

INDIVIDUAL AND SPECIES PREFERENCE IN TWO PASSERINE BIRDS: AUDITORY AND VISUAL CUES

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ABSTRACT.—Young American Robins (*Turdus migratorius*) and Blue Jays (*Cyanocitta cristata*) were raised in isolated allospecific and conspecific (nest-mate) pairs to determine if Blue Jays could distinguish between a "nest mate" and a strange bird of the nest-mate's species, based on auditory cues or visual stimuli. After 25 days of being raised exclusively with another individual, each subject was tested in an electronic choice apparatus. Jays preferred: (1) to perch near a recording of their nest-mate's vocalizations over those of a bird that was not its nest mate; (2) the visual stimulus of their nest mate over that of a bird that was not its nest mate; (3) an unfamiliar bird of the nest-mate's species when given a choice between two unfamiliar birds, although the preference was not statistically significant; and (4) a recording of a jay when choosing between the recordings of two unfamiliar birds. Robins showed a preference for a recording of the alternate of its nest-mate's species, but no visual preference. In light of these findings, it appears that jays can recognize their nest mate using either visual or auditory cues, regardless of whether the nest mate is a conspecific or a robin. However, jays are more attracted to a conspecific's vocalizations when the choice is between two strange bird recordings (one a robin and one a jay), even if the subject was raised with a robin. Received 20 August 1992, accepted 25 November 1992.

MANY AVIAN SPECIES are able to recognize conspecifics individually. This ability functions to maintain social contact and may also play a role in striking an optimal balance between inbreeding and outbreeding (Bateson 1978). Controlled studies of individual recognition in birds have focused almost entirely on vocal recognition between mates, parents and offspring, or occasionally nest-mate or sibling recognition (Beecher and Beecher 1983). A few species have been studied comparatively to see if those that exhibit varying degrees of sociality differ in their ability to distinguish kin (Cullen 1957, Beecher et al. 1981a, b, 1985, 1986, Beecher and Beecher 1983, Stoddard and Beecher 1983, Medvin and Beecher 1986). However, no study has examined two or more species simultaneously under the same controlled experimental conditions. Furthermore, although Stoddard and Beecher (1983) have suggested that Cliff Swallows (*Hirundo pyrrhonota*) may be able to identify individuals using only visual cues, this has not been demonstrated in any passerine species.

In a previous comparative study, we looked at nest-mate recognition in the American Robin (*Turdus migratorius*) and the Blue Jay (*Cyanocitta cristata*) and determined that a Blue Jay raised in the company of an allospecific or a conspecific demonstrated a preference for its nest mate and a preference for the nest-mate's species whether an allo- or conspecific (Schimmel

and Wasserman 1991). Initially, familiarity had a greater effect than possible innate species preferences. Robins did not show a preference for their nest mate and tended to choose the alternative of the nest-mate's species. Since Blue Jays tend to be a forest-dwelling species (at least historically), we might expect auditory cues to be especially important in maintaining the cohesiveness of the family group (Hardy 1961) and, indeed, they are very vocal. However, at close range visual cues may also play an important role in individual identification.

Neither Blue Jays nor American Robins nest colonially, and both establish and defend breeding territories, although Blue Jay territories usually overlap and conspecifics may be tolerated near the nest (Hardy 1961, Cohen 1977). American Robins are multiple brooded, the young dispersing from the parental territory about two weeks after fledging (pers. obs.). Blue Jays are generally single brooded, their young remaining with the parents for several months after fledging (Laskey 1958), and form large groups (often composed of family units) in late summer (Hardy 1961). Because of the extended parental care and fairly complex social organization of Blue Jays (Racine and Thompson 1983), the young would have a greater opportunity to interact with unrelated conspecifics (during dependency) than would the young of the relatively nonsocial American Robin. Al-

though robins form large flocks to forage during migration, there is no evidence that family units are maintained or even that pairs remain together at this time; breeding pairs appear to remain loyal only to the breeding territory and separate after the breeding season (pers. obs.). Conversely, small flocks of wintering jays have been observed to be composed consistently of the same individuals (Racine and Thompson 1983).

