procedural changes were made. (1) The flavour used was saccharin rather than sucrose, thus allowing us to be sure that the effects of interest are not unique to sucrose but can be found in a training preparation more widely used in studies of flavour neophobia (see, e.g., Domjan, 1977). (2) Water bottles were not available for Groups S2 and D2 during their sessions of familiarization with the second context. This procedure was introduced to eliminate the possibility that Groups D1 and D2 might differ in their test performance simply because D2 had had a chance to learn the whereabouts of the drinking spouts in the test context, whereas D1 had not.

Method

The subjects were 32 male hooded rats with a mean free-feeding body weight of 420 g (range: 325–505 g). They were naive with respect to the stimuli and procedures to be used. The apparatus was that employed in the previous experiments, with the exception that the bedding used in the smaller cages was commercially obtained cat litter rather than wood-shavings. The flavoured solution used was of sodium saccharin at 2 g/litre. In order to ensure that this solution would be consumed in adequate quantities, a regime of water deprivation was initiated two days prior to the start of exposure to the training contexts, access to water being allowed in the home cages for two 15-min periods at approximately 1100 and 1700 each day. Home-cage presentations of water at 1700 were maintained throughout the experiment.

For training, the subjects were divided into four equal-sized groups. Those in Groups S2 and D2 received two 30-min sessions each day, one at 1100 and one at 1200, one in Context A and one in Context B. Drinking bottles were present for 15 min during sessions in Context A. On the first day the bottles contained water; for the next six days they contained the

saccharin solution. For half of each group, the fluid was given on the first of the daily sessions, for the remainder on the second session. For half of each of these groups the large cage was used for the first session and the small cage for the second; for the remaining subjects, this arrangement was reversed. Groups S1 and D1 received the same training as Groups S2 and D2, except for the omission of the daily session in Context B.

On the test day, Groups S1 and S2 received sessions identical to those given during training. Subjects in Group D2 were given two sessions as before, but the saccharin was presented in Context B rather than in Context A. Subjects in Group D1 received a single session in which they were given access to saccharin in the novel context.

Results and Discussion

Figure 3 shows the mean amount of saccharin consumed in Context A during two-sessions blocks of training. The increase in consumption from the first to the last block is consistent with the occurrence of neophobia and its habituation. There were no obvious differences among the groups; in particular, the groups that also received a daily session in Context B showed much the same level of consumption as the groups that did not. An ANOVA was conducted on the scores summarized in the figure with group, context (large or small cage), and block as the factors. This showed

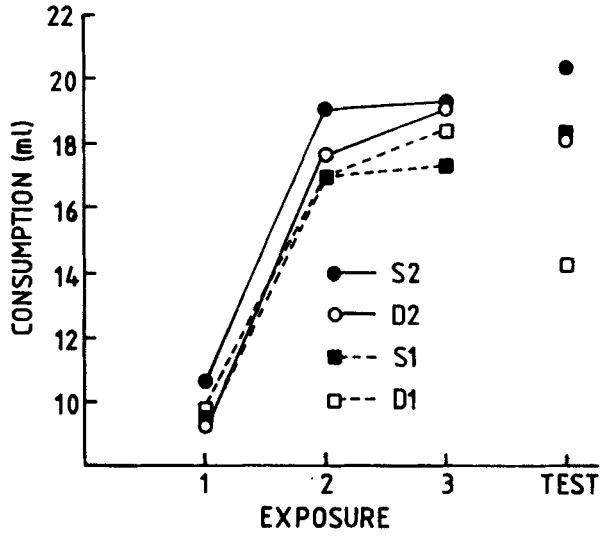

FIG. 3. Experiment 3: Group mean consumption of a saccharin solution during 2-session blocks of exposure and a test session given either in the same context as used for exposure (S groups) or a different context (D groups). Groups S2 and D2 experienced the test context during the exposure phase; Groups S1 and D1 did not.

there to be a significant effect of block, $F(2, 48) = 139.442$, $p < 0.01$. No other effects or interactions were significant (largest $F = 1.61$), apart from a Cage Size × Block interaction, $F(2, 48) = 3.68$, $p < 0.05$. This interaction reflects the fact that the tendency to consume more in the small cages was evident only on the first block of training (the mean consumption on this block in the small cages was 10.83 ml and in the large cages 8.72 ml; on each of the next two blocks the difference between the corresponding means was less than 1 ml).

