Behaviour of American Crows (*Corvus brachyrhynchos*) when Encountering an Oncoming Vehicle

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A carrion feeder attempting to forage on a road benefits greatly from an appropriate response to vehicular traffic. In this observational study, we tested the ability of American Crows (*Corvus brachyrhynchos*) to judge the behaviour of fast-moving vehicles and avoid collision on a narrow road. Unsurprisingly, American Crows feeding in the same lane as the approaching vehicle always flew off, but interestingly, a significant proportion of American Crows in the opposite lane chose to remain on the road. In addition, 21% of the American Crows in the same lane as the approaching vehicle walked over to the opposite lane to avoid injury, but none of the American Crows in the opposite lane walked over to the lane in which the vehicle was approaching. These are among the first quantitative data indicating that a non-human animal can detect the directionality of oncoming vehicles on a road and, like humans, actively move out of the way or switch lanes to avoid death based on an understanding of the bahaviour of vehicular traffic.

Key Words: boldness; behavioural response; *Corvus brachyrhynchos*; American Crow; cognition; Everglades National Park; learning; road ecology; Florida

Introduction

Cognitive abilities in animals are suggested to have evolved in response to social and ecological problems that cannot be solved through simple trial and error or instinct (Kamil 1988). Such challenges include the complexities of interacting with other individuals in a group (Emery *et al*. 2007), finding food (Stephens and Krebs 1986), and avoiding predators (Bateson and Kacelnik 1998). Despite the evidence of intelligence among different taxa, relatively little is known about the selective forces driving the evolution of intelligence (Seed *et al*. 2009). Studying how organisms cope with challenges associated with foraging in new landscapes can provide an opportunity to elucidate the nature of these selective forces.

Both urban and suburban habitats host an array of wildlife populations, and use of these habitats by wildlife will only expand as urbanization increases (Ditchkoff *et al*. 2006). Roads in particular are an important component of urbanization and create movement challenges for many animals. The presence of vehicles specifically poses a threat to animals on roadways (Trombulak and Frissell 2000). However, the presence of animals killed on the roads can make roads an attractive foraging site for carrion feeders. To exploit this resource, most synanthropes (wild animals and plants that live near, and benefit from, an association with humans) avoid periods of high vehicle activity (e.g., by foraging at night) (Ditchkoff *et al*. 2006).

Feeding innovations can strongly contribute to the success of species living in a novel environment (Garamszegi *et al*. 2007). The most successful species in urban and suburban environments are those that take the greatest risks and are the most innovative feeders (Moller 2009). These traits in American Crows (*Corvus brachyrhynchos*), one of the most intelligent birds (Emery and Clayton 2004), might allow them to successfully scavenge on roads, and these traits have likely contributed to the success of American Crows in urban environments. Although several studies have focused on the adaptations of American Crows to urbanization (see Marzluff *et al*. 2001), very few studies (e.g., Cristol *et al*. 1997; Cristol and Switzer 1999; Moller *et al*. 2011) have examined their behaviour on roads.

American Crows feed on road kill (Marzluff *et al*. 2001), but are they able to judge vehicular speed and patterns of traffic flow? Such abilities might allow them both to feed on road kills by successfully trading off between food and safety and to reduce the number of situations in which they need to abandon a food source that could be stolen by a competitor or destroyed by a vehicle.

Birds and insects have a fairly sophisticated collision detection system that uses optical flow fields. This system allows them to avoid obstacles in flight (Lee and Kalmus 1980). However, to our knowledge, there are no quantitative data that show whether American Crows (or any other animal) can exploit vehicular traffic lanes in order to forage and avoid injury or death from fast oncoming traffic. Consequently, we asked the following question: how good are American Crows at avoiding vehicles on roads? We addressed this question by studying the road-use behaviour of American Crows on a narrow paved two-lane road within Everglades National Park in South Florida, USA.

Birds have larger eyes in proportion to their body size than other vertebrates. This gives birds high visual acuity (defined as the minimum angular separation between two objects) at greater distances (Fernandez-Juricic *et al*. 2004). Since a larger eye has a greater number of photoreceptors, visual acuity also increases with eye size. There is a positive relationship in birds between body mass and eye size (Brooke *et al*. 1999), so larger birds are better at identifying objects at greater distances (Fernandez-Juricic *et al*. 2004). In addition, since larger birds can resolve objects earlier than small birds (Brooke *et al*. 1999), the large eyes of American Crows allow them to identify vehicles at great distances and can help American Crows to actively use roads.

This ability could also enable them to perceive whether an automobile is directly in their path and whether it poses a threat. Therefore, we predicted that scavenging American Crows in the same lane as an approaching vehicle should always fly away when they see the vehicle approaching (a natural anti-predatory locomotory response to a looming stimulus) (e.g., Gray *et al*. 2001). We predicted that they should remain on the road when a vehicle in the opposite lane approaches and passes by.