Hand-raised jays that had been released always appeared at feeding times with the other (jay) group members that they were raised with and continued to return for supplemental food throughout the winter and sometimes for years thereafter. In contrast, hand-raised robins rarely returned with their nest mates at feeding times, but always appeared individually to be hand fed or to self feed from a food table (pers. obs.). These robins usually stopped returning for supplemental feedings within two weeks of release (they were released at four to five weeks of age) and usually dispersed from the area immediately. Banding records have proven that at least some of these robins and jays survived for several years after their last sighting. These personal observations are the result of hand raising and banding hundreds of robins and scores of jays over a 10-year period. Therefore, based on the available literature on these two species' social habits and the authors' extensive observation of passerines—especially jays and robins—we have predicted that individual recognition is more likely expressed in the Blue Jay than in the American Robin.

Controlled studies are scarce and published information on the behavioral ecology of the two species tends to be anecdotal despite their relative abundance. Here we use laboratory-raised nestlings to further investigate nest-mate preference (Blue Jays only) and species preference (American Robins and Blue Jays), and whether such preference is based on auditory cues, visual cues, or both.

METHODS

The nestlings chosen for the study were all at approximately the same developmental stage (pin feathers unfurling, but bare patches between feather tracks still apparent). Jays ($n = 16$) were 10 to 12 days old and robins ($n = 25$) 6 to 8 days old when assigned to a conspecific or an allospecific pair group. The difference in age of the subjects reflects the different

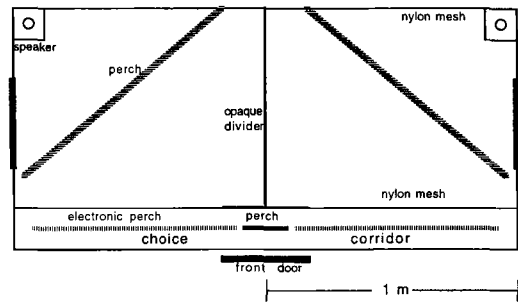


Fig. 1. Experimental apparatus as seen from above. An opaque divider separated two stimulus animals and a perpendicular nylon-mesh divider separated the subject from the stimulus birds/recordings. Subject entered through front door and hopped onto one of mass-sensitive perches in choice corridor. Height of apparatus was 1 m.

developmental rates of the two species. Natural sibling groups were separated such that conspecific experimental pairs never contained siblings.

Birds were obtained from the New England Wildlife Center in Hingham, Massachusetts. Prefledging masses were approximately 60 to 70 g for robins and 70 to 80 g for jays. Birds were housed and reared in the Center's avian-rearing wards, and the experiments were performed in an adjacent building. Conspecific and allospecific pairs of subjects were visually isolated from other birds in plastic airline pet carriers, such that each carrier held two jays, or two robins, or one robin and one jay. After 25 days in paired (visual) isolation, birds were transferred to a large outdoor aviary (see Schimmel and Wasserman 1991).

Data collection began at the end of the 25-day isolation period just before subjects were released together into the outdoor aviary. Individual birds were placed in a three-chambered choice cage (Fig. 1). In the "choice corridor" of this apparatus, each subject was allowed to move to one of two mass-sensitive electronic perches, each next to a chamber containing a stimulus bird; chambers were separated by an opaque divider. The stimulus birds were visible to the subject through a 1.75-cm² nylon mesh divider. The time spent on each perch was electronically recorded. The six tests involved choices by the subject bird between: (1a) its nest mate and an unfamiliar bird of the nest-mate's species; (1b) a recording of its nest-mate's calls and recordings of the calls of an unfamiliar bird of the nest-mate's species; (1c) its visible but inaudible nest mate and a visible but inaudible unfamiliar bird of the nest-mate's species; (2a) an unfamiliar robin and an unfamiliar jay; (2b) a recording of an unfamiliar robin and a recording of an unfamiliar jay; (2c) a visible but inaudible unfamiliar robin and a visible but inaudible unfamiliar jay. In experiments 1a-1c, only jays were tested, since robins do not display a choice under similar conditions (Schimmel and Was-

TABLE 1. Experimental design for Blue Jays (all experiments) and American Robins (experiments 2a–c). Subjects provided with live-stimulus choices in tests labeled a and c, and recorded begging calls in those labeled b.

