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ARTICLE

House martins respond to perceived danger

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Abstract We designed a field experiment on breeding house martins (*Delichon urbica*) which build conspicuous nests in human structures, which require the parents to be wary of potential predators. Some birds therefore avoid entering the nest in the presence of a potential nest predator when the parent is most vulnerable when inside the nest. Therefore, the hesitation to enter the nest in the presence of a potential predator might be for the bird's own safety. A number of species show such a hesitation in response to a human observer. Using this behaviour exhibited by the house martin, we show here that the bird appreciates the perspective of the observer and behaves as if it can understand what the observer 'knows'.

Keywords House martin · *Delichon urbica* · Perceived danger · Gaze following

Introduction

Perceived danger has been shown to affect normal behavior in many animals (Dukas 2001). The subsequent antipredator measures are known to affect fitness, life history, inter- and intra-specific interactions, and foraging considerations (e.g., Grubb and Greenwald 1982; Martin 1995; Morse 1986; Nonacs and Dill 1990; Slotow 1996; Stamps and Bowers 1991; Watts 1990).

Domestic dogs (*Canis familiaris*; e.g., Hare and Tomasello 1999; Agnetta et al. 2000) and primates (Povinelli and Eddy 1997) have been shown to react to the direction of gaze of humans or conspecifics. Ristau (1991) described differences in distraction behavior in the presence of a predator based on the direction of the latters eye gaze in Wilson's (*Charadrius wilsonia*) and piping (*C. melodus*) plovers. Emery and Clayton (2001) observed that scrub jays (*Aphelocoma coerulescens*) changed caching behavior if they were being observed by conspecific(s), and reached their food items if they had previously experienced and indulged in pilfering. They discerned that scrub jays remembered being observed and were also able to relate their experiences with the possible behavior of the conspecifics. Dukas (2001) found that honeybees take anti-predatory measures and showed sensitivity to perceived danger at flowers by preferring safe flowers over equally rewarding alternatives that harbored either a dead bee or a spider.

Smitha et al. (1999) claimed a low-level "theory of mind" (Baron-Cohen 1995) in little green bee-eaters (*Merops orientalis*) by showing that birds hesitated to enter the nest in the presence of a potential predator. They also claimed that the birds responded to prior experience with the researchers. Watve et al. (2002) found that the angle of gaze was associated significantly positively with the probability of entering the nest whereas the angle from the bird was not. Further, they discovered that birds showed considerable flexibility as well as individual variation in the methods of judging the predators' position and direction of gaze.

The aim of this study was to verify the hypothesis that house martins (*Delichon urbica*), like green bee-eaters,

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also show a response to human gazing and indicate the presence of “theory of mind” in a different species from a different continent. We predicted that: (1) breeding parents would ignore us at a distance from the nest if we did not look at them directly and did not pose as potential predators as described by Watve et al. (2002); (2) the parents would be wary of the researchers’ presence under the nest and reduce their visitations in order to reduce the chances of discovery of the nest by a potential danger; and (3) minimize their visitations and presence at the nest while the researcher stood under the nest and gazed directly at the nest, which can be interpreted as a direct threat to the nest and its’ occupants, and also to the feeding parents.

Because all the nests had nestlings, we predicted that parents would ignore our presence at distances over 25 m, reduce the frequency of visits to the nest when we stood under them, and minimize their visits if we gazed directly at the nest site.

In this study, we show how human presence and the angle of gaze of the observer can affect food provisioning of breeding house martins. The study species are a common sight in areas of human habitation taking advantage of artificial structures for nesting (Turner and Rose 1989). The species is known to react to inter-specific intruders. They are very plastic to different predator pressure and are able to shift from outdoor to indoor breeding as a defense measure against usurping, and predation by, house sparrows (*Passer domesticus*; Tryjanowski and Kuczyński 1999).

