Journal of Comparative Psychology
1985, Vol. 99, No. 4, 403–410

0735-7036/85/$00.75

Avfail in Color Avoidance Learning by Starlings (*Sturnus vulgaris*) and Red-Winged Blackbirds (*Agelaius phoeniceus*)

J. Russell Mason
Monell Chemical Senses Center
Philadelphia, Pennsylvania,
and Department of Biology
University of Pennsylvania

Adam H. Arzt
Monell Chemical Senses Center
Philadelphia, Pennsylvania

Russell F. Reidinger
U.S. Fish and Wildlife Service
Denver Wildlife Research Center, Lakewood, Colorado

Certain unconditioned stimuli (UCS) in flavor avoidance learning sometimes become ineffective after pairings with relatively stronger UCS. This failure of avoidance learning (avfail) has been demonstrated only with rodents. The present investigations were conducted to determine whether avfail might also occur with avian species, the food selection of which is guided primarily by visual cues. In Experiment 1, starlings were given pairings of methiocarb (a relatively weak UCS) and LiCl (a relatively strong UCS). In Experiment 2, red-winged blackbirds were given pairings of two concentrations of methiocarb (relatively weak and relatively strong UCS, respectively). Pairings were followed by a conditioning trial (UCS gavage in the presence of a color cue) and two-choice tests. Conditioned avoidance was always observed except (a) when methiocarb preceded LiCl and (b) when the low preceded the high methiocarb dose in preconditioning pairings. Experiment 3 demonstrated that UCS habituation could not account for the results of Experiments 1 and 2. The data reflect avfail in the visual modality, and a biological implication of the results is that birds may not learn strong avoidance of aposematic prey containing varied levels of toxicant.

Pentobarbital normally elicits weak, easily extinguished conditioned flavor avoidance, whereas lithium chloride usually is a more effective unconditioned stimulus (UCS). When pentobarbital precedes LiCl administration, one reasonable prediction (Revusky, Taukulis, & Peddle, 1979) is that pentobarbital will become a more effective UCS because it elicits conditioned lithium sickness (Parker, 1979) that summates with the mild sickness normally produced by pentobarbital. The opposite frequently occurs, and pentobarbital loses its capacity to produce any measurable flavor avoidance (Revusky, Taukulis, Parker, & Coombes, 1979; Revusky, Taukulis, & Peddle, 1979). This phenomenon, termed *avfail*, has been demonstrated with a number of drug–drug pairings (Revusky, Coombes, & Pohl, 1982).

Explanations of avfail include the development of conditioned inhibition (Revusky, Taukulis, & Peddle, 1979; Taukulis & Revusky, 1975) and the development of a conditioned antisickness response (e.g., Lett, 1983). The former hypothesis has been discarded for two reasons. First, conditioned stimuli in the avfail procedure do not show the usual properties of a conditioned inhibitor (e.g., measurable increases in preference). Second, avfail occurs with

The research was broadly supported by the U.S. Fish and Wildlife Service, and it was supported in part by U.S. Army Research Office Grant DAAG29-82-K-0192, National Science Foundation Grant BNS-8310892, and National Institute of Neurological and Communicative Disorders and Stroke Grant NS19424-01 to J. R. Mason.

The authors thank Lincoln P. Brower, J. Jay Braun, Lowell T. Nicolaus, and Samuel Revusky for their insightful criticism of previous drafts of this manuscript.

Requests for reprints should be sent to J. Russell Mason, Monell Chemical Senses Center, 3500 Market Street, Philadelphia, Pennsylvania 19104.

intervals up to 320 min between daily preconditioning injections (Revusky & Coombes, 1982; Revusky, Taukulis, & Peddle, 1979). Unlike conditioned inhibition, the conditioned antisickness hypothesis has received some experimental support (Lett, 1983). In brief, this hypothesis maintains that avfail occurs because the pairing of a weak toxicant with a stronger one during preconditioning enables the weak toxicant to evoke a conditioned antisickness response in anticipation of sickness produced by the strong toxicant. Thus, on the day of conditioning, administration of the weak toxicant evokes the conditioned antisickness response, and that, in turn, makes it ineffective in producing flavor avoidance learning.