Experiment	Choice 1	Choice 2
1a	Nest mate	Unfamiliar conspecific of nest mate
1b	Recording of nest-mate's calls	Recording of unfamiliar conspecific of nest mate
1c	Visual stimulus of nest mate	Visual stimulus of unfamiliar conspecific of nest mate
2a	Unfamiliar conspecific	Unfamiliar allospecific
2b	Recording of unfamiliar conspecific's calls	Recording of unfamiliar allospecific's calls
2c	Visual stimulus of unfamiliar conspecific	Visual stimulus of unfamiliar allospecific

serman 1991). In experiments 2a–2c, both robins and jays were tested (see Table 1).

Each test trial consisted of two 10-min periods, with a 5-min acclimation time prior to each period. For the first 10-min period, a stimulus bird/recording was placed/played in each of the two chambers. A subject began each trial on a fixed (insensitive) perch in the center of the choice corridor from which it could see/hear neither stimulus until it had hopped onto one of the two mass-sensitive perches. If the subject did not move off of the central perch, it was recorded as having made no choice. Almost without exception, however, subjects hopped back and forth between the two (mass-sensitive) perches for a few minutes and then rested on one of these, always facing towards the bird/speaker on the side it had chosen.

All subjects seemed agitated initially but calmed down quickly. Timing devices recorded the amount of time in seconds spent on each perch, and this was interpreted as the amount of time spent with each choice. The side with which a subject spent at least 60% of the total time spent on both sides was recorded as the subject's choice. When the first 10-min period was completed, the stimulus birds/recordings were switched to eliminate the possibility of a side bias.

In the experiments testing visual recognition, white ambient noise was employed to render stimulus animals inaudible. The noise was played at a low volume and gradually (over about 30 s) increased to 105 dB (measured at 0.5 m from speaker) in order to avoid alarming the birds. Stimulus birds perched 0.2 to 0.5 m from the center of the speaker nearest them, and subjects could perch anywhere from 0.5 to 0.8 m from the center of either speaker.

Recordings of calls were made of each stimulus animal one to two days before employing them in the preference test. The recorded vocalizations were active begging calls given by fledglings when about to be fed. American Robin and Blue Jay begging calls are dissimilar, and the robin calls tend to be higher in frequency with more clear frequency modulation than the jay calls (Fig. 2). Recordings were made in each bird's cage and, from these tapes, playback tapes

were prepared using a Macintosh SE computer and Sound Edit software. Each 10-min playback tape consisted of tandem repeats of a 10-s call separated by 5 s of silence. All stimulus call recordings were played at a volume of approximately 60 dB. Recordings were timed so that each stimulus could be heard alone for 5 s, but then overlapped with the alternate stimulus for 5 s, throughout the 10-min tape.

In total, data were collected on 16 jays and 25 robins. Seven of the jays were raised with conspecifics, while the other nine each had a robin as a nest mate. We raised 16 of the 25 robins with conspecifics, and the other nine with jays. Subjects were identified by numbered bands placed on one leg.

Experiment 1: Individual recognition in Blue Jays.—In part a of the experiment, jays were given a choice between their nest mate on one side and an unfamiliar bird of the nest-mate's species on the other side. Stimulus birds were visible and audible to the subject and vice versa. The jay was given 10 min to make its choice, and then the stimulus birds were switched and the trial repeated after the subject had been allowed 5 min to rest with stimuli in place. The choice was recorded and part b of the experiment began 1 h later.

The subject and stimulus birds were removed for part b of the experiment and an opaque cloth lowered between the choice corridor housing the subject and the stimulus chambers so as to completely obstruct the subject's view into the chambers. Loudspeakers, one for each stimulus chamber, were connected to separate amplifiers, and positioned in the back of each chamber, one to the far right of the right-hand chamber, and one to the far left of the left-hand chamber (Fig. 1). The recorded calls of the subject's nest mate were played on one side, and the recorded calls of an unfamiliar individual of the nest-mate's age and species were played on the other side. The same recording of an unfamiliar individual was used for all tests and all subjects. After the 5-min acclimation period, the subject was placed in the center of the corridor and the timing devices were activated. Data were gathered as in the previous experiment.

