# Experience does not enhance avian avoidance of vehicles

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# Background

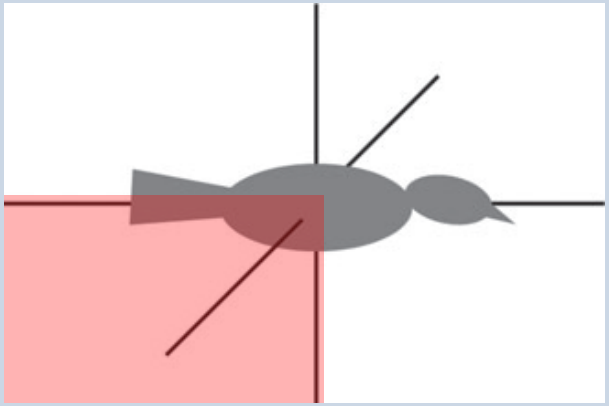
- **>13,000** reported bird strikes with aircraft in USA in 2014
- **>$900 million** in damages in USA each year

# Background

- Estimated **89–340 million** bird-automobile collisions annually in USA
  - 850 times more birds killed by cars than wind turbines
  - Especially important for rare and endangered species

# Birds use antipredator behaviors to avoid vehicles

- Necropsies of 92 aircraft-killed birds (32 spp.) from JFKIA
- Injury locations were most frequently posterior and ventral
  - Indicate evasive maneuvers, especially for gulls
  - Birds were not “blindsided”—they tried to react but didn’t have time



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Short communication

**Fatal injuries to birds from collisions with aircraft reveal anti-predator behaviours**

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**Keywords:** airport, bird strike, Cartesian distance, laterality, necropsy, US Federal Aviation Administration.

Between 1990 and 2008, more than 87 000 bird–aircraft collisions (hereafter, bird strikes) were reported to the US Federal Aviation Administration (FAA) and represented more than US$600 million in direct and indirect costs to US civil aviation annually (Dolbeer *et al.* 2009). Worldwide, the costs to civil aviation associated with bird strikes exceed US$1.2 billion annually (Allan & Orosz 2001). In the United States, 381 avian species have been reported as struck by civil aircraft, with gulls (Laridae 19%), doves/pigeons (Columbidae 15%), raptors (including New-World Vultures, Cathartidae 13%) and waterfowl (Anatidae 8%) the most frequently reported non-passerine bird groups (Dolbeer *et al.* 2009).

The possibility that necropsies of struck birds could provide information on behaviour at the point of collision (e.g. evidence of avoidance response) has received little attention. For example, to our knowledge only unpublished reports by Lyne *et al.* (1998) and Sheehy *et al.* (2005) document results of detailed necropsies on birds found dead on runways. Findings from those reports indicate that injuries to birds due to vehicle strikes were largely concentrated on the ventral surface; as a consequence, the authors suggest that a generic avoidance response was initiated prior to impact.

Clearly, an aircraft poses a hazard to birds (Blackwell *et al.* 2009a, Dolbeer *et al.* 2009) and there is empirical evidence that birds utilize anti-predator strategies in response to human disturbance similar to strategies used when encountering a predator (e.g. Frid & Dill 2002, Møller *et al.* 2008, Blackwell *et al.* 2009b). Thus, in an applied context, anti-predator behaviours can help us to understand the mechanisms behind the responses of wildlife to different types of human activities (Fernández-Juricic *et al.* 2001, Blackwell *et al.* 2009b).

We questioned, therefore, whether information obtained via necropsy of struck birds would indicate not only a behavioural response to the aircraft, but distinct anti-predator behaviours (e.g. Lima 1993, Hedenström & Rosén 2001, Blackwell *et al.* 2009b). If so, necropsies of struck birds could provide information useful in understanding avian response to aircraft approach and, potentially, in the development of predictive methods intended to reduce the frequency of bird strikes. Our objectives were to determine whether injuries associated with a strike were discernible from those incurred due to impact with the ground, and whether injuries to birds within phylogenetic groups and foraging guilds (cohorts) were distinctive, thus indicating cohort-specific response behaviours. We assumed that if a fatal injury occurred because of a strike (i.e. a strike not involving engine ingestion), but the carcass received further damage due to impact with the ground or crushing by ground vehicles, the location of injuries would be randomly distributed. In contrast, the location of strike injuries alone is likely to be governed by either a generic avoidance response (e.g. Sheehy *et al.* 2005) or species-specific anti-predator behaviours, and therefore be clumped.

Across all birds examined in our study, fatal injury locations were generally posterior, ventral and on the left side. Because of the predominant ventral distribution of injuries we conclude that the birds had taken evasive action in response to the aircraft, reflecting known aspects of anti-predator behaviour.