To our knowledge, avfail has been demonstrated only in rodents. It is unclear whether the phenomenon can occur in species that, unlike the rat, select food mainly in terms of visual rather than flavor characteristics. Although raptors (*Buteo jamaicensis*—Brett, Hankins, & Garcia, 1976), chickens (*Gallus gallus*—Westbrook, Clarke, & Provost, 1980), and crows (*Corvus brachyrhynchos*—Nicolaus, Cassel, Carlson, & Gustavson, 1983) exhibit flavor-potentiated color avoidance learning, at least two avian species (i.e., European starlings [*Sturnus vulgaris*] and red-winged blackbirds [*Agelaius phoeniceus*]) learn color avoidance directly, without potentiation (e.g., Mason & Reidinger, 1983a, 1983c, 1984b).

In Experiment 1, starlings were given paired gavages of two toxicants that differed in their effectiveness as UCS. After five pairings, the birds were given one toxicant or the other in the presence of a color cue (CS+). (Throughout all experiments, all toxicants were given intragastrically.) Subsequently, the birds were given daily two-choice preference tests between the CS+ and another color (CS−).

Experiment 1

Method

Subjects. Twenty adult male European starlings (*Sturnus vulgaris*) were decoy-trapped in September the laboratory and individually housed (cage dimensions: 36 × 61 × 41 cm) in a room with an ambient temperature of 23 ± 2 °C. Each bird was visually isolated from the others (Mason & Reidinger, 1981). A 6:18 hr light/dark cycle was used to maximize feeding rates of the birds without reducing the total quantity of food consumed (Rogers, 1974). Water and grit were always available. Before the experiment began, the birds had free access to Purina Flight Bird Conditioner (PFBC) in unpainted metal food cups (7.5 cm in diameter).

Toxicants. Lithium chloride and methiocarb were used. Methiocarb [3,5 dimethyl-4-(methylthio)phenol methylcarbamate] is a commercially available bird repellent that reliably produces conditioned avoidance similar to, but more rapidly extinguishing than, that produced by LiCl (Mason & Reidinger, 1983c). Stock solutions were produced by dissolving 0.12 g of methiocarb or 1.5 g of LiCl in 100 ml of warmed propylene glycol.

Procedure. After 8 weeks of adaptation to the laboratory, the birds were randomly assigned to five groups (Figure 1). Each group was given 4 days of adaptation to a food deprivation regimen that remained in effect until completion of the experiment. Food was removed daily during the last hour of light and replaced during the second hour of the next light period. The only exceptions to this regimen were on treatment days and the day of conditioning, when food was replaced during the third hour of light (after birds had recovered from the observable effects of intubation).

All preconditioning toxicants were given during the first hour of light on Days 5, 7, 9, 11, and 13. The first gavage was followed 40 min later by the second. The interval between gavages and the number of toxicant pairings were selected on the basis of work by Revusky and Coombes (1982). The birds in the first group (Lm; $n = 4$) received LiCl (2 mg/kg) followed by methiocarb (2 mg/kg). These dose levels reliably produce color avoidance (Mason & Reidinger, 1983c). The second group (mL; $n = 4$) was given the opposite pairings. The third group (mP; $n = 4$) received methiocarb (2 mg/kg) followed by propylene glycol (1 ml/kg, a neutral vehicle), and the fourth group (LP; $n = 4$) received LiCl (2 mg/kg) followed by propylene glycol (1 ml/kg). The fifth group (PP; $n = 4$) was given paired gavages of propylene glycol (1 ml/kg). On Days 14–17, birds were deprived of food during the dark cycle, but otherwise were left undisturbed, to permit recovery from the effects of treatment.