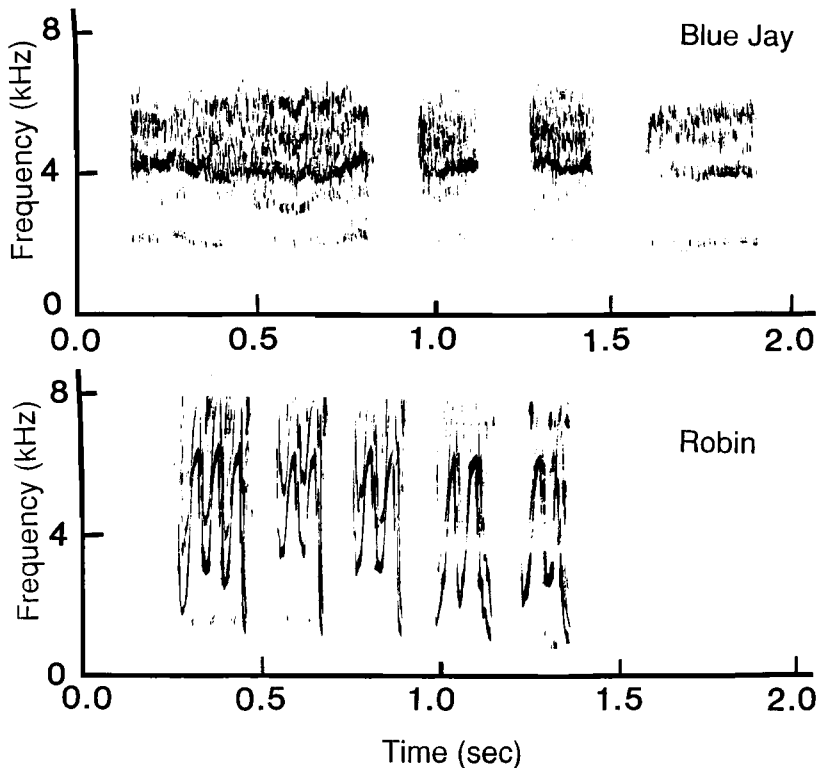


Fig. 2. Sonograms of begging calls of Blue Jay and American Robin used as stimuli during auditory experiments.

Part c of the experiment followed 1 h after the second and for each subject involved the same stimulus birds used in the first, except that this time white noise provided a background over which the birds' vocalizations were inaudible. The test proceeded as in part a, except that the subjects had to rely on visual cues alone to identify their nestmates.

Experiment II: Species preference in American Robins and Blue Jays—We tested both robins and jays to see whether species preference would be displayed based on visual or auditory cues alone. Experiment II followed the same procedures as Experiment I except that the choices were of two unfamiliar birds, one robin and one jay. Upon completion of these trials, subjects were placed in an outdoor aviary to prepare them for release.

RESULTS

EXPERIMENT II: INDIVIDUAL RECOGNITION IN BLUE JAYS

Part a: Stimulus birds visible and audible.—Of the seven jays raised with conspecifics, five chose to perch nearest their jay nest mate when given

a choice between two jays, one chose the alternative to its nest mate, and one did not choose. Out of nine allospecifically paired jays, eight chose to perch nearest their robin nest mate when given a choice between two robins that they could see and hear (occasional soft vocalizations). One did not choose. Thus, nearly all jays perched nearest their nest mate (13 of 16; one chose the alternative, and two did not choose; $P < 0.01$; binomial distribution [Zar 1974]; Table 1).

Part b: Recorded calls of stimulus birds.—Six of the seven conspecifically paired jays chose to perch nearest the recording of their jay nest mate when given a choice between the recorded calls of two jays, and one did not choose. Seven of the nine allospecifically paired jays chose to perch nearest the recording of their robin nest mate when given a choice between the recorded calls of two robins, and two did not choose. Thus, jays (all 13 that made a choice) chose the recorded calls of their nest mate over those of a stranger ($P < 0.001$; binomial distribution; Table 2).

TABLE 2. Nest-mate recognition test and significance in Blue Jays (binomial distribution). Subjects that did not choose were not included in analysis.