The test results (the isolated points on the right of the figure) showed that consumption levels were maintained in all groups apart from Group D1. Difference scores (test consumption minus consumption on the last block) for the groups were: 1.55 for Group S2, −0.78 for Group D2, 2.46 for Group S1, and −5.73 for Group D1. An ANOVA was conducted on these scores, the factors being which cage was used for the test (large or small), the relationship between the training and the test context (same or different), and whether or not prior exposure had been given to the test context. This revealed a main effect of the S/D factor, $F(1, 24) = 17.51$, $p < 0.01$, and a significant interaction between this factor and whether or not the test context was familiar, $F(1, 24) = 5.48$, $p < 0.05$. No other effects or interactions reached significance (largest $F = 3.17$). The nature of the significant interaction was explored by applying Tukey's test to the test means. This showed that Group D1 differed (at $p < 0.05$) from each of the other three groups, which did not differ among themselves. We may conclude, in line with the findings of Experiments 1 and 2, that the effects of habituation training will transfer perfectly well to a different context when that context is familiar, but not when it is novel.

The failure of a change of context to affect habituation in Group D2 (and in Experiment 2) means that the context sensitivity evident in Group D1 (and in Experiment 1) is not to be explained as a simple case of generalization decrement in which the physical characteristics of the two contexts influence the perceived characteristics of the flavour. It also appears to render untenable the explanation for context dependence offered by Wagner's (1976) theory of habituation. If habituation depends on the existence of an association between the context and the stimulus, then dishabituation should occur with a change of context, both when the test context is novel and when it is familiar.

The absence of dishabituation in Group D2 is of theoretical significance, however, only if we can be sure that the two contexts used are discriminable to rats. The effectiveness of the change of context for Group D1 provides some evidence on this matter, but it cannot prove that the contexts retained their discriminability under the rather different conditions of training experienced by the S2 and D2 groups. To obtain more direct evidence, Groups S2 and D2 were given further training designed to establish an

aversion to saccharin. Group S2 received this training in Context A, the context in which pre-exposure to saccharin had been given; Group D2 in Context B, the context in which saccharin had been encountered only on the test session. On the day after the test, all subjects were given 10 ml of saccharin, followed by an intraperitoneal injection of 0.3 *M* LiCl at 10 ml/kg body weight. After a recovery day spent in the home cage, they were given access to saccharin for 15 min on each of the next five days. A further LiCl injection followed the first of these trials. The mean amount of saccharin consumed over these five sessions was 7.68 ml for Group S2 and 4.40 ml for Group D2. Although the difference between these scores fell short of statistical significance [$F(1, 14) = 2.93$, $p > 0.10$], the direction of the effect is just what would be expected if the initial phase of training produced a latent inhibition effect specific to the context in which pre-exposure had taken place (see, Hall & Channell, 1986). Such context specificity could not have been found, of course, if subjects in Groups S2 and D2 had been unable to discriminate between the two contexts.

Although the pattern of results obtained here (and in Experiments 1 and 2) appears to rule out Wagner's (1976) associative account, it is quite consistent with the other theories considered above. The relative novelty interpretation predicts that the UR will be restored in Group D1 but not in D2, as there will be no contrast in novelty between the target stimulus and the context in the latter case. The version of the two-process account outlined above implies that a change of contextual cues will be effective in enhancing the magnitude of an habituated response only when those cues are novel and arousing. And competing exploratory responses evoked by contextual cues may occur only when the context is novel and not when it is familiar. Experiment 4 includes an attempt to distinguish among these theoretical possibilities.

EXPERIMENT 4

So far we have considered only how the novelty or familiarity of contextual cues will interact with a familiar target stimulus in determining the amount of the test solution that is consumed. In this experiment we extend the analysis to include the effects of contextual factors on the response to a novel target. The notion of relative novelty predicts that a novel stimulus in a familiar context should be especially effective at evoking its UR because of the contrast in novelty between stimulus and context. Consumption of the test solution should therefore be slight. But if competing responses evoked by contextual cues are of critical importance in determining the amount consumed, then familiarizing the subject with the test context should result in more being consumed, whether the flavour is novel or familiar. According to S–R theory, a novel stimulus should evoke its

UR wherever it occurs, and little of the sucrose should be consumed in either test context. Whether or not the higher level of arousal provoked by the novel test context would enhance the neophobia observed there is not clear, as it is possible that the effects of arousal may be evident only on an S–R pathway that has suffered some loss of effectiveness.

