The Role of Elements Common to the Preexposed Stimuli in the Perceptual Learning Effect

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Abstract

Rats were given exposure to two compound flavour stimuli (AX and BX), presented either on alternate trials (for the intermixed group) or on separate blocks of trials (for the blocked group). Previous work has shown generalization between AX and BX to be less after intermixed than after blocked preexposure – the perceptual learning effect. The present experiments tested the effect of these preexposure schedules on the properties of the X element. Three measures were used: The magnitude of unconditioned response elicited by X; the ability of X to interfere with the conditioned response controlled by another stimulus; the readiness with which X acquired strength when used as a conditioned stimulus. None of these measures revealed any reliable difference between groups given the different forms of preexposure. It was concluded that change in the perceptual effectiveness of the common X element is not responsible for the perceptual learning effect observed with these preexposure procedures.

The Role of Elements Common to the Preexposed Stimuli in the Perceptual Learning Effect

According to Gibson (1969) appropriately scheduled exposure to a pair of similar stimuli will enhance their discriminability, and will do so for two main reasons. First it will enhance the perceptual effectiveness (what Hall, 2003, refers to as the effective salience) of the distinctive feature or features that each stimulus will possess; second, it will reduce the perceptual effectiveness of those features that the stimuli hold in common. Over recent years, we (e.g., Mondragón & Hall, 2002; Symonds & Hall, 1995) and others (e.g., Bennett & Mackintosh, 1999) have investigated this proposal in experiments with rats as the subjects and flavours as the stimuli. The flavours used have been compounds, to be referred to as AX and BX, where A and B are distinctive features, and X a feature they hold in common. Preexposure in which these two compounds are presented in alternation enhances their discriminability, as is evidenced by the fact that an aversion conditioned to one of them (AX) generalizes only poorly to the other (BX). This outcome is anticipated by Gibson's analysis. Generalization from AX to BX will be determined primarily by the associative strength acquired by X. If the preexposure reduces the effective salience of X then X will be less able to acquire strength during conditioning with AX, and the response to BX will be correspondingly restricted. Heightened sensitivity to A will also contribute to the effect by virtue of the fact that the salient A element will be able to overshadow acquisition by the X element during conditioning. And the presence of the salient B element during the test with the BX compound is likely to interfere with perception of the X element and further limit its ability to evoke the conditioned response (CR).

Analysis of this procedure has confirmed the suggestion that this form of preexposure enhances the effective salience of the unique features of the stimuli. Three lines of evidence may be cited. First it has been shown (Blair, Wilkinson, & Hall, 2004, Experiment 3; Mondragón & Hall, 2002, Experiment 4) that after such preexposure the unique feature (i.e., A or B) is learned about readily when it used as the conditioned stimulus (CS) in flavour aversion learning. In the study by Mondragón and Hall, comparison was made with the performance of a control group that had received the AX and BX trials in separate blocks during preexposure, rather than in alternation. Acquisition of the aversion to A proceeded more rapidly in the alternating group than in the blocked group. Blair et al. used a within-subject design in which the rats received preexposure to a block of CX trials in addition to alternating trials with AX and BX. Different groups then received conditioning with A (or B) as the CS or with C as the CS, and the former learned more readily than the latter.

Second, tests of the ability of the unique feature to evoke its unconditioned response (UR) have shown that this is maintained by the intermixed preexposure procedure. Blair et al. (2004, Experiment 1), gave rats alternating presentations of AX and BX, and a block of CX trials. For half the subjects A was a quinine solution and for half C was the quinine solution, a substance that, when first presented, tends to be rejected even by a thirsty rat. When, after preexposure, the rats were tested with quinine presented alone, those in the former condition showed a stronger rejection response than those in the latter condition. Blair et al. suggested that exposure to quinine normally produces a loss of effective salience and, with it, a diminution in the UR of rejection. Intermixed preexposure, however, tends to maintain the effective salience of the quinine and thus the UR,

Third, a unique feature that has been experienced during intermixed preexposure has been shown to retain the ability to interfere with the CR controlled by some other stimulus. Blair and Hall (2003, Experiment 5) gave rats alternating trials with AX and BX, and a separate block of trials with CX. They then conditioned an aversion to another stimulus, Y, and tested the rats with compounds BY and CY. They found that the rats consumed more of BY than of CY, a result consistent with the view that the effective salience of B was greater than that of C.