Materials and methods

The breeding season of the house martin is usually between late April and late July, during which they fledge two broods. The nest is bowl-shaped with a small oval aperture and is made of mud pellets and other light materials. Both parents participate in all parental duties and they breed in colonies that can range from 2 to 3 nests clumped together to several hundreds. House martins feed almost exclusively on flying insects (Snow and Perrins 1998).

The study was conducted at the Salino Horse Ranch, northern Poland (54°40′N, 17°56′E). We chose to count the number of visits for three clusters of four nests each, i.e., a total of 12 active nests that had one or more nestlings in each. The three nest clusters were ~50 m apart such that the experiments conducted on one did not affect the others. One cluster was located at the entrance to the horse stables, the second in the eves of the dining hall, and the third under the slanting roof of the dormitories.

We capitalized on the constant vigilance behavior of the species (e.g., Tryjanowski and Kuczyński 1999), and their immediate response to intruders or potential predators, and conducted the study during two consecutive days, two sessions on each day—one in the morning and one in the late afternoon. Each set of observations was divided into three sections—when the observer stood 25 m away from the nest and did not look at it directly, stood/sat directly under the nest and also did not gaze at it directly, and then while under the nest while gazing at it constantly. The sessions, the sequence of the clusters observed, were randomized but not the treatments within the sessions.

The weather during the four sessions of our study were clear skies for both the sessions on the first day, overcast in the morning of the second day (the third session), and a drizzle during the fourth session in the afternoon.

All observations were confined to 0800–0930 hours for the morning session and 1730–1900 hours for the afternoon session. During these hours, we observed an increased frequency of foraging and feeding activity of the house martins and expected to discover any responses to our presence and behavior.

In each of the treatments, we estimated the anti-predatory behavior of the parents by counting the frequency of their visits to the nests, and the length of time spent on each of the visits.

Data analysis

Since we did not record any difference between the clusters of nests in the reaction to any of the treatments, we did not differentiate between the clusters and we did the analysis for the pooled data.

Since all three factors, i.e. day of observation (1 or 2), time of the day (morning or afternoon) and presence of the observer (control, standing under the nest, gazing) could affect the number of parental visits to the chicks, we did a 3-way ANOVA with all above treatments as fixed factors.

Due to large variance within the sets of data on the duration of visits, we used non-parametric Kruskal–Wallis ANOVA. To check whether particular treatments resulted in different reactions on the first and second day, we did additional Kruskal–Wallis ANOVA. We applied Bonferroni correction to avoid the effect of multiple comparisons.

The number of visits to the nest is reported as a mean ± SEM, while the duration of visits as a median, minimum and maximum duration of the visit.

Results

Number of visits

While undisturbed and watched from the distance, birds visited the nest between 10 and 38 times during the 5-min period (mean = 20.6 ± 11.03). This frequency differed

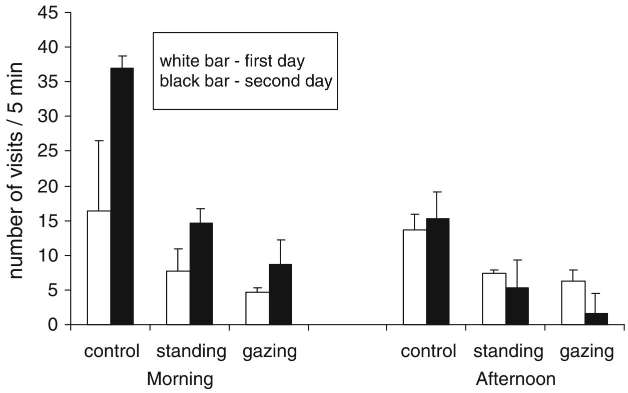

Fig. 1 Mean (±SEM) number of visits of breeding house martins (*Delichon urbica*) when observers were at different distances, and looking away from the nest or gazing directly at it

