(7:3). Breakdown of CMP-NANA to free NANA was greater than 30 percent in the absence of UTP and negligible in its presence. Addition of UTP may prevent breakdown by inhibiting CMP-NANA hydrolase [E. L. Kean and K. T. Bighouse, *J. Biol. Chem.* **249**, 7813 (1974)] and it may also enhance serum enzyme activity allosterically (*13*). Addition of 0.3 mg of desialylated human α_1-acid glycoprotein in place of desialylated fetuin resulted in relative enzyme activities slightly higher (~ 10 percent) than those found with fetuin (data not shown); otherwise the results were similar. No serum neuraminidase activity was detectable in any of the rat serums tested with a highly sensitive assay [R. J. Bernacki and H. B. Bosmann, *Eur. J. Biochem.* **34**, 425 (1973)], although substrate competition from endogenous serum sialoproteins cannot be entirely ruled out. The serum sialyltransferase assay systems were incubated for 30 minutes at 37°C and the reactions were terminated by addition of 2 ml of 1.0 percent phosphotungstic acid in 0.5*N* HCl. The insoluble material was extracted twice with 10 percent trichloroacetic acid and once with ethanol and ether (1:1). Radioactivity was determined by scintillation counting. All assays were performed in duplicate on at least two separate occasions. Serum sialic acid was determined in 50 μl of acid-hydrolyzed (0.1*N* H_2SO_4, 80°C, 1 hour) serum by the method of Aminoff (*18*). No free sialic acid was detected in serum. *N*-Acetylneuraminic acid (Sigma Chemical Co.) was used as a standard. Protein was determined in individual serum samples by the method of Lowry *et al.* (*19*) and very little variation in serum protein content was found in any of the rat serums (from control and tumor-bearing animals) used for these studies.

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20. Sialyltransferase activity was measured by using desialylated fetuin as an acceptor. Endogenous activity was subtracted from total activity (activity in the presence of 0.3 mg of desialylated fetuin) to obtain exogenous activity. Endogenous activity never exceeded 10 percent of total activity with liver microsomes but was higher and more variable with tumor tissue. The incubation medium consisted of 50 μl of microsomal enzyme suspension [0.1 to 0.5 mg of protein (*19*)]; 10 m*M* tris buffer, *p*H 7.0; 10 m*M* $MgCl_2$; 1 m*M* UTP; 0.3 mg of desialylated fetuin; and 0.5 μc of CMP-[4,5,6,7,8,9-^{14}C]sialic acid, 196 c/mole (Amersham/Searle). The incubation mixture was incubated for 30 minutes at 37°C and activity determined as described in (*17*). Duplicate samples were used. Liver and primary tumor free of necrotic tissue were pooled from three animals for each microsomal preparation.

21. Human α_1-acid glycoprotein used in these studies was provided by the National Fractionation Center of the American Red Cross with partial support from the National Institutes of Health [grant HE 1388 (HEM)]. We thank M. Hillman, N. Porter, and R. Izquierdo for their technical assistance. Supported in part by grants CA-19814, CA-15757, and CA-13038 and contract NO 1-CB-23864 from the National Cancer Institute and by American Cancer Society institutional grant IN-54-13.

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Visual Detection of Cryptic Prey by Blue Jays (*Cyanocitta cristata*)

Abstract. *Blue jays learned to respond differentially to the presence or absence of* Catocala *moths in slides. This detection of the moths by the jays was affected by the background upon which the moth was placed and its body orientation, thus providing an objective measure of crypticity. These procedures are useful for the study of visual detection of prey.*

The visual searching behavior of predators is affected by the density, crypticity, and oddity of prey (*1, 2*). However, the effects of these variables often have been difficult to isolate because of problems in controlling factors such as prey preferences, novelty, or the relative ease of capture of particular prey items (*3*). We have developed a new technique for the study of prey detection based on complex discrimination procedures, which provides excellent experimental control of these factors. Here we report data on the detection of cryptic, barklike *Catocala* (Noctuidae) moths by the blue jay (*Cyanocitta cristata*), an avian predator that commonly hunts them (*4*).