Much less attention has been paid to the other aspect of Gibson's (1969) account – the proposal that the perceptual effectiveness of common elements will be reduced by preexposure (a proposal that amounts, in the experimental paradigm being considered here, to the prediction that intermixed preexposure to AX and BX will reduce the effective salience of the X element). Such experiments as have been done have produced only rather limited support for this prediction. Both Bennett and Mackintosh (1999, Experiment 1c) and Mondragón and Hall (2002, Experiment 2) gave different groups of rats either intermixed or blocked presentations of AX and BX prior to conditioning trials with X alone as the CS. In neither experiment was there a difference between the groups in the course of acquisition of the aversion. But Mondragón and Hall went on to give further test sessions in which X was presented in extinction, and in these the aversion of the blocked group was found to be more sustained than that shown by the intermixed group. This observation leaves open the possibility that the effective salience of X was indeed lower in the intermixed than in the blocked group but that the test supplied by the conditioning procedure was not sensitive enough to detect the difference.

In order to investigate this matter further it is necessary to make use of other tests that, we may hope, will be more sensitive to the salience of the X element. This

is what we attempted in the experiments to be reported here. In all of them, one group (intermixed) received alternating presentations of the compound AX and BX; a second group (blocked) received a block of AX and a block of BX trials in preexposure. The properties of the X element were then assessed by means of the tests that have been shown to be effective in revealing differences in the effective salience of the unique stimulus elements. Thus in our first experiment we chose an X element (quinine) that evokes a marked UR and measured this for the two groups in a test in which X was presented alone. In our next experiment we tested the ability of X to interfere with the CR controlled by another stimulus, by establishing an aversion to Y and testing with the compound XY. Finally, we tested the ability of X to acquire strength as a CS, choosing conditioning parameters designed to ensure that acquisition would proceed slowly, allowing any difference between the groups in rate of acquisition to show itself.

Experiments 1a and 1b

The flavours used as stimuli in these experiments were the same as those used by Blair et al. (2004) in their investigation of the effect of preexposure on the UR evoked by a distinctive element. In this case, however, the target flavour (quinine) was used as the X element. All subjects received the same number of preexposures to X, presented in compound with either A or B. Half received these in the intermixed and half in the blocked arrangement. All then received a test with X presented alone. If the effective salience of X is less after intermixed than after blocked preexposure, we expect that subjects given the former schedule would drink more on test than those given the latter.

In Experiment 1a, preexposure trials were given at one per day for both groups, the arrangement used by Symonds and Hall (1995) in their demonstration of the

perceptual learning effect. In Experiment 1b two trials per day were given, the arrangement used by Mondragón and Hall (2002) in their study of perceptual learning. (Blair et al., 2004, also gave two trials a day in their study of the effects of preexposure on the UR.)

Method

Subjects and apparatus. The subjects for Experiment 1a were 16 naive male hooded Lister rats. A further 16 were used in Experiment 1b. They had a mean ad lib weight of 505 g at the start of experimentation. The rats were singly housed with continuous access to food in a colony room that was artificially lit from 8:00 a.m. to 8:00 p.m. each day. Access to water was restricted as detailed below.

The solutions used as experimental stimuli were administered in the home cages at room temperature in 50-ml plastic centrifuge tubes, each equipped with a rubber stopper to which was fitted a stainless steel, ball-bearing tipped spout. The following flavoured solutions were used: .00003 M quinine sulphate; a compound consisting of .00003 M quinine sulphate and .16 M saline (NaCl); a compound of .00003 M quinine sulphate and .165 M sucrose. Consumption was measured by weighing the tubes before and after trials, to the nearest 0.1 g

Procedure. In both experiments a schedule of water deprivation was initiated by removing the standard water bottles overnight. On each of the following three days access to water was restricted to two daily sessions of 30 min, at 11:00 a.m. and 5:00 p.m. Presentation of fluids continued to be given at these times daily throughout the experiments.

Over the next 8 days (the preexposure phase) all subjects in Experiment 1a received presentations of 10 ml of a flavoured solution at 11:00 a.m. The compounds AX and BX were presented on alternate trials. Water was made available in the

afternoon drinking sessions. For subjects in the intermixed group the compounds AX and BX were presented on alternate trials in the morning sessions; subjects in the blocked group received presentations of AX on the first four sessions and of BX on the last four. For all subjects, X was quinine, A and B were salt and sucrose (counterbalanced). In the morning session of day following the end of preexposure, all subjects were given free access to flavour X for 30 min.

The procedure for Experiment 1b was the same as that just described except that the preexposure phase lasted for four days, with flavoured solutions being given in both morning and afternoon drinking sessions.