During the first hour of light on Day 18, all birds were given green (CS+) food cups, each containing 20 g of PFBC. After the birds had consumed at least 1 g of PFBC, the cups were removed, and each bird was given a toxicant. Groups LP and Lm were given LiCl (2 mg/kg). Our prediction was that these birds would show conditioned color avoidance. Groups mP and mL were given methiocarb (2 mg/kg). We expected that mP birds would exhibit conditioned avoidance but that mL birds might not (which would suggest development of avfail). Group PP was given propylene glycol (1 ml/kg). We expected that these birds would not exhibit conditioned avoidance because they had not received

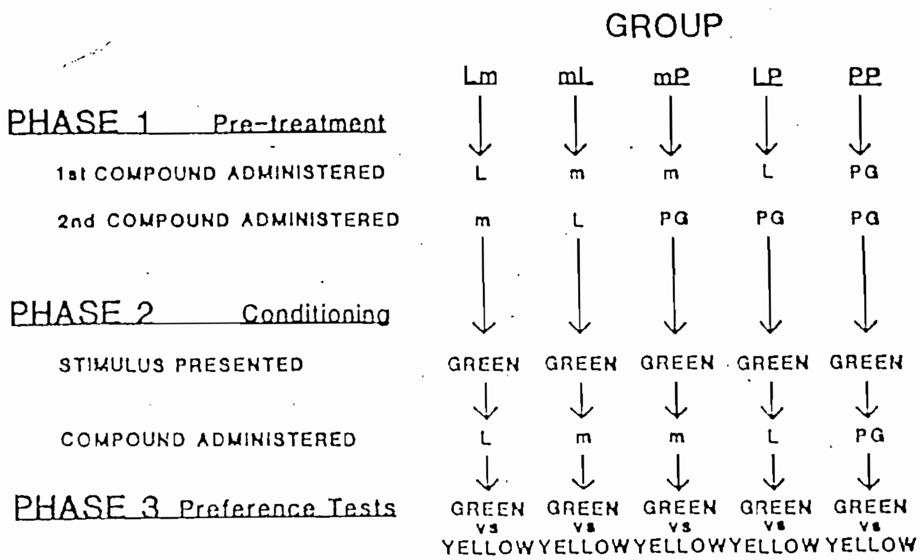

Figure 1. A schematic of the procedure used in Experiment 1. (Procedures used in Experiments 2 and 3 were similar to those depicted here. During pretreatment, Group Lm was given lithium chloride [L] followed by methiocarb [m]. Group mL was given opposite pairings. Group mP was given methiocarb and propylene glycol [PG]. Group LP was given L and then PG, and Group PP was given two gavages of PG. All groups were then given a conditioning trial in which green was paired with m, L, or PG gavage. Preference tests [green CS+ vs. yellow CS−] followed conditioning.)

Counterbalanced two-choice preference tests (Dragoin, McCleary, & McCleary, 1971) were given during the first hour of light on each of the 3 days following the day of conditioning. In these tests, each bird was presented with two food cups, each containing 20 g of PFBC. The two cups, one green (CS+) and the other yellow (CS−), were placed 5 cm apart at the center of the front of each cage. Consumption was measured after 1 hr. Spillage was not recorded because in all previous work it merely reflected consumption (e.g., Mason & Reidinger, 1983c).

The data were assessed by a three-factor analysis of variance (ANOVA) with repeated measures on two variables. The independent factor was groups (five levels), and the repeated factors were days (three levels) and consumption of CS+ versus CS− food (two levels). Tukey (b) post hoc comparisons (Winer, 1962) were used to identify significant differences among means.

Results

There were no significant differences in consumption across test days or between groups ($ps > .25$). However, there was a significant difference between consumption of food paired with CS+ and consumption of food paired with CS−, $F(1, 15) = 11.8$, $p < .01$, a significant two-way interaction between groups and days, $F(8, 30) = 9.6$, $p < .001$, and a significant three-way interaction between groups, days, and CS+ versus CS−, $F(8, 30) = 5.2$, $p < .001$.

Tukey comparisons revealed that all birds in Groups LP, mP, and Lm ate significantly less PFBC paired with CS+ than PFBC paired with CS− ($ps < .05$; Table 1). Groups mL and PP failed to exhibit differential consumption ($ps > .25$).