Catocala moths are active during the night, spending the daylight hours resting on appropriate substrates. Sargent (*4, 5*) has identified two aspects of the resting behavior of *Catocala* moths which probably affect their crypticity. The moths select resting substrates that match the reflectance of their forewings and adopt species-typical body orientations on the substrate by which they appear to align their disruptive markings with those of the substrate. However, there is little direct evidence that these behaviors affect a natural predator's ability to detect the moths (*6*).

The technique we have developed is based upon procedures used in the study of concept formation in pigeons (*7*). We first trained blue jays to respond differentially to the presence and absence of moths in projected images. After this task was learned the jays were tested with a wide variety of different slides. Their responses provided a measure of the effects of substrate choice and body orientation of the moths on the ability of the jays to detect the moths.

Six blue jays, obtained locally when 10 to 12 days old and hand-raised in the laboratory, were subjects. The birds were maintained at 80 percent of their free-feeding weight throughout the experiment. The apparatus was a modified Lehigh Valley Electronics pigeon chamber. A food magazine was located centrally on the intelligence panel, with an 11.4 by 7.5 cm stimulus key mounted to the left of the magazine and a round changeover (CO) key 2.54 cm in diameter mounted to the right. Slides could be projected upon the stimulus key by a programmable Kodak Carousel projector mounted behind the panel. Reinforcement consisted of halves of *Tenebrio* larvae delivered into the magazine by a Davis universal feeder mounted on top of the chamber. A wooden perch was located parallel to and in front of the intelligence panel.

Throughout the experiment positive slides contained the image of a moth and negative slides contained no moth. Each trial began with illumination of the CO key with red light. When the CO key was pecked once, an image was projected upon the stimulus key, and the display on the CO key changed to a white cross on a black background. If the projected slide was positive, ten pecks at the stimulus key (correct response) resulted in reinforcement. Reinforcement was followed by a 10-second intertrial interval (ITI) to allow ingestion of the reward before the next trial began. A peck at the CO key on positive trials (incorrect response) produced a 60-second ITI. On negative trials, the tenth peck at the stimulus key (incorrect response) was followed by a 60-second ITI, but a peck at the CO key (correct response) produced a 4-second ITI.

Slides were prepared in matched pairs, identical except for the presence or absence of a moth, by pinning a dead moth into position, taking a picture of the scene, then removing the moth and taking another picture. Three species of barklike moths were photographed: *Catocala cara* (dark brown forewings with a faint disruptive pattern of brown lines), *C. retecta* (gray forewings with a prominent disruptive pattern of brown lines), and *C. relicta* (white forewings with prominent stripes of black and gray). *Catocala retecta* and *C. cara* appear most cryptic on gray-brown bark and typically rest in a head-down position, while *C. relicta* appears most cryptic on white birch bark and rests head up. Three separate sets of matched pairs of slides were used. Set 1 consisted of 60 slides, taken indoors, of upright logs to which dead moths were pinned. Set 2 consisted of 60 slides taken outdoors in a lightly wooded area. Sets 1 and 2 were counterbalanced so that each species of moth appeared on both oak and white birch, at three subject-to-camera distances (0.6, 1.2, and 2.4 m). Set 3 consisted of 270 slides taken in a lightly wooded area and counterbalanced so that each species appeared once on oak, white birch, and a nonbark surface, in each of three orientations (head up, head down, and horizontal), at each of five distances (0.6, 1.2, 2.4, 3.6, and 4.8 m). In all sets, the quadrant of the slide in which the moth appeared varied randomly.