Results and Discussion

There was evidence, in Experiment 1a, of neophobia on the first trial of the preexposure phase, but thereafter the rats consumed almost all the fluid offered (about 9 ml – the structure of the drinking tubes made it difficult for the rat to extract the last drop of the 10 ml). Thus the blocked group drank a mean of 3.5 ml (range: 1.5 – 5.9 ml) on the first preexposure trial with AX, but drank a mean of 8.6 ml on the second trial. The change from the AX to the BX compound on Day 5 of preexposure did not reinstate neophobia: Group mean consumption was 8.9 ml on this trial. On Day 1 the intermixed group drank a mean of 3.3 ml (range 1.6 – 4.9 ml) of AX; on the second presentation of AX (Day 3) the group mean was 9.3 ml. On Day 2 (the first presentation of BX), the group mean was 7.0 ml. Figure 1 (left panel) shows the group mean scores for the test trial with flavour X (quinine). There was no sign of a difference between the two groups, an impression confirmed by statistical analysis ($F < 1$).

The pattern of consumption during preexposure in Experiment 1b was similar to that observed in Experiment 1a, apart from the fact that consumption was low, not

only on the first trial, but also on the afternoon trial of Day 1. The group mean for the blocked group was 5.2 ml (range 2.8 – 6.3 ml) on the first trial with AX, and was 6.2 ml (2.6 – 9.5 ml) on the second (afternoon) trial. On the morning trial of Day 2 the mean score was 9.0 ml. Consumption on the first trial with BX (the morning of Day 3 of preexposure) was also 9.0 ml. For the intermixed group the mean consumption score for the first trial was 5.6 ml (4.5 - 8.7 ml) and for the afternoon trial of Day 1 (with BX) was 4.4 ml (2.2 – 6.5 ml). The mean score for the first trial of Day 2 was 9.1 ml. Levels of consumption on the test with X presented alone (right panel of Figure 1) were somewhat lower than in Experiment 1a, but again there was no difference between the groups ($F < 1$).

In our previous work (Blair et al., 2004) we have shown that the UR to a quinine solution can be modulated by the preexposure schedule when quinine serves as one of the unique stimulus features. The present experiments provided no evidence for such modulation when quinine was used as the common (X) feature during preexposure – rats that experienced X during blocked presentations of AX and BX drank the quinine as readily as those that experienced intermixed AX and BX presentations in preexposure. It should be noted, however, that making quinine the common feature meant that it was presented eight times (on each of the four AX and four BX trials) whereas when it was used as a unique feature in the experiment by Blair et al., it was presented only four times. This raises the possibility that habituation was more profound in the present experiments and that a “floor effect” might have occurred, obscuring a difference between the groups that would have been evident after less preexposure.

We chose to give four trials each of AX and BX in the present experiments as this is the preexposure regime known to be effective in producing the perceptual

learning effect. None the less, we thought it worthwhile to examine the effect on the X element of giving less preexposure. Accordingly, we have conducted a further study that was an exact replication of Experiment 2b apart from the fact that we gave only two trials each with AX and BX in preexposure. The test with X alone again revealed no difference between the groups: The mean consumption score for the intermixed group was 10.9 ml and for the blocked group was 10.6 ml. These scores did not differ reliably ($F < 1$). If the effective salience of X is in fact different after these two forms of preexposure, the test used in the present experiment is evidently not sensitive enough to detect it. Experiment 2 made use of a different measure.

Experiments 2a and 2b

Blair and Hall (2003) made use of a superimposition test to assess the effective salience of preexposed flavour stimuli. After the preexposure phase, the rats received aversion conditioning with a novel flavour as the CS. The test consisted of presenting this CS in compound with one of the unique features of the preexposed stimuli. It was found that the aversion was reduced when the superimposed feature was one presumed to be high in its effective salience. In the present experiment we made use of this same technique to assess the effective salience of the X element. Rats received either intermixed or blocked preexposure to AX and BX; they then received aversion conditioning with a novel flavour (Y) as the CS, followed by a test with the XY compound. If X is less salient after intermixed than after blocked preexposure we would expect consumption on test to be less in the former group than in the latter. In Experiment 2a we used saline as the X element and solutions of almond and vanilla as A and B. In Experiment 2b the flavours used as A, B, and X, were the same as those used by Mondragón and Hall (2002) in their demonstration of the perceptual learning effect.

Method

The subjects in Experiment 2a were 16 naive male hooded Lister rats, with a mean ad lib weight of 385 g at the start of the experiment; a further 16 from the same stock (mean ad lib weight: 400 g) were used in Experiment 2b. In Experiment 2a, flavour X was a .16 M saline solution, and flavour Y was .083 M sucrose. A and B (counterbalanced) were 1% vanilla (vol/vol; vanilla flavouring supplied by Supercook, Leeds, UK), and 2% almond (vol/vol; Supercook almond flavouring). In Experiment 2b flavour X was a .01 M solution of hydrochloric acid, and flavour Y was 1% vanilla. A and B (counterbalanced) were .33 M sucrose and .16 M saline. The US for both experiments was an intraperitoneal injection of .15 M lithium chloride (LiCl) at 10 ml/kg of body weight.