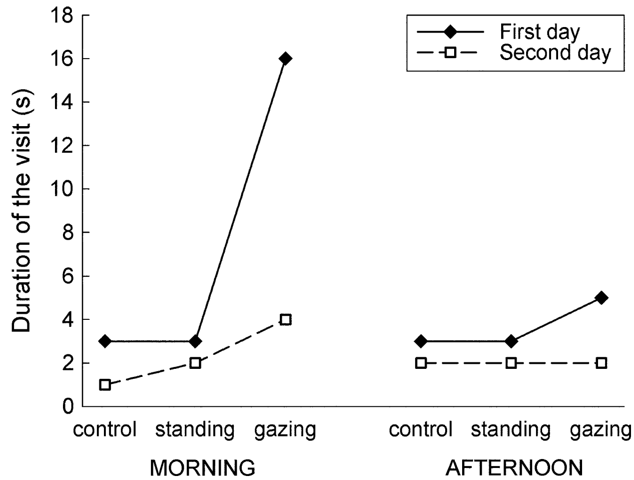

Fig. 2 Median duration of visits of breeding house martins (*Delichon urbica*) in reaction to observer gazing at the nest twice a day, on two consecutive days

between the days of experiment (3-way ANOVA, $F = 11.87$, $P < 0.01$; Fig. 1); birds on the second day visited the nest more often than on the first day. Number of visits was also affected by the time of the day (3-way ANOVA: $F = 25.83$, $P < 0.001$) and by the presence of the observer (3-way ANOVA: $F = 52.33$, $P < 0.001$). In the morning, birds visited the nests more often than in the evening. However, there was a significant interaction between time of the day and day of experiment (3-way ANOVA: $F = 22.44$, $P < 0.001$). On the first day, parents visited the nest on average 9.3 ± 5.7 times during 5-min intervals. On the second day in the morning, parents visited the nests 20.1 ± 13.1 times, while the afternoon frequency of visits was 7.44 ± 6.9. While undisturbed, house martins visited the nests over twice as often as when the observer was close to the nest, either looking at the birds (mean no. of visits: 5.3 per 5 min) or not looking at the nest (mean no. of visits: 8.75 per 5 min). Also, the day of the experiment affected the results. Control birds visited nests more often on the second than on the first day [$P(T) < 0.001$]. The results did not differ between the days whether the observer was standing under the nest or gazing.

Duration of the visit

The time birds spent in the nest ranged from 1 to 158 s. There was a significant effect of the experimental day on the time spent in nest (Kruskal–Wallis ANOVA, $H = 134.034$, $P < 0.001$). Birds on the first day spent much more time in the nest than on the second day (median 3 s, min 1 s, max 158 s; and median 2 s, min 0 s, max 158 s, respectively; Fig. 2).

The presence of the observer significantly affected the time birds spent in the nest (Kruskal–Wallis ANOVA, $H = 66.342$ $P < 0.001$). When undisturbed and watched from the distance, house martins spent from 1 to 58 s in the nest. When the observer was standing under the nest, but not looking at birds: from 1 to 38 s; while gazing, birds either did not enter the nest at all or spent up to 2.6 min in the nest.

On the first day, when we were gazing at the nest, martins stayed in the nest much longer (median 7 s, min 2 s, max 158 s) than on the second day [median 4 s, min 0 s, max 111 s; $Z = 3.76$, $P(U) < 0.001$]. The same was the case when the observer was only standing under the nest [1st day: median 3 s, min 1 s, max 38 s; 2nd day: median 2 s, min 1 s, max 27 s; $Z = 4.49$, $P(U) < 0.001$] and also for the control treatment [1st day: median 3 s, min 2 s, max 85 s; 2nd day: median 1 s, min 1 s, max 9 s; $Z = 10.06$, $P(U) < 0.001$]. In the morning, birds spent more time in the nest (median 3 s, min 0 s, max 158 s) than in the afternoon (median 2 s, min 1 s, max 111 s; Kruskal–Wallis ANOVA, $H = 8.75$, $P < 0.01$).