Experiment	Test	Subject chose		P
		Nest mate	Stranger	
1a	Control	13	1	<0.01
1b	Audio	13	0	<0.001
1c	Visual	12	0	<0.001

Part c: Stimulus birds visible but inaudible.—Of the seven conspecifically paired jays given a choice between two inaudible jays, five chose their nest mate, and two did not choose. Seven of the nine allospecifically paired jays chose their robin nest mate when given a choice between two inaudible robins, while two did not choose. Thus, jays (all 12 that made a choice) chose their nest mate ($P < 0.001$; binomial distribution; Table 1).

Behavioral observations: Experiment 1.—Upon first being exposed to the white noise, several of the stimulus robins began to sing a quiet "subsong," a warbled whistle that did not resemble adult song. Each increased the amplitude of its output as the amplitude of the white noise was incrementally increased until the ambient noise completely masked the bird's vocalizations, although the bird continued to sing as evidenced by its posture and moving throat muscles. When the white noise was turned off, the robins immediately stopped singing. Although robins were occasionally observed "singing" in the aviary or rearing wards, they never reached the volume observed under the above-described circumstances.

Jays did not alter their behavior upon exposure to the white noise. They also did not respond to the recorded calls of strange stimulus birds, but when exposed to a recording of their nest mate, their behavior immediately changed to a state of agitation. They jumped rapidly from one perch to another, and hopped back and forth on the perch nearest the speaker playing the nest-mate's recorded voice. Several individuals responded by vocalizing loudly, with what we will describe here as contact calls. The same type of call was heard from jays whenever nest mates were temporarily separated during experimentation. The remaining bird called loudly and persistently until its nest mate was returned to their shared enclosure. Only the jays responded in this way. Robins did not alter their

TABLE 3. Species preference test and significance in Blue Jays and American Robins (binomial distribution). Subjects that did not choose were not included in analysis.

Experiment	Test	Subject chose		P
		Conspecific of nest mate	Allopecific of nest mate	
Blue Jay				
2a	Control	9	3	0.146
2b	Audio	4	4	>0.500
2c	Visual	9	2	0.065
American Robin				
2a	Control	8	6	0.500
2b	Audio	3	11	>0.057
2c	Visual	8	10	0.500

behavior upon the removal of a nest mate. This was in contrast to the response of jays that were given a choice between the recorded calls of two strange individuals. Under these circumstances, jays did not vocalize and only changed perches occasionally, coming to rest on one perch where they usually sat quietly.

EXPERIMENT II: SPECIES PREFERENCE IN JAYS AND ROBINS

Part A: Stimulus birds visible and audible.—Three of the seven conspecifically paired jays chose a jay over a robin, one chose a robin, and three did not choose. Six of the nine allospecifically paired jays that were allowed to choose between an unfamiliar jay and an unfamiliar robin chose a robin, two chose the jay, and one made no choice. Thus, jays did not show a significant preference for the nest-mate species (nine choosing the nest-mate's conspecific, three the nest-mate's allospecific, and four not choosing; $P = 0.146$; binomial distribution; Table 3).

The robins were roughly equally likely to choose a conspecific as an allospecific in all testing situations when given a choice between an unfamiliar conspecific and an unfamiliar allospecific. Six of the 16 conspecifically paired robins chose a robin, four chose a jay, and six did not choose. Two of nine allospecifically paired robins chose a jay, two chose a robin, and five did not choose. Thus, of 25 robins, 8 chose the nest-mate species, 6 chose the alternative to the nest-mate species, and 11 did not choose; robins did not significantly prefer the nest-mate species (binomial distribution, $P > 0.50$; Table 3).

Part B: Recorded calls of stimulus birds.—Three of the seven conspecifically paired jays chose to perch nearest the recording of a jay when given a choice between the recording of a strange jay and a strange robin, and four did not choose. One of nine allospecifically paired jays chose to perch nearest the recording of a robin when given a choice between the recording of a strange jay and that of a strange robin, four chose the strange jay recording, and four did not choose. Thus, four jays chose the recording of the nest-mate's allospecific, four chose the recording of a conspecific of their nest mate, and eight did not choose ($P > 0.50$; Table 3).