Discussion

The effectiveness of methiocarb as a UCS was decreased after preconditioning methiocarb–LiCl pairings (Group mL). Conversely, the effectiveness of lithium chloride as a UCS was not diminished by prior pairings with methiocarb (Group Lm). Pairings with propylene glycol did not

Table 1
Mean (± SE) CS+ and CS− Consumption (in g) in Experiment 1

Group	Conditioning toxicant	CS+ consumption	CS− consumption
Lm	L	0.31 ± 0.08	0.90 ± 0.15*
mL	m	0.81 ± 0.11	0.87 ± 0.20
mP	m	0.42 ± 0.10	0.98 ± 0.05*
LP	L	0.33 ± 0.18	0.99 ± 0.20*
PP	P	0.80 ± 0.23	0.74 ± 0.17

Note. L = lithium chloride; m = methiocarb; P = propylene glycol. CS− is the novel color.
* $p < .05$, compared with CS+ consumption.

change the effectiveness of either toxicant (Groups mP and LP, respectively). We inferred that the lack of differential consumption by Group mL was an indication of avfail in color avoidance learning.

For avfail to possess greater importance within an ecological context, we reasoned that it should occur when birds are administered varied amounts of a single toxicant. In nature, a bird would be likely to experience varying amounts of a single toxicant, as in the ingestion of a species of toxicant-containing prey (e.g., Fink & Brower, 1981). Also, we reasoned that if avfail were to have general importance, it should occur in learning by other avian species that use color cues for food selection. In Experiment 2, paired gavages of methiocarb were given to red-winged blackbirds, another passerine that exhibits visually mediated food avoidance learning (Mason & Reidinger, 1982, 1983b, 1983c, 1984a).

Experiment 2

Method

Subjects. Twenty adult male red-winged blackbirds (*Agelaius phoeniceus*) were decoy-trapped and adapted to the laboratory as the starlings were in Experiment 1.

Toxicants. Two concentrations of methiocarb were prepared by dissolving 0.12 g or 0.24 g of methiocarb in 100 ml of warmed propylene glycol. These methiocarb solutions are referred to as "low" and "high," respectively.

Procedure. Food deprivation, toxicant pairings, conditioning, and testing procedures followed the logic described in Experiment 1. Birds were randomly assigned to five groups, and the groups were administered the following paired gavages during pretreatment: Group Mm (n = 4), high methiocarb (4 mg/kg) followed by low methiocarb (2 mg/kg); Group mM (n = 4), low methiocarb followed by high methiocarb; Group mP (n = 4), low methiocarb followed by propylene glycol (1 ml/kg); Group MP (n = 4), high methiocarb followed by propylene glycol; Group PP (n = 4), propylene glycol followed by propylene glycol.

As in the previous experiment, a three-factor ANOVA with repeated measures on two variables was used. The factors in this analysis were identical to those previously described, with the exception that one of the repeated factors (days) had four (rather than three) levels. Tukey tests were used subsequently to identify significant differences between means.

Results

There were significant differences in overall consumption between groups, $F(4, 15) = 3.6, p < .05$, and across test days, $F(3, 45) = 8.1, p < .01$. Also, the two-way interaction between groups and CS+ versus CS− was significant $F(4, 15) = 4.6, p < .05$, as was the three-way interaction between groups, test days, and CS+ versus CS−, $F(12, 45) = 2.0, p < .05$.

Tukey comparisons revealed a pattern of results similar to that obtained in Experiment 1. Groups MP, mP, and Mm ate significantly less food paired with CS+ than with CS− on all test days ($ps < .05$; Table 2). Group mM exhibited a preference for CS+ ($p < .05$), and Group PP failed to exhibit differential consumption ($p > .25$).

Discussion

The results of Experiment 2 suggest avfail in yet another avian species, this time with two levels of a single toxicant. Specifically, a low dose of methiocarb failed to act as a UCS following preconditioning pairings with a higher dose. This result stands in contrast to the findings of Revusky et al. (1982), who paired low and high doses of amphetamine and failed to obtain avfail effects in rats. We speculate that this discrepancy may be due to differences in the toxicants used, species differences, or differences in taste versus color avoidance learning per se.