Discussion

Evidence for "theory of mind" is reported from apes, whereas monkeys do not seem to recognize mental states of others (Smitha et al. 1999). They contended that theory of mind in animals can be demonstrated only if it brings about a detectable and preferably quantifiable behavioral change. We designed a field experiment on breeding birds which was used as a simple test for theory of mind in birds. House martins build nests in human dwellings and this can lead to conflicts. Humans can be considered a potential predator because the accumulation of feces under nests can be a nuisance and nests are removed because of this (Turner and Rose 1989).

Hence, we assume that the inconspicuousness of a nest is its best protection. For the breeding attempt to be successful, it is also necessary that the bird's behavior does not betray the nest site. In addition, adults must remain alert to the presence of potential danger in order to ensure their personal safety, especially since the house martin is more vulnerable when inside the cup-nest. Hence, some birds avoid entering the nest in the presence of a potential nest predator. Therefore, the hesitation to enter the nest in the presence of a potential predator might be for the bird's personal safety. Smitha et al. (1999), using this behavior exhibited by the little green bee eater, showed that the bird can appreciate the perspective of the observer and behaves as if it can understand what the observer 'knows'. Similarly, we interpret the fact that parents reduced their presence in the nest on the second day of our observations as evasive action from potential predators, i.e. us, who were constantly present for extended periods of time around or under their nests. It is possible that the nestlings also required less brooding as they grow older, but such a significant decrease in their time spent in the nest within 24 h is unusual. It appears that the reduced presence at the nest was compensated for by an increased frequency of visits of shorter durations than those of the first day or at the control nests. This pattern is also apparent when we gazed directly at the nest or stood under it. These results support our predictions that breeding parents would ignore us at a distance from the nest if we did not look at them directly, that the parents would be wary of the researchers' presence under the nest and reduce visitations in order to reduce the chances of discovery of the nest by a potential danger, and minimize their visitations and presence at the nest while the researcher stood under the nest and gazed directly at the nest which could be a direct threat to the nest and its occupants and the parents.

The use of gaze has recently gained momentum in cognitive science (review by Itakura 2004) because these abilities contribute to a human-like "Theory of Mind" (Baron-Cohen 1995). In gaze-following studies, animals are tested for their ability to co-orientate with, or react to, other individuals by responding to their gaze direction (e.g., chimpanzees, *Pan troglodytes*; Tomasello et al. 1998, 1999). So far, the only non-mammalian species tested for their gaze following abilities is for foraging in common raven (*Corvus corax*; Bugnyar et al. 2004), caching in scrub jays (*Aphelocoma coerulescens*; Dally et al. 2006), and anti-predator "state of mind" in the little green bee-eater (Smitha et al. 1999; Watve et al. 2002). Our study contributes to this little-studied field and also contributes to the cognition abilities of breeding house martins.

In this study, house martins that bred in the proximity of humans were shown to react to human presence and to their directional gaze. When study nests were observed from a distance and parent birds remained unaware of our interest, they visited the nests to feed the nestlings at a comparatively high frequency. This frequency halved in the presence of human presence in the immediate vicinity of the nest. Further, the number of visits was lower and of shorter durations if the observer was gazing directly at the nest than if looking elsewhere. These findings have an important implication. It shows a cognitive ability of the breeding parents to discern between humans, and other potential predators, which are in the vicinity of the nest coincidentally or which show an interest in the nest and its precise location as suggested by a fixed gaze.

We attribute the difference in frequency between the 2 days to the increasing needs of the growing nestlings and not necessarily to our presence. Not having evaluated the nesting phase, it is possible that we conducted our observation during the hatching phase wherein the number of mouths to be fed increased overnight, or during the first days of the nestlings' growth stage when they require large amounts of food for acquiring maximum body mass at the earliest possible time. This line of thought is strengthened by the fact that the control birds also visited nests at a higher frequency on the second day.

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