One of the 16 conspecifically paired robins chose a perch nearest the recording of a strange robin, eight chose one nearest that of a strange jay, and seven did not choose. Two of the nine allospecifically paired robins chose to perch nearest the recording of a strange jay, three chose to be nearest that of a strange robin, and four did not choose. Thus, only 3 robins (of 14 that made a choice) chose the conspecific of their nest mate, 11 chose the alternative, and 11 did not choose ($P = 0.057$; Table 3).

Part C: Stimulus birds visible but inaudible.—When presented with inaudible stimulus animals, four of seven conspecifically paired jays chose to perch next to the strange jay instead of the strange robin, and three did not choose. Five of the nine allospecifically paired jays chose to perch next to the strange robin instead of the strange jay, two chose the jay, and two did not choose. Thus, nine of 16 jays chose the conspecific of their nest mate, two did the opposite, and five did not choose ($P = 0.065$; Table 3).

Robins did not appear to have a preference for the visible but inaudible conspecific of their nest mate. Out of the 16 conspecifically paired robins, five chose the strange robin, six chose the strange jay, and five did not choose. Three of the nine allospecifically paired robins chose the strange jay, four the strange robin, and two did not choose. Thus 8 of 25 robins chose the nest-mate's conspecific, 10 chose the nest-mate's allospecific, and 7 did not choose ($P > 0.50$; Table 3).

DISCUSSION

The most obvious conclusion that can be drawn from these data is that Blue Jays can distinguish their nest mate visually or on the basis of a recording of its begging call alone, regard-

less of whether the nest mate was a conspecific. It appears that American Robins may be as individually distinguishable to Blue Jays as are conspecifics, based on auditory or visual cues.

Individual young of at least some passerines (e.g. Cliff Swallows; Stoddard and Beecher 1983) can be distinguished from conspecifics by the human eye using simple visual cues such as subtle differences in plumage color and markings. It is not known, however, if the birds actually use these cues in identifying individuals. Studies with Ring-billed Gulls (*Larus delawarensis*) have demonstrated that parents will initially reject young that have been experimentally altered in appearance (Miller and Emlen 1975), showing that at least some species do rely on visual cues for individual recognition. Although not impossible, it is unlikely that Blue Jays use olfactory cues in distinguishing individuals. The use of olfactory cues as a means of identifying individuals has never been demonstrated in any avian species.

The potential number of visual cues that may have been used by the Blue Jays to distinguish American Robins is great. The young of unrelated American Robins can differ considerably in plumage color; the breast plumage varies from pure white to brick red, but is usually intermediate between these extremes such as a light orange with patches of white. Variable markings include size and shape of spots, and distribution of spotting on the chest and back; color, length and width of "eyebrows"; shape of the eyes and flanges, and even shape of the head (pers. obs.). Furthermore, American Robins coming from the same nest usually resemble each other to such an extent as to make them quite difficult for the human observer to distinguish. It is reasonable then to inquire why distinct "signatures" have evolved in a species that is nonsocial in its breeding habits. It is possible that American Robins do not use these cues to recognize individuals. Furthermore, they may not have evolved the perceptual ability to do so. We believe it is unlikely that American Robins even recognize their own young. It has not yet been demonstrated experimentally if either American Robins or Blue Jays reject foreign, fledged young of conspecifics and direct their parental care selectively. Personal observations, however, indicate that American Robins will readily adopt foreign fledged conspecific young if they are introduced at the appropriate stage in the breeding cycle (see also Skutch 1987).

Furthermore, species recognition would be sufficient to maintain the cohesiveness of any conspecific flock, and is not indicative of sociability in American Robins.

Both individual recognition capabilities and the evolution of individually distinct signatures facilitating recognition would appear adaptive in Blue Jays, a species that exhibits extended parental care and forms stable family groups. Several species of jays are known to be cooperative breeders (i.e. Fitzpatrick and Wolfenden 1986; see reviews in Brown 1987, Skutch 1987, Stacey and Koenig 1990) and corvids in general are renowned for their highly complex social behavior (see Goodwin 1984).