In both experiments the preexposure procedure was the same as that described for Experiment 1b, with half the animals experiencing the intermixed schedule, and half the blocked. The first conditioning trial was given in the morning session the day after preexposure ended. It consisted of a 30-min presentation of 10 ml of Y, followed immediately by an injection of LiCl. The rats were given free access to water in the afternoon session. The next day was a recovery day on which animals were given unrestricted access to water on both morning and afternoon drinking sessions. This procedure was repeated twice in Experiment 2a. Acquisition of the aversion occurred more rapidly in Experiment 2b (in which flavour Y was vanilla, rather than the sucrose used in Experiment 2a), and only one further conditioning trial was given.

Testing began on the morning session following the final recovery day. The rats were given free access to the XY compound for 30 min. Water was made available for half an hour in the afternoon session. There were four such test days in Experiment 2a. Consumption was more profoundly suppressed in Experiment 2b and

so, after six test trials, water was not provided in the afternoon of Day 6; this allowed enhanced levels of consumption to be observed in the tests given on Days 7and 8.

Results and Discussion

With the flavours used in Experiment 2a, there was no evidence of neophobia during preexposure. On the first preexposure trial, the intermixed group drank a mean of 9.3 ml and the blocked group a mean of 9.4 ml. These levels of consumption were maintained throughout the phase. On the first conditioning trial the intermixed group drank 9.4 ml of Y and the blocked group 9.3 ml. The equivalent scores for Trial 2 were 6.3ml and 3.8 ml. An ANOVA with group and trial as the variables showed there to be a significant effect of trial, $F(1, 14) = 37.94$. Neither the effect of group, $F(1, 14) = 2.91$, nor the interaction, $F(1, 14) = 3.23$, achieved significance.

The results for the test trials with the XY compound are shown in Figure 3. Consumption increased in both groups over the course of testing, presumably reflecting extinction of the conditioned aversion, but there was no indication of a difference between the groups. An ANOVA showed there to be a significant effect of trial, $F(3, 14) = 31.59$, but there was no effect of group, and no significant interaction (Fs < 1).

The results from Experiment 2b closely paralleled those for Experiment 1a. Again the subjects drank the solutions readily during preexposure; the intermixed group drank a mean of 9.2 ml on the first trial, and the blocked group a mean of 9.0 ml. Both groups drank a mean of 9.1 ml on the first conditioning trial. The scores for the second trial were 3.3 ml for the intermixed group and 1.8 ml for the blocked group. The effect of trial was significant, $F(1, 14) = 102.75$, but not the effect of group, $F(1, 14) = 1.30$, or the interaction, $F(1, 14) = 1.44$.

Figure 4 shows the results of the test trials with the XY compound. As has been noted, consumption remained very low over the first six trials and the figure shows group mean totals for these trials. The score for the intermixed group was somewhat less than that for the blocked group, but the difference between the groups was not statistically reliable ($F < 1$). Levels of consumption were higher for the tests given on trials 7 and 8 (the figure shows the group mean per trial), but again there was no significant difference between the groups ($F < 1$).

Previous work (Blair & Hall, 2003) suggests that a stimulus that is high in salience will detract from the conditioned response controlled by some other, separately trained, CS when the two are presented as a compound. The conclusion prompted by the present results, therefore, is that there is no marked difference between the intermixed and blocked groups in the effective salience of the X stimulus in the test phase of these experiments.

Experiments 3a and 3b

Perhaps the most straightforward method of assessing the salience of a stimulus is to use it as the CS in a conditioning procedure – the CR will be acquired more readily the more salient the CS. A possible problem, already noted, is that the conditioning procedures usually used in flavour aversion learning produce acquisition so rapid that differences between CSs may not be detectable. But this problem can easily be overcome by reducing the magnitude of the US -- Blair, Wilkinson, and Hall (2004, Experiment 3b), using an injection of LiCl at one-tenth the volume used in the present Experiment 2, demonstrated the gradual acquisition of an aversion over the course of eight trials. In Experiment 3a, therefore, we made use of this conditioning procedure to examine the acquisition of an aversion to stimulus X as the CS in animals given either intermixed or blocked preexposure to AX and BX.