That Group mM exhibited a preference for CS+ is somewhat puzzling, and at least two explanations exist. One possibility is that this result may reflect an association of the CS+ and recovery from malaise produced by a conditioned antisickness response (Lett, 1983). Tangential support for this possibility is that avians sometimes

Table 2
Mean (± SE) CS+ and CS− Consumption (in g) in Experiment 2

Group	Conditioning toxicant	CS+ consumption	CS− consumption
Mm	M	0.34 ± 0.10	1.65 ± 0.09*
mM	m	0.88 ± 0.18	0.37 ± 0.08*
mP	m	0.54 ± 0.05	1.26 ± 0.09*
MP	M	0.39 ± 0.02	1.00 ± 0.05*
PP	P	0.91 ± 0.11	0.90 ± 0.13

Note. M = "high" methiocarb (4 mg/kg); m = "low" methiocarb (2 mg/kg); P = propylene glycol. CS− is the novel color.
* $p < .05$, compared with CS+ consumption.

prefer foods associated with recovery from malaise (e.g., Kare & Ficken, 1963). A second plausible explanation is that UCS habituation as a function of toxicant pairings (Braveman, 1977), and not avfail, may have been responsible for CS+ preferences; that is, the low dose of methiocarb may have become ineffective through habituation as a function of mM pairings, and birds may have shown preferences for the CS+ color merely because it was less novel than CS−.

This problem with UCS habituation as an alternative explanation of Experiment 2 also confounds interpretation of Experiment 1 (i.e., Group mL results). Consequently, Experiment 3 was performed to eliminate UCS habituation as an alternative. In this third investigation, we assessed whether LiCl in mL pairings, low methiocarb in Lm pairings, high methiocarb in mM pairings, and low methiocarb in Mm pairings retained their effectiveness as UCS concurrent with a loss of effectiveness by low methiocarb in mL or mM pairings. If obtained, this pattern of results would be inconsistent with UCS habituation, because habituation should decrease the effectiveness of both toxicants administered in preconditioning pairings.

Experiment 3

Method

Subjects. Twenty adult male starlings and 20 adult male red-winged blackbirds were individually housed and visually isolated as previously described. These birds were experimentally naive and were trapped at the same time and place as the birds used in Experiments 1 and 2.

Toxicants. A lithium chloride solution (1.5 g/100 ml of propylene glycol) and two methiocarb solutions (0.12 and 0.24 g/100 ml of propylene glycol) were prepared as previously described.

Procedure. All birds were adapted to food deprivation, and then each species was randomly assigned to two groups. One of the groups of starlings ($n = 8$) was given toxicant pairings identical to those described for starlings in Group Lm (Experiment 1). Likewise, one of the groups of red-wings ($n = 8$) was given toxicant pairings identical to those described for red-wings in Group Mm (Experiment 2). The remaining groups of starlings ($n = 12$) and red-wings ($n = 12$) were given toxicant pairings identical to those given starlings in Group mL (Experiment 1) or red-wings in Group mM (Experiment 2).

Each group was partitioned on the day of conditioning. For starlings in Group Lm, 4 birds were given food in a green cup (CS+) followed by LiCl (2 mg/kg). The remaining 4 birds in this group were given CS+ paired with methiocarb (2 mg/kg). Likewise for red-wings in Group Mm, half of the birds ($n = 4$) received CS+ paired with low methiocarb (2 mg/kg), and the remaining birds ($n = 4$) received CS+ paired with high methiocarb (4 mg/kg).

Groups mL ($n = 12$) and mM ($n = 12$) were each divided into three subgroups. For starlings in Group mL, 4 birds were conditioned with methiocarb, 4 with LiCl, and 4 were given paired gavages of LiCl and methiocarb. For red-wings in Group mM, 4 birds were conditioned with low methiocarb, 4 with high methiocarb, and 4 were given paired gavages of low and high methiocarb.

For all groups, two-choice tests were given on each of the 4 days following conditioning. Testing procedures were identical to those previously described.