Experiment 4 employed a factorial design in which the two factors were test context novelty and test stimulus novelty. The general procedures used were the same as for Experiments 1 and 2. One pair of groups matched those studied in Experiment 1 (and thus provide us with a further opportunity of replicating the results of that experiment). Thus, Group S received pre-exposure to sucrose in Context A and was tested in this same context. Group D received identical pre-exposure but a test in the novel B context. The two remaining groups, Groups S–N and D–N, received the same training as Groups S and D, respectively, but were not given habituation training with the test stimulus. For Group S–N, therefore, the test context, A, was familiar and the test stimulus was novel, whereas for Group D–N both the test context and the stimulus were novel.

Method

The subjects were 32 male hooded (Lister) rats with a mean free-feeding weight of 350 g (range: 300–415 g). The experiment was performed in two replications, with 16 rats in each. The rats had previously taken part in a study of appetitive conditioning. The apparatus was that used in Experiment 1.

On the first six days of the study all subjects were put in Context A, where those in Groups S and D received presentations of sucrose, whereas those in Groups S–N and D–N were given access to water. On the following day, in an attempt to ensure that they would readily locate the spouts on the test session, all subjects received a single session in which they were given access to water in the test context. For Groups S and S–N this was Context A, and for Groups D and D–N this was Context B. On the following day the subjects were again placed into the test context, and all were given sucrose. In this experiment the large cages were used as the test context for all animals; thus Groups S and S–N received training in the large cages, and Groups D and D–N were given training in the small cages. All other details of the experiment were identical to those described for Experiment 1.

Results and Discussion

The mean quantity of sucrose consumed by Groups S and D during the first 15 min of each of the training sessions (in two-session blocks) is shown in Figure 4. Also shown is the amount consumed by each group on the

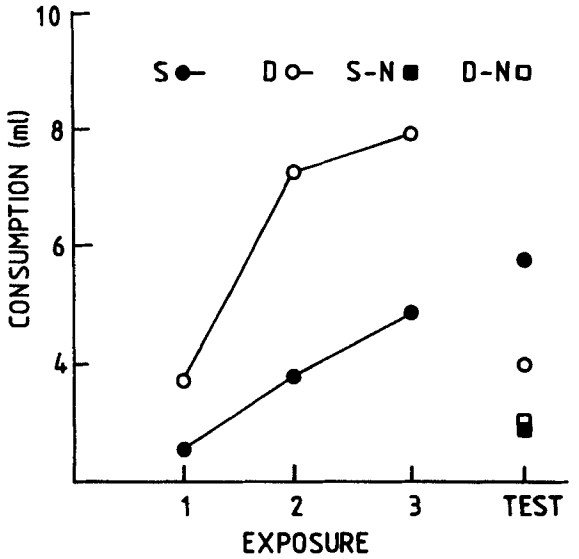

FIG. 4. Experiment 4: Group mean consumption of a sucrose solution during 2-session blocks of pre-exposure and a test session. Groups S and D received the same treatment as the equivalent groups of Experiment 1. Group S–N experienced sucrose for the first time at test in a familiar context; Group D–N experienced sucrose for the first time at test in a novel context.

final test session. It is apparent that during the initial days of training subjects in Groups S and D consumed relatively little sucrose, but that subsequently they came to consume it more readily. As in Experiment 1, subjects that received sucrose presentations in the small cages (Group D) consumed more than those that received sucrose in the large cages (Group S). Statistical analysis confirmed this description of the results. An ANOVA with group (S or D) and block as the factors revealed an effect of group, $F(1, 14) = 10.25$, $p < 0.01$, and an effect of block, $F(2, 28) = 17.66$, $p < 0.01$, and no significant interaction [$F(2, 28) = 2.32$].

This difference in consumption between Groups S and D complicates matters a little, but it seems unlikely that it can be responsible for the test results. The extra consumption in Group D might be expected to result in more profound habituation, but, as the points on the right-hand side of the figure show, these subjects showed a marked return of neophobia, whereas those in Group S did not. Comparing consumption of sucrose on the test with that recorded for the last block of training yielded a mean difference score of −3.97 ml for Group D. The equivalent score for Group S was 0.87 ml. Statistical analysis of these scores revealed that the groups

differed reliably, $F(1, 14) = 9.87$, $p < 0.01$. The two remaining points on the right of Figure 4 represent the test performance of Groups S–N and D–N. These groups consumed less sucrose than did either of the other groups. They did not, however, differ from one another in the amount they consumed on the test ($F < 1$)—the rats were equally likely to consume the novel sucrose, whether it was presented in a familiar or a novel context. It should be added that every subject consumed at least some of the sucrose (the smallest quantity consumed by any subject was 1.5 ml).