In Experiment 3a we found, to anticipate, no difference between the blocked and intermixed groups. Accordingly, in Experiment 3b, we reverted to the conditioning parameters used by Mondragón and Hall (2002). With these, it will be recalled, there was no opportunity to see a difference between the groups during acquisition, but a difference emerged during test trials given in extinction. This test procedure was used in Experiment 3b.

Method

The subjects in Experiment 3a were 16 male hooded Lister rats (mean ad lib weight 330 g) that had previously served in an appetitively reinforced, operant conditioning procedure. A further 16 rats from the same stock (mean ad lib weight 384 g) were used in Experiment 3b. In both experiments the flavours used as the stimuli were the same as those described for Experiment 2b (and the same as those used by Mondragón & Hall, 2002); thus A and B were saline and sucrose (counterbalanced), and X was acid. The preexposure procedure was identical to that described for Experiment 2, with half the rats receiving intermixed presentations of AX and BX, and half receiving blocked presentations.

On the morning session of the day following the end of preexposure, subjects in Experiment 3a received a test trial consisting of free access to flavour X for 30 min. This allowed a further test of the hypothesis investigated in Experiment 1 – that the UR to X might differ between the two groups. There followed six conditioning trials. On the first the subjects were given access to 10 ml of X for 30 min; on subsequent trials they were given free access to X for 30 min. The US was an intraperitoneal injection of .15 M LiCl at 1 ml/kg. Water was made available in the afternoon sessions. In Experiment 3b, preexposure was followed immediately by three conditioning trials, each followed by a recovery day. On the first they were given

access to 10 ml of X for 30 min; thereafter they were given free access for 30 min. The US was an injection of .15 M LiCl at 10 ml/kg. Following the last recovery day, all subjects received daily tests consisting of free access to flavour X in the morning sessions. Water was given in the afternoon drinking sessions. In the experiment by Mondragón and Hall (2002) on which Experiment 3b was based, there were four such test sessions. In the present experiment. Suppression of consumption was more profound than in the earlier study, and it was necessary to give six test sessions for consumption to rise to the levels reported by Mondragón and Hall.

Procedural details not specified here were the same as those described for Experiments 1 and 2.

Results and Discussion

In both experiments the animals drank the full amount of fluid offered throughout the preexposure phase. In the absence of initial neophobia it could not be expected that the test with X alone given in Experiment 3a would reveal a difference between the groups in the degree to which neophobia was restored. On this test the group mean consumption score was 10.2 ml for the intermixed group and 12.2 ml for the blocked group; these scores did not differ significantly, $F(1, 14) = 3.48$.

The results for the conditioning phase of Experiment 3a (group means for consumption of X) are shown in Figure 3. It is evident that our conditioning procedure was effective in producing a gradual decline in consumption; also that there was no difference between the groups in the rate at which they acquired the aversion. An ANOVA with group and trial as the variables produced a significant effect only of trial, $F(5, 65) = 36.84$ (other Fs < 1).

The three conditioning trials of Experiment 3b produced a substantial aversion in both groups (group means are shown in Figure 4). The blocked group drank

slightly more than the intermixed group on Trials 2 and 3, but the difference between the groups was not reliable. An ANOVA conducted on the data for these trials produced only a significant effect of trial, $F(2, 28) = 142.64$; for the effect of group, $F(1, 14) = 3.08$, and for the interaction, $F(2, 28) = 1.63$. The modest difference between the groups was maintained as consumption increased over the course of the six extinction test trials (Figure 4), but again it was not statistically reliable; there was a significant main effect of trial, $F(5, 70) = 15.13$, but not of group, $F(1, 14) = 1.95$, or of the interaction between these variables ($F < 1$).

The failure to find a reliable difference between the groups in the extinction in Experiment 3b accords with the results of the conditioning phase (and with the results of Experiment 3a). It conflicts, however, with the results reported by Mondragón and Hall (2002) who, in the study on which Experiment 3b was based, found consumption to be significantly lower, on test, in the blocked than in the intermixed group. We are unable to account for this discrepancy – Experiment 3b was, as near as we could make it, an exact replication of the Mondragón and Hall experiment. A reexamination of the data for the latter experiment revealed only one difference. Although all the rats drank all the fluid presented on the first trial of the preexposure phase there was (for some unknown reason – the rats were randomly assigned to the experimental conditions) a dip in consumption on the afternoon trial of Day 1 in the intermixed group. The group means for Trial 1 were both 9.1 ml; for Trial 2 they were 9.36 ml and 7.6 ml. The latter difference was statistically reliable, $F(1, 14) = 14.75$. A similar pattern was seen on Day 2 of preexposure. We cannot account for this effect (which was not present in the new experiments reported here). We can only speculate that, in the Mondragón and Hall study, rats that were relatively unwilling to drink flavoured solutions were assigned, by chance, predominantly to the intermixed group. A reemergence of this

tendency during the test might thus account for the results obtained in that experiment.