Study Area and Methods

We recorded three behavioural responses of American Crows to approaching vehicles—fly away, stay, or walk away—while they were feeding on road kill (e.g., small amphibians, reptiles, and insects), or walking and looking for food, between the Flamingo (25°08'28.96"N, 80°55'25.73"W) and Homestead gate (25°23'42.97"N, 80°34'59.36"W) within Everglades National Park on Florida State Road 9336. While travelling in a Ford F250 truck (2.5 m wide) at 80–90 km per hour (within posted speed limits), we counted the number of American Crows standing on the road and quantified their behavioural responses to our approaching vehicle.

Two observers drove a total of nine transects (seven in August 2010 and two in October 2010) along the 60 km stretch (45-50 min drive) of two-lane paved road (6.8 m wide). However, to ensure statistical independence, we used data from only a single transect between Homestead Gate and Flamingo (conducted on 21 August 2010 at around 9 AM, two hours after sunrise) for analysis. Given the speed at which our vehicle was travelling, we were confident that the same individual American Crow was unlikely to be observed at more than one location along a single transect. We chose this single transect because it had the most observations of American Crows.

Whenever an American Crow was encountered during our drive, we made two observations: 1) the lane in which the American Crow was standing (the same lane as our vehicle or the opposite lane) and 2) the American Crow's response to our approaching vehicle (stay, fly away, or walk away). The "stay" behaviour was quantified as an instance when an American Crow continued to stand in the opposite lane while our vehicle passed by. The "fly away" behaviour was an instance in which an American Crow standing in either the same lane as the approaching vehicle or the opposite lane flew off as we approached. The "walk away" behaviour was an instance in which an American Crow walked away from the approaching vehicle, either to the opposite lane or to the curb.

Because of the risk our vehicle posed, the flight initiation distance for the American Crows was approximately 25–75 m from our approaching truck. No birds were killed by our vehicle in this study. Although State Road 9336 is used by other vehicles, we recorded the flight response only for American Crows that we approached. Generally, traffic was infrequent on this road (on average, vehicles were sighted every 5–10 minutes). While driving, we maintained a minimum distance of approximately 500 m between our vehicle and the vehicle in front of us by either overtaking slower vehicles or allowing faster vehicles to pass us.

Two species of crows are found in Everglades National Park, the more common American Crow and the rare Fish Crow (*Corvus ossifragus*). Only American Crows were recorded in this study. To determine the species of crow, we made two additional drives (not part of the analysis) along the same stretch of the road and photographed the crows on the road. The photographs were then sent to Dr. Kevin J. McGowan (Cornell Laboratory of Ornithology, Ithaca, New York), who identified them as American Crows.

A 3 × 2 contingency table was used to analyze whether American Crows used different behaviours (response variable) to avoid injury/death in the two lanes (explanatory variable). Since our expected numbers were small, Fisher's exact test was used to determine whether the two variables were independent of one another. Fisher's exact test is considered to be more accurate than the χ^2 test or *G*-test for any test of independence with small numbers (Zar 1999).

Results

Thirty eight American Crows (nineteen crows in the driving lane and nineteen in opposite lane) were recorded during the drive. Fisher's exact test indicated there were significant differences in the response behaviour of American Crows that were in the same lane as the approaching vehicle and American Crows that were in the opposite lane ($P < 0.0001$). No birds that were in the same lane as the approaching vehicle chose to stay. Conditional proportions that represent the conditional distribution of the response variable (behaviour), given the explanatory variable (lanes), show that 78.95% of the American Crows in the same lane as the approaching vehicle flew away and the remaining 21.05% walked over to the opposite lane to avoid our oncoming vehicle (Figure 1). In the opposite lane, 63.16% of the American Crows remained on the road while our vehicle passed by and 36.84% flew away when our vehicle approached (Figure 1).

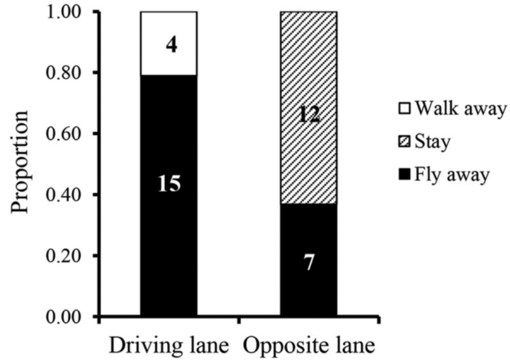

FIGURE 1. Proportional differences in behavioural responses of American Crows (*Corvus brachyrhynchos*) in the same lane as an oncoming vehicle and in the opposite lane. Numbers within bars indicate the total number of individuals observed exhibiting a particular behaviour. Note that no individuals that were in the same lane as the approaching vehicle stayed, and no individuals walked away from the opposite lane.