The results for Groups S and D replicate those of Experiment 1. Consumption of sucrose increased across a series of presentations in one context but was reduced when the sucrose was subsequently presented in another context. This finding may be interpreted as showing that a stimulus having relative novelty is capable of evoking neophobia; but the new findings of Experiment 4, for Groups S–N and D–N, argue against any simple version of this interpretation. Both these groups experienced sucrose for the first time at test, Group S–N in a familiar context and Group D–N in a novel context, but they did not differ in the amount they consumed in spite of the fact that for Group S–N the sucrose possessed relative novelty, whereas for Group D–N it did not.

This pattern of results is also incompatible with the suggestion that test consumption is not a consequence of flavour neophobia and its habituation but is determined solely by the extent to which the context is novel and likely to evoke competing responses. This view implies that consumption of sucrose should be less in a novel than in a familiar context, whether or not the sucrose is itself novel—not the result that was found. This is not to say that competing responses play no role at all. It could still be that competing responses evoked by the test context are important in lowering the level of consumption shown on test by Group D. (The failure to find a difference between Groups S–N and D–N may mean only that the levels of consumption were already so low as to make it impossible to detect an additional effect of competing responses in Group D–N.) But the fact that test performance depends on the novelty (or lack of it) of both context and stimulus means that competing responses evoked by the former cannot be the *sole* source of these effects.

Two-process theory can explain the difference between Group S and Group D by supposing that even an habituated stimulus will be capable of evoking its response when the arousal level is high. In order to explain the lack of a difference between Groups S–N and D–N, it is necessary to suppose that only when the effectiveness of the S–R pathway has been reduced will the arousal generated by a novel test context be of importance. The status of the context will thus be important when the sucrose has been pre-exposed, but neophobia can be expected both in Group S–N and in Group D–N.

GENERAL DISCUSSION

The experiments reported here show that the neophobia evoked by a flavoured solution will habituate over repeated presentations but will reappear when the now-familiar flavour is presented in a novel test context (Experiments 1, 3, and 4). Neophobia does not return, however, when the test context, although different from that used for habituation training, is one with which the animal is familiar (Experiments 2 and 3). The novelty of the test context does not influence the magnitude of the initial neophobic response. Experiment 4 showed that a novel stimulus in a familiar context evoked much the same response as the same stimulus presented in a novel context.

The results of the first three experiments add to the growing list of findings (see Hall & Honey, 1989; Hall, 1991) suggesting that in appropriate testing conditions (i.e. when the test context is familiar and does not induce generalization decrement) habituation will transfer readily across contexts. Given that other phenomena such as latent inhibition and perhaps conditioning itself (Hall & Honey, 1989) show context specificity in such conditions, this finding has implications for our understanding of these phenomena. In particular, it implies that habituation and latent inhibition are unlikely to be products of the same underlying mechanism, a conclusion that presents a special difficulty for Wagner's (1976) attempt to explain both in terms of the formation of a context–stimulus association.

The currently dominant non-associative account of habituation is that provided by Groves and Thompson's (1970) two-process theory. This theory can accommodate the effects of contextual factors by postulating that novel contextual cues will raise levels of arousal. Enhanced arousal might allow even an habituated stimulus to evoke its response when the contextual cues are quite novel; and the assumption that the effects of increased arousal will be evident only when habituation has already reduced the effectiveness of the S–R pathway allows an explanation for the finding (Experiment 4) that response to a quite novel test stimulus is unaffected by the familiarity or novelty of the test context. Although this analysis has been presented in terms of the effects of contextual cues on arousal, it should be noted that much the same conclusions emerge if it is supposed that novel contextual cues evoke competing responses whereas familiar ones do not. We have already argued that the habituation of responses to contextual cues cannot be the sole explanation of the effects reported here; but they could well play a role as a second process, modulating the performance that is primarily determined by the habituation of an S–R pathway involving the target stimulus.

The results of Experiment 4 run contrary to any simple version of the suggestion that a UR will be particularly marked when there is a contrast

in novelty between the stimulus and the context in which the stimulus is presented. It should be acknowledged, however, that a more elaborate version of the relative novelty theory might be able to deal not only with the results of the present Experiment 4 but also with results from related experiments reported previously.