General Discussion

In the experiments reported here, rats were given alternating trials of preexposure to the compounds AX and BX, a procedure that, as we argued in the Introduction, enhances the effective salience of the unique stimulus elements. This effect is consistent with Gibson's (1969) stimulus differentiation account of perceptual learning. Gibson's account also implies that this form of preexposure will lead to a reduction in the effective salience of common stimulus elements, that do not distinguish between the stimuli (i.e., of X, in this case). Our present experiments tested this latter proposal and found no evidence to support it. We tested the effective salience of X in three ways: By the strength of the UR it evoked; by its ability to interfere with the CR evoked by another CS; by its ability to serve as a CS. In no case were the properties of X after alternating preexposure different from those seen after preexposure in a control condition (in which AX and BX were presented, not in alternation, but in separate blocks of trials).

This is not to say that X was quite uninfluenced by the preexposure. It is likely that in both preexposure conditions habituation would have occurred, producing a loss of effective salience in both. And, to the extent that latent inhibition involves a process different from that involved in habituation (see Hall, 1991), X would have suffered latent inhibition in both conditions. The important point is that these changes were not influenced by the schedule of preexposure, and may be assumed to have occurred to the same extent in both the intermixed and blocked condition.

Although the results reported here are uniformly negative as regards (one aspect of) Gibson's (1969) account, they do have a positive implication. Specifically

they simplify the picture for those who are trying to devise a theoretical account of the mechanisms responsible for perceptual learning —the theorist needs to devise a mechanism for increasing (or maintaining) effective salience but need not devise one for producing a reduction. This conclusion is encouraging for those (e.g., Hall, 2003; McLaren & Mackintosh, 2000) who are developing theories that have just this property.

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Figure Captions

Figure 1. Experiment 1: Group mean scores for consumption of flavour X (quinine) in rats given preexposure to the compounds AX and BX, either intermixed or in separate blocks of trials. In Experiment 1a, one exposure trials was given each day; in Experiment 1b there were two trials a day. The vertical bars represent the standard errors of the means (SEMs).

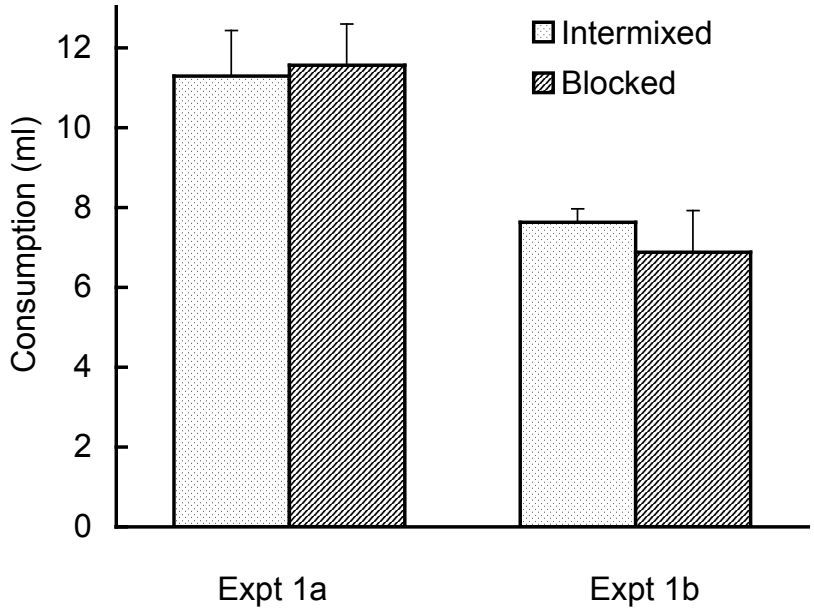
Figure 2. Experiment 2a: Group mean consumption of the compound flavour XY. Y had been trained as a CS. The intermixed group had been preexposed to alternating trials of AX and BX; the blocked group had received separate blocks of trials with AX and BX. Y was a sucrose solution and X was saline. Vertical bars represent SEMs.

Figure 3. Experiment 2b: Group mean consumption of the compound flavour XY. Y had been trained as a CS. The intermixed group had been preexposed to alternating trials of AX and BX; the blocked group had received separate blocks of trials with AX and BX. Y was a vanilla solution and X was acid. Vertical bars represent SEMs. The pooled results for the first 6 test trials are shown on the left; daily means for the last two test days are shown on the right.