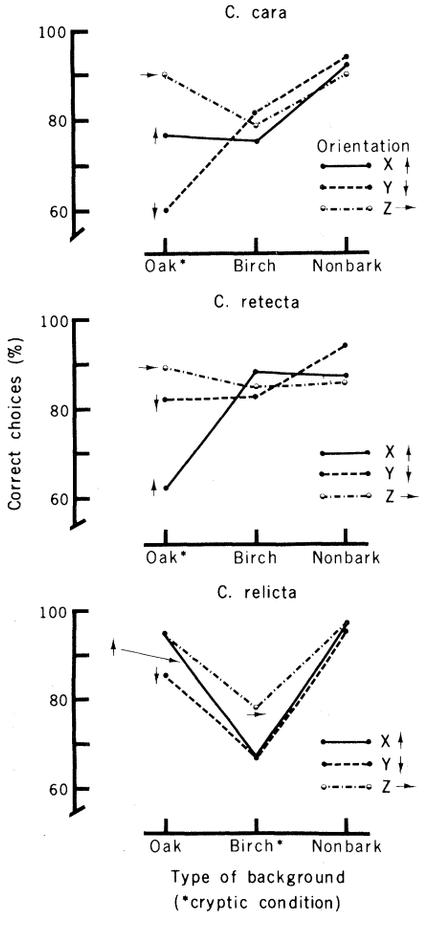
Three of the jays received initial training on set 1, the others on set 2. This initial training continued until the behavior of the individual bird met a stabilization criterion of less than 10 percent variation in percentage correct in ten consecutive 60-trial sessions. All birds were then exposed to set 3, divided into three subsets of 90 slides. Each subset consisted of 45 matched pairs and included an equal number of slides of each species of moth, on each substrate, and at each distance. The birds were exposed to the subsets sequentially, tested on the first until performance stabilized, then on the second, and finally on the third. During this testing, daily sessions consisted of 45 trials each.

We report here the effects of substrate, orientation, and distance on the ability of the jays to detect the moths after stabilization of performance during set 3 testing, rather than data on the acquisition of the discrimination [the jays did learn to respond appropriately at equally high levels to both positive and negative slides (*8*)]. The effects of these factors upon the accuracy of detection were examined by analyzing the asymptotic performance during set 3 testing with analysis of variance procedures. Figure 1 presents the mean percentage of correct responses on positive slides as a function of species of moth, substrate, and orientation. *Catocala cara* and *C. retecta*, the brown bark mimics, were detected less frequently on the oak substrates than on the nonbark substrate. *Catocala relicta*, the birch mimic, was detected least frequently on white birch bark. Overall, the moths were detected most frequently when placed on the nonbark substrate. The differential effects of substrate for different moth species were reflected in a significant species-substrate interaction ($P < .001$). Orientation of the moths also affected detection (Fig. 1). However, orientation had the largest effect when the moth was placed upon the appropriate matching background. This differential effect of orientation depending upon species and background was reflected in a significant interaction of these three factors ($P < .001$).

The accuracy of detection decreased with increasing subject-to-camera distances ($P < .001$). However, this effect was largest and most consistent under cryptic conditions, as shown by significant interactions of distance with background and species ($P < .01$) and with background, species, and orientation ($P < .05$). As shown in Fig. 2, the detection of *C. cara* and *C. retecta* in the vertical orientations declined most rapidly as a function of distance when the moth was presented on oak, whereas detection of *C. relicta* in the vertical orientation declined most rapidly on white birch (*9*).

We will address three issues in considering these data.

1) The jays were in fact detecting the presence of the stimulus configurations of resting *Catocala* moths in the projected images, and responding accordingly. The high levels of performance with matched pairs of positive and negative slides is fairly convincing evidence in itself. The fact that the accuracy of responding was significantly affected by the parameters of moth placement further strengthens this conclusion, as does our informal observation that on positive trials the jays typically pecked directly at