Experiment 4 produced results in accord with those of previous experiments using similar procedures. Hall and Channell (1986, Experiment 2) and Kurz and Levitsky (1982) monitored the consumption of a flavoured solution by rats in a novel or familiar context. Both studies found that, although consumption was somewhat less in a novel context, there was no effect of whether or not the flavour had been experienced previously. But a study of the orienting response by Hall and Channell (1985) produced a quite different result. Rats showed a particularly high level of orienting to a light when this stimulus was novel and was presented in an environment with which they were fully familiar, a result subsequently confirmed by Hall and Schachtman (1987). This last result is what would be expected on the basis of relative novelty; but equally (and this was the explanation offered by Hall and Schachtman, 1987) it might reflect the low level of competing exploratory responding evoked by the familiar test context. And, of course, the novel light in the familiar context might have evoked a high level of response both because competing responses had been habituated and also because the target stimulus possessed relative novelty.

If both factors do indeed operate, then an explanation for the results of the S–N and D–N groups of Experiment 4 emerges. Here the effect of relative novelty will be to enhance neophobia and thus suppress consumption of the target solution. But the absence of competing responses in the familiar test context would tend to increase the amount consumed. These two factors could cancel out, leaving the level of consumption much the same as that seen in subjects tested in the novel environment. Some support for this analysis comes from a study by Mitchell, Winter, and Moffitt (1980). They gave rats a choice between water and a novel saccharin solution either in a very familiar context (cages in which they had lived for 30 days) or in one that was less familiar (cages in which they had lived for only five days). Animals tested in the familiar environment were much less ready to choose the saccharin—that is, neophobia was more evident in this condition. If this "two-bottle" test procedure acts to reduce or eliminate the role of competing responses, then it might be expected that the relative novelty effect would be revealed, producing the result obtained.

There is nothing in our data to rule out the elaborated version of the relative novelty theory that has just been discussed. But considerations of parsimony might be taken to favour the explanation derived above from the two-process theory. For in order to apply this version of the relative novelty account to our data, it is necessary to assume that the overall result

is determined both by a relative novelty effect and by the state of habituation of competing responses evoked by the context. It becomes necessary, therefore, to offer some explanation for the latter phenomenon. Such habituation is conveniently explained in terms of our standard theories of habituation (accounts that do not use the notion of relative novelty) and accordingly it seems economical to attempt to explain all the phenomena, including those that seem to imply a role for relative novelty, in terms of one of these theories.

REFERENCES

Archer, T., & Sjödén, P.O. (1979). Neophobia in taste-aversion conditioning: Individual differences and effects of contextual changes. *Physiological Psychology, 7*, 364–369.

Archer, T., Sjödén, P.O., & Nilsson, L.G. (1985). Contextual control of taste-aversion conditioning and extinction. In P.D. Balsam & A. Tomie (Eds.), *Context and learning* (pp. 225–271). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Baker, A.G., & Mercier, P. (1982). Prior experience with the conditioning events: Evidence for a rich cognitive representation. In M.L. Commons, R.J. Herrnstein, & A.R. Wagner (Eds.), *Quantitative analyses of behaviour, Vol. 3* (pp. 117–143). Cambridge, MA: Ballinger.

Berlyne, D.E. (1960). *Conflict, arousal, and curiosity*. New York: McGraw-Hill.

Domjan, M. (1976). Determinants of the enhancement of flavored-water intake by prior exposure. *Journal of Experimental Psychology: Animal Behavior Processes, 2*, 17–27.

Domjan, M. (1977). Attenuation and enhancement of neophobia for edible substances. In L.M. Barker, M.R. Best, & M. Domjan (Eds.), *Learning mechanisms in food selection* (pp. 151–179). Waco, TX: Baylor University Press.

Evans, J.G.M., & Hammond, G.R. (1983). Differential generalization of habituation across contexts as a function of stimulus significance. *Animal Learning and Behavior, 11*, 431–434.

Groves, P.M., & Thompson, R.F. (1970). Habituation: A dual-process theory. *Psychological Review, 77*, 419–450.

Hall, G. (1991). *Perceptual and associative learning*. Oxford: Clarendon Press.

Hall, G., & Channell, S. (1985). Differential effects of contextual change on latent inhibition and on the habituation of an orienting response. *Journal of Experimental Psychology: Animal Behavior Processes, 11*, 470–481.

Hall, G., & Channell, S. (1986). Context specificity of latent inhibition in taste aversion learning. *Quarterly Journal of Experimental Psychology, 38B*, 121–139.