Figure 4. Experiment 3a: Group mean consumption of flavour X during aversion conditioning with X as the CS. The intermixed group had been preexposed to alternating trials of AX and BX; the blocked group had received separate blocks of trials with AX and BX. Vertical bars represent SEMs.

Figure 5. Experiment 3b: Group mean consumption of flavour X during three trials of aversion conditioning with X as the C, followed by six nonreinforced test trials. The intermixed group had been preexposed to alternating trials of AX and BX;

the blocked group had received separate blocks of trials with AX and BX. Vertical bars represent SEMs.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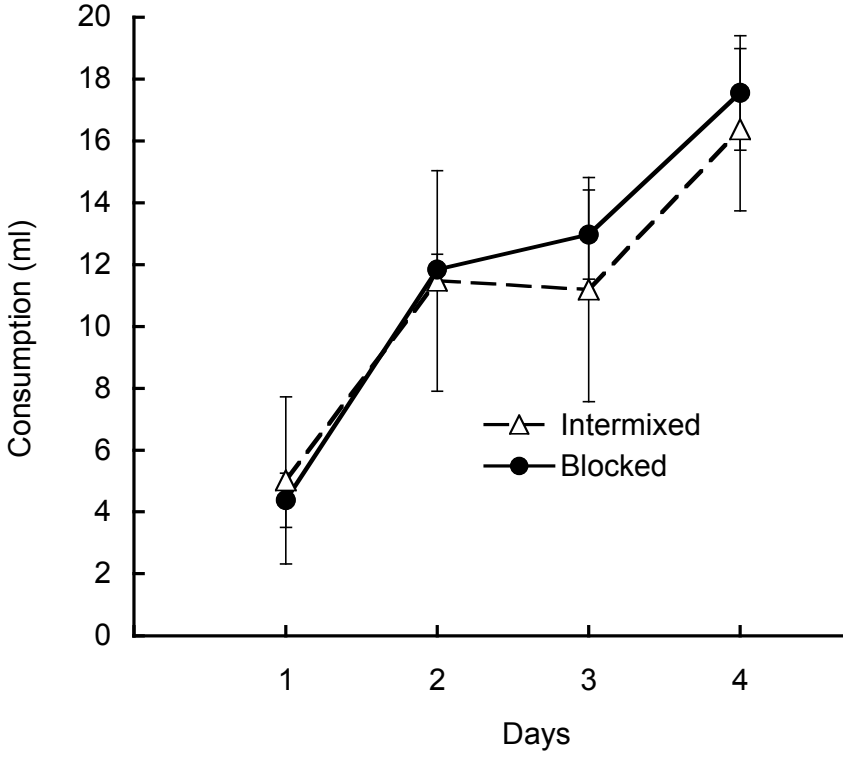
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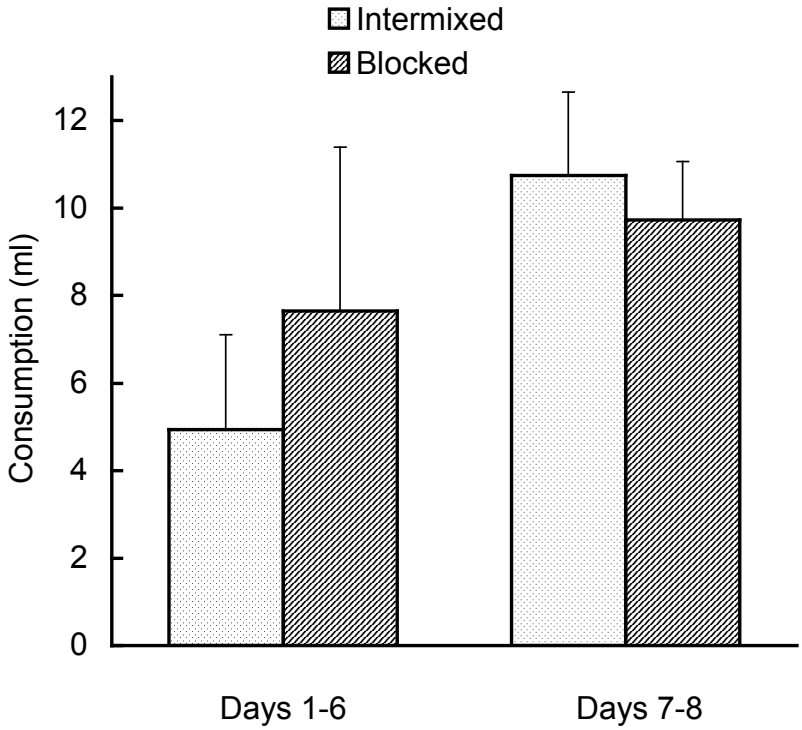
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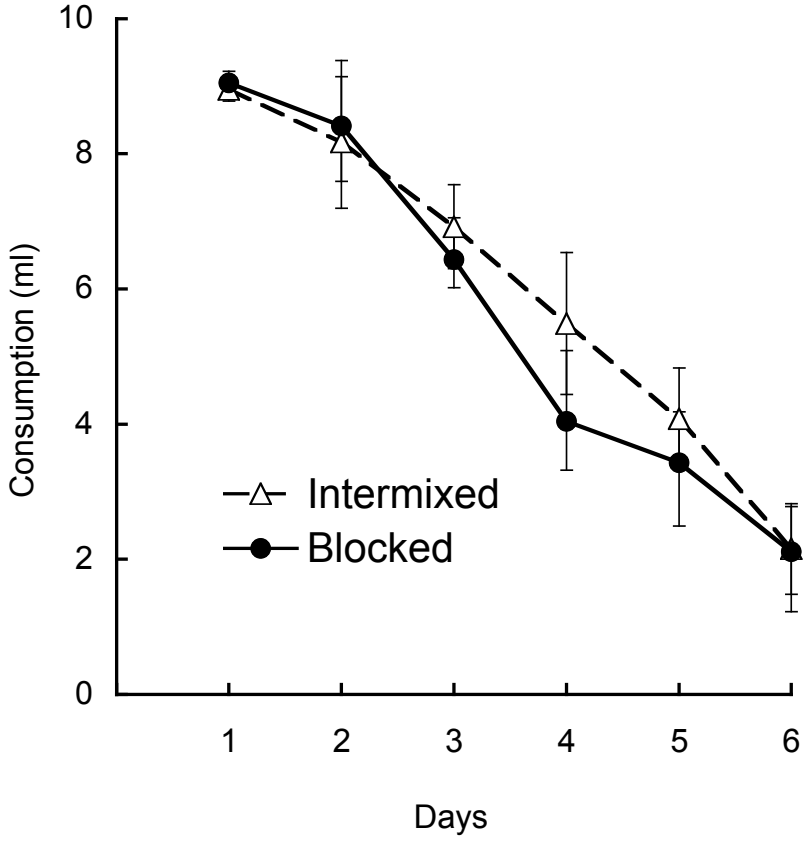
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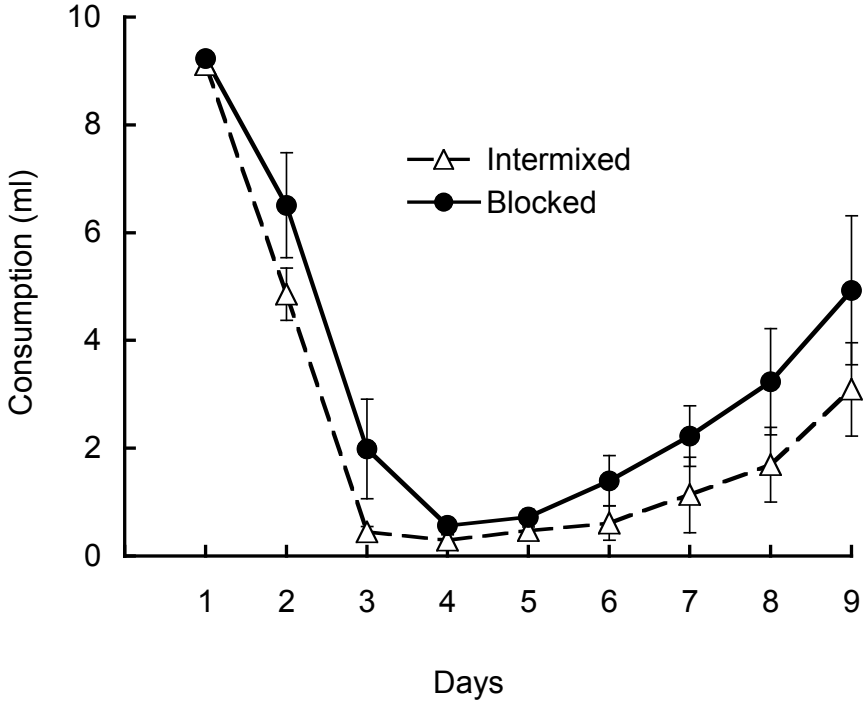
6
Days


10
8
6
4
2
0
Consumption (ml)
Intermixed
Blocked
1
2
3
4
5
6
7
8
9
Days