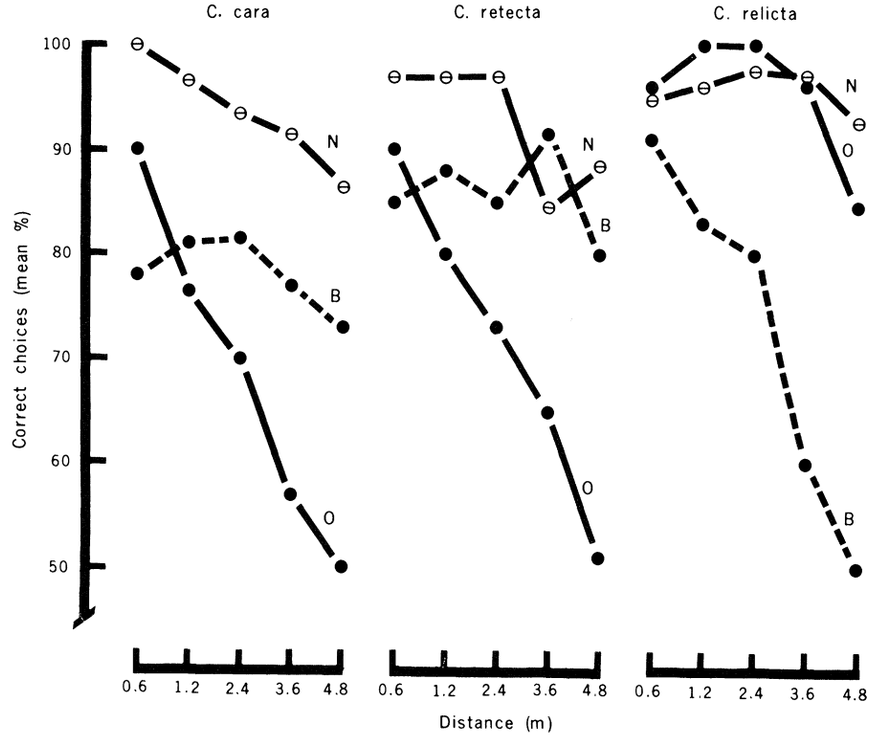


Fig. 1 (left). Mean asymptotic percentage of correct choices, during set 3 testing as a function of species, background, and orientation of the moth in slides with moths. Under cryptic conditions, detection of *C. cara* was least accurate when the moth was placed in the head-down position, while detection of *C. retecta* was least accurate in the head-up position. Detection of *C. relicta* was least accurate when the moth was in either vertical orientation on birch bark. Fig. 2 (above). Mean asymptotic percentage of correct choices during set 3 testing as a function of species, background, and moth-to-camera distance for those slides in which moths were presented in either vertical orientation. The vertical orientations produced moderate to high degrees of crypticity only on the appropriate substrates; this indicates the interaction of distance with crypticity. *Catocala cara* and *C. retecta* appear cryptic on the oak substrate, whereas *C. relicta* appears cryptic on the white birch substrate; *O*, oak; *B* white birch; *N*, nonbark.

the image of the moth. While this learned detection might justifiably be called a specific search image, we prefer to limit use of this term to changes in detection due to consecutive encounters with the same prey item (*2*).

2) Although both substrate choice and body orientation contributed to crypticity in our results, they were interdependent. Detection of moths on the proper substrate was seriously reduced when the moth was placed in a vertical rather than horizontal position, whereas orientation had very little effect for moths placed on a nonmatching substrate. This indicates that body orientation is an important component of crypticity for these moths. Although the effects of substrate choice are apparent to the human eye, the effects of orientation are not. Finally, the effects of distance accord well with the observations of field workers that distance affects detection of prey most quickly and consistently under cryptic conditions (*2*).

3) The procedures developed in this study could easily be adapted for use in future studies of prey detection with a wide variety of avian and mammalian visual predators. Although the method seems artificial in some respects, it offers many advantages as a laboratory simulation of predator-prey interactions. It provides excellent control of the parameters of prey preference and the appearance and palatability of the prey. The effects of prey density and polymorphisms could be examined by varying the slides shown to the subjects. Furthermore, the data already generated with the technique reflect the operation of at least some of the processes that undoubtedly affect the detection of prey in the field. Thus, these procedures have great potential for the study of many aspects of predator-prey interactions.