Discussion

As predicted, American Crows in the same lane as the approaching vehicle always moved away, either by flying away or by walking over to the opposite lane or to the curb, suggesting that American Crows are very good at determining when the trajectory of the approaching vehicle poses a threat (Figure 1). Furthermore, when American Crows are approached by a fast-moving vehicle in the opposite lane on a narrow road, a high percentage of American Crows will remain on the road (Figure 1). These lane-specific behaviours suggest that American Crows have learned that vehicles tend to drive in a straight line (do not change lanes) and in the same direction.

Why did not all American Crows decide to remain in the opposite lane or walk from the lane in which the vehicle was approaching to the opposite lane? The decision to fly often depends on the costs and benefits of escaping from predators, and this decision is context-dependent (Ydenberg and Dill 1986). Additionally, several other factors, such as an American Crow's age (experience), sex, personality (e.g., Moller 2009), or number of competitors might affect the decision to stay, move, or fly. In addition, the size of the carrion or the individual's energetic state can also play a role in an American Crow's behaviour. Controlled studies manipulating the above factors would be needed to determine the exact reasons behind the decisions of the American Crows that remained on the road.

Why did American Crows in the same lane as the approaching vehicle choose to walk to the opposite lane and remain on the road rather than walk over to the adjacent curb? One likely explanation is that the American Crows chose to walk away because they preferred having a clear sightline from which to detect a threat from the approaching vehicle. Multiple studies suggest that prey organisms prefer having a clear sightline that allows them to better detect an approaching predator and consequently manage their risk of predation (Vijayan *et al*. 2007; Embar *et al*. 2011). Since the landscape beyond the curbs on both sides of the road was grass (approximately 20 cm high), the sightline of an American Crow moving onto the curb would have been blocked, thus increasing its perceived risk of predation. Conversely, an American Crow that waited on the road in the opposite lane would continue to have a clear view of the approaching vehicle and would therefore feel safer. Varying grass height past the curb (this area is regularly mowed and maintained by the park authorities) can provide excellent experimental opportunities to test this concept further. According to our hypothesis, if the grass is completely mowed, American Crows should increase their preference for the grass area next to the curb, since it will be providing them with a clear sightline.

Are these behaviours unique to American Crows? No study has assessed the visual fields of perception in American Crows. To our knowledge, there are also no experimental studies that have assessed their escape response to looming objects (natural or artificial). However, it is likely that American Crows may not respond to all looming objects in the same way. American Crows have few natural predators. However, if a raptor or a Florida Panther (*Puma concolor coryi*) approached along the lane that the American Crow was in, it might not choose to wait in the opposite lane. Although we did not quantify other birds foraging on the road, we did note that all other bird species observed (e.g., sparrows; flycatchers, Turkey vulture, *Cathartes aura*) flew away when our vehicle approached, regardless of the lane they were in.

What is clear from this study is that American Crows likely are better at assessing the trajectory of a fast-moving vehicle than other birds. The ability of prey to assess and realize that a predator's approach trajectory will intercept its own trajectory helps to significantly reduce the risk of predation (Stankowich and Blumstein 2005).

Other studies have looked at flight initiation distances in urban settings (e.g., Moller 2009; Carrete and

Tella 2011), but to our knowledge this study is the first to focus on selective lane use by a bird on a road. Bold behaviour (which is commonly inferred from flight initiation distance when approached by humans) is a key characteristic of birds that colonize urban environments (Moller 2009). Even though this study was conducted in a rural setting, these American Crows might have gained experience with passing vehicles through associative learning, thus allowing them to be adept at judging a safe distance. Earlier studies on nut-cracking behaviour of Western American Crows (*Corvus brachyrhynchos hesperis*) (Cristol *et al*. 1997) and American Crows on roads (Cristol and Switzer 1999) have documented that crows fly off when a vehicle approaches. However, to our knowledge, the present study is among the first to provide quantitative data showing that American Crows (or any other bird) can judge the directionality of an approaching vehicle and react accordingly, an ability often associated with humans.

Roads form an ideal system to study learning behaviour and rapid evolution in birds, particularly their flexibility in adapting to varying environments. Our observations form a baseline that can be used to address an array of future questions. Is it a simple rule of thumb for American Crows or are they using their cognitive skills to respond (e.g., using cues such as the painted dividers to distinguish lanes)? Do American Crows take fewer chances where traffic is less predictable? How will increased traffic affect the behaviour of crows in Everglades National Park? Testing these questions will further help us understand the basis of decision making in American Crows. In particular, controlled experiments involving shifts in vehicle patterns, food manipulations, and road conditions (e.g., in sections where the road turns and multiple lane roads) are needed to comprehend the underlying mechanisms for such behaviours. Understanding how fledgling American Crows learn to use roads and lanes would be very important in strengthening this field of research. This study can be instrumental for future studies in urban ecology as well as the ethology of this group of birds.

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