Studies on colonial and noncolonial species of swallows have indicated that colonial parents reject foreign fledglings and search for lost young, while noncolonial species accept foreign fledglings and respond to the calls of both their own young, as well as unrelated young (Beecher et al. 1986). Related studies on other species of birds whose young normally mix with unrelated conspecific young have demonstrated parental recognition of young (Balda and Balda 1978, van Elsacker et al. 1988, Miller and Emlen 1975) and, similarly, a lack of recognition in species where young do not mix (i.e. Black-legged Kittiwakes, *Rissa tridactyla*; Cullen 1957). Furthermore, Loesche et al. (1991), using operant-conditioning techniques, have suggested that the signature calls of the colonial Cliff Swallow are more easily distinguished by both Barn Swallows (*Hirunda rustica*) and Cliff Swallows (as well as by European Starlings, *Sturnus vulgaris*) than those of the typically noncolonial Barn Swallow. If this is characteristic of a general trend found throughout passerine species, we might expect Blue Jays to have evolved more complex signature specializations and/or better perceptual abilities than American Robins. Although the Blue Jays in this study appear to have better perceptual abilities than their robin counterparts, they do not seem to have better signature adaptations than the American Robins (that would make them more distinguishable as individuals). Blue Jays were equally able to distinguish between two Blue Jays or two American Robins, in all three tests. However, investigating two closely related species of jays with different social systems would be necessary to rule out the effect of phylogenetic constraints.

Results from the second set of experiments

suggested that most Blue Jays preferred the species they were raised with, when their choice was based on visual cues alone. Perhaps Blue Jays based their choice on learned visual species-specific characteristics during their exclusive association with their nest mates. However, when the choice was based on auditory cues alone, the birds appeared to choose the begging call of another Blue Jay, whether they were raised with a conspecific or not (seven of eight choices were for a conspecific). Since the Blue Jays could not see themselves or other jays, but could hear themselves, it is possible that they relied on the general characteristics of their own voice or an innate species preference instead of their nest-mate's voice when making a choice (since a recording of a conspecific's voice might be more familiar than that of a strange American Robin's voice). This hypothesis is tentatively supported by the fact that, in the control experiment (experiment 2A), the Blue Jays' choice behavior resembled that of the choice patterns described in the visual experiment (experiment 2C). In other words, Blue Jays that could see and, to a lesser extent, hear the stimulus birds tended to choose their nest-mate's species; thus, responding as in the experiment using visual cues only. It is also possible that the birds innately recognize some species-specific auditory cues and are responding to those. Such cues are most likely to be in the form of begging calls, contact calls, or alarm calls, all of which appear innately in young birds of many species that have had no prior exposure to these calls. Such vocal production has been noted for Blue Jays and American Robins that were hand reared in complete isolation from other birds (pers. obs.).

The clarity of the responses of Blue Jays in the nest-mate choice experiments is in contrast to the vagueness of the choices exhibited in the species-preference experiments. This result might be explained by the real possibility that the Blue Jays are distinguishing their nest mates by using only information learned about their nest-mates' individually specific signature characteristics, while relying on more general species-specific characteristics learned about themselves and their nest mates when faced with a choice of species in these experiments. If this is the case, then a Blue Jay that strongly prefers its American Robin nest mate may be ambivalent about choosing between a strange conspecific that shares general species-specific char-

acteristics with itself, and a strange robin, which does not resemble the jay itself, but does share species-specific characteristics with its nest mate. Notably, the number of Blue Jays not choosing in the species preference tests (especially the auditory test, where eight did not choose) was much higher than in the nest-mate choice tests, possibly reflecting confusion experienced by subjects applying conflicting information in making their choice.

The behavior of American Robins in the species preference tests is more difficult to interpret. In the auditory test they tended to choose the alternative to the nest-mate species, but choices were evenly divided within the other two tests, with a large number of subjects not choosing in all tests. American Robins tended to take much longer to "settle down" in the experimental apparatus than did the Blue Jays, and perhaps they needed more adjustment time as well as longer testing time in order to display a choice. American Robins may be trying to avoid perching near any other bird, and this possibility remains to be tested. Other possible reasons for the robins' behavior are discussed in Schimmel and Wasserman (1991). It is also possible that American Robins do not base their choice on the cues as presented to them in these experiments, and the failure to demonstrate discrimination in these tests does not imply a lack of discrimination ability for these robins. American Robins differ from Blue Jays greatly in their behavior, both in natural and laboratory settings; thus, a different experimental design than that used here may be required to test American Robin perceptual abilities.

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