Hall, G., & Honey, R.C. (1989). Contextual effects in conditioning, latent inhibition, and habituation: Associative and retrieval functions of contextual cues. *Journal of Experimental Psychology: Animal Behavior Processes, 15*, 232–241.

Hall, G., & Schachtman, T.R. (1987). Differential effects of a retention interval on latent inhibition and the habituation of an orienting response. *Animal Learning and Behavior, 15*, 76–82.

Holder, M.D. (1988). Possible role of confounded taste stimuli in conditioned taste aversions. *Animal Learning and Behavior, 16*, 231–234.

Kurz, E.M., & Levitsky, D.A. (1982). Novelty of contextual cues in taste-aversion learning. *Animal Learning and Behavior, 10*, 229–232.

Leaton, R.N. (1974). Long-term retention of the habituation of lick suppression in rats. *Journal of Comparative and Physiological Psychology, 87*, 1157–1164.

Lubow, R.E., Rifkin, B., & Alek, M. (1976). The context effect: The relationship between stimulus preexposure and environmental preexposure determines subsequent learning. *Journal of Experimental Psychology: Animal Behavior Processes, 2,* 38–47.

Marlin, N.A., & Miller, R.R. (1981). Associations to contextual stimuli as a determinant of long-term habituation. *Journal of Experimental Psychology: Animal Behavior Processes, 7,* 313–333.

Mitchell, D., Kirschbaum, E.H., & Perry, R.L. (1975). Effects of neophobia and habituation on the poison-induced avoidance of exteroceptive stimuli in the rat. *Journal of Experimental Psychology: Animal Behavior Processes, 1,* 47–55.

Mitchell, D., Winter, W., & Moffitt, T. (1980). Cross-modality contrast: Exteroceptive context habituation enhances taste neophobia and conditioned taste aversions. *Animal Learning and Behavior, 8,* 524–528.

Sjödén, P.O., & Archer, T. (1988). Exteroceptive cues in taste-aversion learning, no artifact: Reply to Holder. *Animal Learning and Behaviour, 16,* 235–239.

Sokolov, Y.N. (1963). *Perception and the conditioned reflex.* Oxford: Pergamon Press.

Wagner, A.R. (1976). An information processing mechanism for self-generated or retrieval-generated depression in performance. In T.J. Tighe & R.N. Leaton (Eds.), *Habituation: Perspectives from child development, animal behavior, and neurophysiology* (pp. 95–128). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

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Facteurs contextuels lors de la néophobie et de son habituation: le rôle de la nouveauté absolue et relative

Au cours de 4 expériences, nous avons examiné le rôle des indices contextuels dans l'habituation de la néophobie chez le rat. L'expérience 1 a montré que la consommation d'une substance ayant une saveur nouvelle augmentait au cours d'une série de présentations dans un contexte (A), mais diminuait quand la saveur était ensuite présentée dans un second contexte (B), nouveau. Dans les expériences 2 et 3, les sujets étaient encore exposés à une saveur dans le contexte A, mais étaient également familiarisés avec le contexte de test B. Ces sujets avaient un comportement consommatoire tout aussi élevé, que la saveur soit présentée dans le contexte A ou dans le contexte B, lors du test. Dans l'expérience 4, les mêmes résultats que ceux de l'expérience 1 sont retrouvés. Il y est également mis en évidence que la consommation d'une substance ayant une saveur nouvelle n'est pas influencée par le fait qu'elle ait été présentée dans un contexte nouveau ou familier. Les différents mécanismes par lesquels la nouveauté ou la familiarité du contexte pourrait interagir avec la nouveauté ou la familiarité d'une saveur sont discutés.

Factores contextuales en la neofobia y si habituación: el rol de novedad absoluta y relativa

En cuatro experimentos se investigó el rol de factores contextuales en la habituación de la neofobia en ratas. El experimento 1 mostró que la consumición de un sabor nuevo aumentó a lo largo de una serie de presentaciones en un contexto (A), pero disminuyó cuando el sabor fue presentado en un segundo, nuevo, contexto (B). En los experimentos 2 y 3, los sujetos nuevamente recibieron exposición a un sabor en el contexto A, pero también fueron familiarizados con el contexto

de prueba B. Estos sujetos consumieron el sabor igualmente en el contexto A que en el B. El experimento 4 reprodujo los resultados del experimento 1 y mostró además que la consumición de un sabor nuevo no dependió de que la presentación haya sido en un contexto nuevo o familiar. Se discuten varios mecanismos por los que la novedad y la familiaridad del contexto pueden interactuar con la novedad o familaridad del sabor.