Because avfail depends upon the sequence of training (i.e., "weak" before "strong" toxicants), we expected that all birds in Groups Lm and Mm would exhibit conditioned CS+ avoidance. Because the logic underlying interpretation of results from Group mL starlings and Group mM red-wings is identical, an explanation only for Group mL is presented below. We expected that the mL starlings conditioned with LiCl or paired toxicants would exhibit conditioned avoidance and that those conditioned with methiocarb would not, because LiCl was the relatively stronger UCS and should have been unaffected by toxicant pairings. In addition, if birds given paired toxicants exhibited weaker avoidance than birds given LiCl, then that might be taken as additional evidence for avfail (e.g., overall malaise might be lessened by a conditioned antisickness response).

As in the previous experiments, a three-factor ANOVA with repeated measures on two variables was used. The factors in this analysis were similar to those of Experiment 2 except that the independent factor (groups) had 10 levels (i.e., for the ANOVA, subgroups were treated as groups).

Results

There were no significant differences in consumption across test days ($p > .25$). However, there was a significant difference between consumption of food paired with CS+ and consumption of food paired with CS−, $F(1, 30) = 5.3$, $p < .05$, a significant two-way interaction between groups and test days, $F(27, 90) = 3.7$, $p < .01$, and a significant three-way interaction between groups, test days, and CS+ versus CS−, $F(27, 90) = 8.8$, $p < .02$.

Tukey tests revealed the following pattern of results for starlings that had been given preconditioning pairings of LiCl and methiocarb (Table 3). Lm birds conditioned with LiCl or low methiocarb, and mL birds conditioned with LiCl or paired toxicants, exhibited avoidance of CS+ ($ps < .05$). Conversely, mL birds conditioned

Table 3
Mean (± SE) CS+ and CS− Consumption (in g) in Experiment 3

Group	Conditioning toxicant	CS+ consumption	CS− consumption
Lm	L	0.45 ± 0.10	1.35 ± 0.36*
	m	0.51 ± 0.21	1.19 ± 0.15*
mL	m	0.77 ± 0.30	0.83 ± 0.12
	L	0.49 ± 0.20	1.32 ± 0.17*
	mL	0.15 ± 0.05	0.85 ± 0.20*
Mm	M	0.50 ± 0.20	1.17 ± 0.28*
	m	0.60 ± 0.12	1.16 ± 0.28*
mM	m	0.94 ± 0.11	0.58 ± 0.17*
	M	0.38 ± 0.05	0.93 ± 0.10*
	mM	0.11 ± 0.37	0.63 ± 0.10*

Note. L = lithium chloride; m = "low" methiocarb (2 mg/kg); M = "high" methiocarb (4 mg/kg).
* $p < .05$, compared with CS+ consumption.

with low methiocarb failed to show significant differential consumption ($p > .25$).

A similar pattern of results was obtained for red-wings that had received preconditioning pairings of low and high methiocarb. Specifically, all birds in Group Mm, and birds in Group mM conditioned with either high methiocarb or paired toxicants, exhibited avoidance of CS+ ($ps < .05$). Birds in Group mM conditioned with low methiocarb failed to show color avoidance and, as in Experiment 2, exhibited CS+ preferences ($p < .05$).

When the test performance of LiCl- and methiocarb-conditioned starlings was compared with that of red-wings given preconditioning pairings of methiocarb, no significant differences were obtained ($ps > .10$). Specifically, conditioned avoidance exhibited by Lm and Mm birds was similar, as was conditioned avoidance shown by mL and mM birds conditioned either with the stronger toxicant or with paired toxicants.

Discussion

The present results provide evidence that UCS habituation (i.e., decreases in the effectiveness of one UCS leading to decreases in the effectiveness of another; Braveman, 1977) cannot easily account for the results of Experiments 1 and 2. If habituation had been important, then methiocarb-conditioned Lm birds and low-methiocarb-conditioned Mm birds should have exhibited results similar to those of methiocarb-conditioned mL or low-methiocarb-conditioned mM birds. The results obtained were essentially opposite to this expectation. The effectiveness of methiocarb in mL pairings or low methiocarb in mM pairings was clearly dependent upon the sequence of methiocarb and LiCl pairings during pretreatment.