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8. Details of acquisition will be described (A. T. Pietrewicz, in preparation). The jays trained on set 1 required a mean of 22.3 sessions for performance to stabilize at a mean percentage correct of 84.7. Corresponding data for jays trained on set 2 were 30.3 sessions and 74.8 percent correct. When transferred to the subsets of set 3, all birds showed a significant degree of transfer, which increased with each subset. At asymptote, mean percentages correct on the three subsets of set 3 were 74.4, 83.9, and 83.7 for positive and negative trials combined, which did not differ significantly.
9. The effects of moth species, substrate, and orientation on the speed of responding to slides were also analyzed. Response speed was defined as the reciprocal of the number of seconds between the initial peck at the stimulus key or CO key after the slide had been projected. In general, these analyses were consistent with those of percentage of correct responses; that is, those conditions which produced poorest accuracy of detection also produced the slowest response speeds. Finally, the average speed of responding to positive slides was significantly faster than that for negative slides ($P < .001$). The mean response speed for positive slides corresponds to a response latency of 2.1 seconds, while the mean response speed for negative slides corresponds to a response latency of 4.1 seconds.
10. Based in part on a thesis submitted to the University of Massachusetts by A.T.P. We thank T. D. Sargent for supplying the moths and for advice, and M. Novak for her helpful comments on the manuscript. Supported in part by NSF grant GB 30501.

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Lithium: Effects on Subjective Functioning and Morphine-Induced Euphoria

Abstract. *The therapeutic usefulness of lithium in decreasing the euphoria and other symptoms associated with manic behavior and the hypothesis of a common final mechanism for elevations in mood have led to speculation that lithium may block the euphoria induced by drugs of abuse. In this study, lithium alone was antieuphoric in drug-free opiate addicts and, further, did not block morphine-induced euphoria.*

Bunney and colleagues (*1*) speculate that a common mechanism may underlie the euphoria induced by drugs of abuse and the sudden onset of euphoria observed in mania or certain other medical illnesses. The therapeutic usefulness of lithium salts in decreasing acute manic symptomatology and decreasing the intensity of recurrent mania and depressive episodes led Bunney to further speculate that lithium might block drug-induced euphoria. Reports indicating that lithium blocks the effects of amphetamine (*2*) support this view. In this study, we report (i) the subjective effects of lithium itself and (ii) the influence of lithium on morphine-induced euphoria.

Subjects were eight federal prisoner volunteers with documented long-term histories of narcotic abuse and concomitant antisocial behavior but without history or evidence of a psychotic disorder. Each was informed as to the drugs involved and the purpose and design of the experiment. Subjects knew that the initiation and termination of lithium administration would be without their knowledge and that before and after lithium administration they would be ingesting placebo capsules. Further, they were aware that a narcotic and blank (placebo) would be administered subcutaneously under double-blind conditions during the period of placebo administration and during lithium administration. The review of the protocol and the procedures for informed consent were in accordance with National Institutes of Health guidelines.

The design of the experiment was based on the protocol for lithium treatment of acute mania. Usually lithium carbonate (300 mg) is administered by mouth three or four times daily to such

Table 1. Scales of the ARCI before, during, and after lithium administration. Numbers represent the mean raw scores and standard deviations for eight subjects. Superscripts represent the probability value of the t calculated for the significance of the mean difference from predrug control scores. Mean serum lithium values on the morning of ARCI testing were 0.81 ± 0.25 meq/liter during lithium stabilization and 0.15 ± 0.05 meq/liter during withdrawal.

Scale	Before lithium	Lithium stabilization	Lithium withdrawal
General drug effect	15.9 ± 2.9	$20.5 \pm 3.3^{.02}$	$22.8 \pm 7.2^{.05}$
Pentobarbital-chlorpromazine-alcohol group (PCAG)	10.5 ± 3.3	$12.6 \pm 4.9^{.40}$	$15.8 \pm 6.04^{.05}$
Tired	7.5 ± 1.8	$9.0 \pm 2.4^{.05}$	$9.6 \pm 2.6^{.10}$
Drunk	3.6 ± 0.9	$5.4 \pm 1.1^{.02}$	$6.6 \pm 2.8^{.05}$
Morphine-benzedrine group (MGB)	17.5 ± 4.6	$12.2 \pm 3.5^{.01}$	$12.5 \pm 3.7^{.02}$
Excitement	11.9 ± 3.3	$8.9 \pm 1.6^{.05}$	$8.5 \pm 2.5^{.05}$
Efficiency	28.0 ± 5.6	$22.0 \pm 3.4^{.05}$	$19.8 \pm 4.9^{.02}$
Popularity	12.4 ± 3.2	$9.2 \pm 3.9^{.02}$	$9.4 \pm 3.9^{.05}$