It is interesting that mM birds given the the low dose of methiocarb again exhibited a significant preference for CS+. This might be taken as additional evidence for association between the CS+ and recovery from malaise produced by a conditioned antisickness response. On the other hand, the results of Experiment 3 also provide weak evidence against conditioned antisickness responding as an explanation of avfail (at least in terms of color avoidance learning). Specifically, Lett (1983) suggested that an antisickness response could be inferred if the paired administration of toxicants (e.g., LiCl and methiocarb, or high and low methiocarb) produced weaker avoidance than administration of the stronger toxicant alone (e.g., LiCl or high methiocarb). We obtained no indication of such results. At least in terms of CS+ versus CS− consumption, there were no significant differences (a) between mL or Lm birds conditioned with LiCl and mL birds given paired conditioning toxicants or (b) between mM or Mm birds conditioned with high methiocarb and mM birds given paired conditioning toxicants. One possible reason for this discrepancy is that Lett more than halved the toxicant doses used for conditioning from those used during pretreatment pairings. If antisickness effects are dose dependent, then perhaps they would have been observed in the present experiment had lower doses of paired toxicants been used on the day of conditioning.

General Discussion

The results of the present experiments demonstrate that avfail can be obtained in color avoidance learning following pairings of different toxicants (methiocarb and LiCl). As such, the present findings are consistent with those of previous work (e.g., Revusky et al., 1982) and broaden the range of stimuli that can mediate avfail effects from flavor to vision. Moreover, the present experiments produced a new finding, in that avfail was obtained in color avoidance learning with two levels of a single toxicant (methiocarb). Previous work with flavor avoidance learning in rats failed to obtain this effect (Revusky et al., 1982). Although the reasons for this discrepancy are not clear, we speculate that it could reflect toxicant or species differences or, perhaps, differences in flavor versus color avoidance per se.

The fact that avfail was observed in two different species suggests that it may be a general effect in birds whose food selection is guided by color cues. It may also influence food selection by avians that exhibit taste-potentiated color avoidance learning (e.g., raptors—Brett et al., 1976; chickens—Westbrook et al., 1980; crows—Nicolaus et al., 1983), although further experimentation is necessary to document this point. One biological implication of our results is that some species of birds encountering aposematic prey that possess varying levels of a toxicant may not learn strong prey avoidance. Field observations may be consistent with this possibility. Black-backed orioles (*Icterus abeiller*) feed on wintering colonies of monarch butterflies (*Pheucticus melanocephalus*), even though they are not insensitive to the emetic effects of cardenolides which these insects sequester (Fink & Brower, 1981). Because the monarchs vary widely in the amount of cardenolides they contain (Fink & Brower, 1981), conditions favoring the development of avfail (as one component influencing the birds' responses) may exist. Just as pairings of different methiocarb concentrations attenuated the ability of methiocarb to produce color avoidance, experience with differing levels of cardenolides by the orioles may result in avfail and thus contribute as a factor leading to the observed failure in the monarch's normally effective automimicry.

References

Braveman, N. S. (1977). What studies on preexposure to pharmacological agents tell us about the nature of the aversion inducing agent. In L. M. Barker, M. R. Best, & M. Domjan (Eds.), *Learning mechanisms in food selection* (pp. 511–532). Waco, TX: Baylor University Press.

Brett, L. P., Hankins, W. G., & Garcia, J. (1976). Prey-lithium aversions: III. Buteo hawks. *Behavioral Biology*, *17*, 87–98.

Dragoin, W. B., McCleary, G. E., & McCleary, P. A. (1971). A comparison of two methods of measuring conditioned taste aversions. *Behavioral Research Methods & Instrumentation*, *3*, 309–310.

Fink, L. S., & Brower, L. P. (1981). Birds can overcome the cardenolide defense of monarch butterflies in Mexico. *Nature*, *291*, 67–70.

Kare, M. R., & Ficken, M. S. (1963). Comparative studies on the sense of taste. In Y. Zotterman (Ed.). *Olfaction and taste* (pp. 285–297). New York: Pergammon Press.

Lett, B. T. (1983). Pavlovian drug-sickness pairings result in the conditioning of an antisickness response. *Behavioral Neuroscience*, *97*, 779–784.

Mason, J. R., & Reidinger, R. F. (1981). Effects of social facilitation and observational learning on feeding behavior of the red-winged blackbird (*Agelaius phoeniceus*). *Auk*, *98*, 778–784.

Mason, J. R., & Reidinger, R. F. (1982). Observational learning of food aversions in red-winged blackbirds (*Agelaius phoeniceus*). *Auk*, *99*, 548–554.

Mason, J. R., & Reidinger, R. F. (1983a). Conspecific individual recognition among starlings after toxicant-induced sickness. *Animal Learning & Behavior*, *11*, 332–336.

Mason, J. R., & Reidinger, R. F. (1983b). Effect of color type generalization of and pre-exposure decrements in aversion learning by red-winged blackbirds (*Agelaius phoeniceus*). *Auk*, *100*, 461–468.

Mason, J. R., & Reidinger, R. F. (1983c). Importance of color for methiocarb-induced food aversions in red-winged blackbirds (*Agelaius phoeniceus*). *Journal of Wildlife Management*, *47*, 383–393.

Mason, J. R., & Reidinger, R. F. (1984a). Comparative assessment of food preferences and aversions acquired by observational learning. *Auk*, *101*, 796–803.

Mason, J. R., & Reidinger, R. F. (1984b). Influence of color and taste cues on bathing by starlings in appetitive and aversive contexts: Implications for animal damage control. In W.B. Jackson & B.J. Jackson (Eds.), *Proceedings of the Ninth Bird Control Seminar* (pp. 99–107). Bowling Green, OH: Bowling Green State University Press.

Nicolaus, L. K., Cassel, J. F., Carlson, R. B., & Gustavson, C. R. (1983). Taste-aversion conditioning of crows to control predation on eggs. *Science*, *220*, 212–214.

Parker, L. A. (1979). *Suppression of consummatory behavior elicited by a lithium conditioned flavor.* Unpublished doctoral dissertation, Memorial University, St. John's, Newfoundland.

Revusky, S., & Coombes, S. (1982). Long-delay associations between drug states produced in rats by injecting two drugs in sequence. *Journal of Comparative and Physiological Psychology*, *96*, 549–556.

Revusky, S., Coombes, S., & Pohl, R. W. (1982). Pharmacological generality of the Avfail effect. *Behavioral and Neural Biology*, *34*, 240–260.

Revusky, S., Taukulis, H. K., Parker, L. A., & Coombes, S. (1979). Chemical aversion therapy: Rat data suggest that it may be countertherapeutic to pair addictive drug state with sickness. *Behavioral Research and Therapy*, *17*, 177–188.

Revusky, S., Taukulis, H. K., & Peddle, C. (1979). Learned associations between drug states: Attempted analysis in Pavlovian terms. *Physiological Psychology*, *7*, 352–363.

Rogers, J. G. (1974). Responses of caged red-winged blackbirds to two types of repellents. *Journal of Wildlife Management*, *38*, 418–423.

Taukulis, H. K., & Revusky, S. (1975). Odor as a conditioned inhibitor: Applicability of the Rescorla-Wagner model to feeding behavior., *Learning and Motivation*, *6*, 11–27.

Westbrook, R. F., Clarke, J. C., & Provost, S. (1980). Long-delay learning in the pigeon: Flavor, color and flavor-mediated color aversions. *Behavioral and Neural Biology*, *28*, 398–407.

Winer, B. J. (1962). *Statistical principles in experimental design.* New York: McGraw-Hill.

Received April 30, 1984
Revision received April 18, 1985 ■

New Look for the APA Journals in 1986

Beginning in 1986, the APA journals will have a new look. All the journals will be 8¼ × 11 inches—a little larger than the *American Psychologist* is now. This change in trim size will help reduce the costs of producing the journals, both because more type can be printed on the larger page (reducing the number of pages and amount of paper needed) and because the larger size allows for more efficient printing by many of the presses in use today. In addition, the type size of the text will be slightly smaller for most of the journals, which will contribute to the most efficient use of each printed page.

These changes are part of continuing efforts to keep the costs of producing the APA journals down, to offset the escalating costs of paper and mailing, and to minimize as much as possible increases in the prices of subscriptions to the APA journals.