## METHODS

### Carcass recovery

During 2000 and 2001, staff at John F. Kennedy International Airport (JFK), New York, USA, recovered carcasses of birds reported to the FAA as killed in collisions with aircraft at the airfield, as well as those presumed so given the location at recovery. We obtained the FAA strike reports for those birds recovered as a result of a reported strike. The carcasses were recovered during five to 10 daily sweeps of the runways, taxiways and ground within 250 feet of the runways. Upon recovery, the carcasses were frozen and sent to the US Department of Agriculture's (USDA) National Wildlife Research Center, Ohio Field Station, and assigned a unique number before examination. We excluded from our sample of birds those which were severely desiccated, partly

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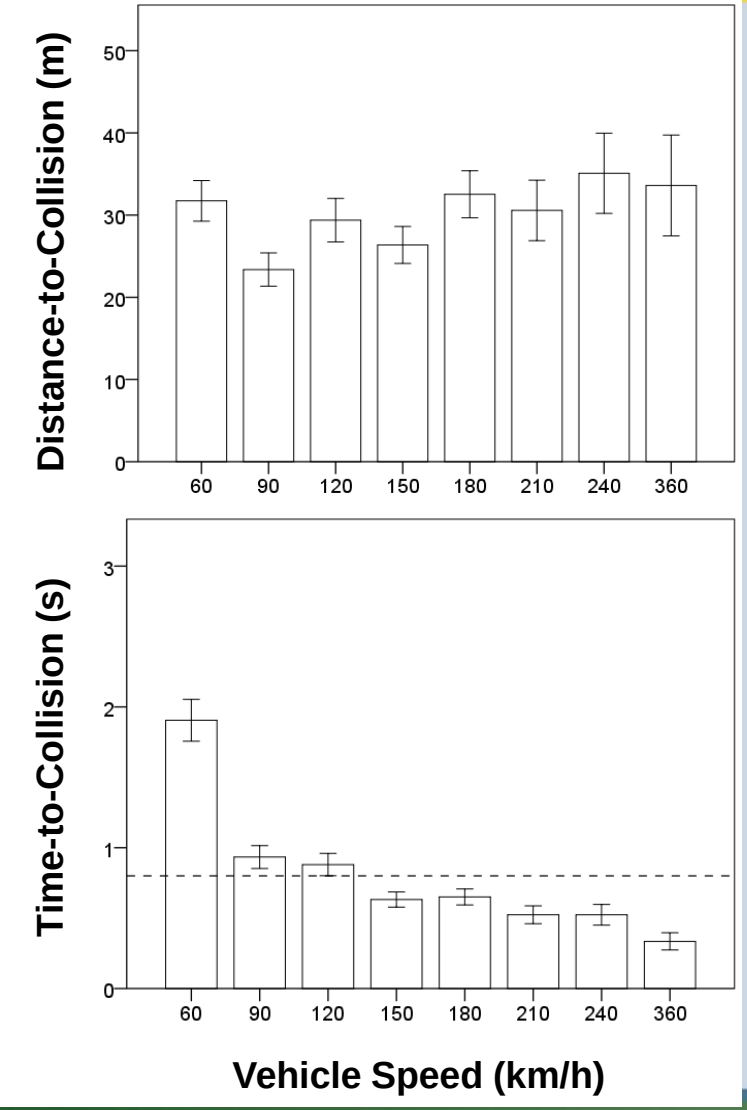
Bernhardt et al. 2010. *Ibis* 152:830-834.

# How do birds decide when to initiate avoidance?



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## Speed kills: ineffective avian escape responses to oncoming vehicles

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Animal–vehicle collisions cause high levels of vertebrate mortality worldwide, and what goes wrong when animals fail to escape and ultimately collide with vehicles is not well understood. We investigated alert and escape behaviours of captive brown-headed cowbirds (*Molothrus ater*) in response to virtual vehicle approaches of different sizes and at speeds ranging from 60 to 360 km h$^{-1}$. Alert and flight initiation distances remained similar across vehicle speeds, and accordingly, alert and flight initiation times decreased at higher vehicle speeds. Thus, avoidance behaviours in cowbirds appeared to be based on distance rather than time available for escape, particularly at 60–130 km h$^{-1}$; however, at higher speeds (more than or equal to 180 km h$^{-1}$) no trend in response behaviour was discernible. As vehicle speed increased, cowbirds did not have enough time to assess the approaching vehicle, and cowbirds generally did not initiate flight with enough time to avoid collision when vehicle speed exceeded 120 km h$^{-1}$. Although potentially effective for evading predators, the decision-making process used by cowbirds in our study appears maladaptive in the context of avoiding fast-moving vehicles. Our methodological approach and findings provide a framework to assess how novel management strategies could affect escape rules, and the sensory and cognitive abilities animals use to avoid vehicle collisions.

### 1. Introduction

When approached by predators and other potential threats, animals must decide when to initiate an escape response. This decision is informed by characteristics of the oncoming object, such as size, speed and directness of approach [1], as well as the state or condition of the animal being threatened, including hunger level, experience and variation in risk-taking behaviours and personalities [2,3]. Animals combine sensory inputs with behavioural rules to assess the costs and benefits of fleeing and thus determine the timing of escape responses [4–6].

Animals appear to react to oncoming automobiles, aircraft and other non-biological threats in a qualitatively similar manner to predators [7,8]. During these encounters, animals use some variation of their antipredator repertoire [9], possibly because the evolutionary novelty of modern vehicles precludes more specialized responses [10]. However, vehicles and natural predators often differ in several important ways, including speed, size and consistency of approach. Such differences can lead to maladaptive (and often fatal) responses when faced with an oncoming vehicle, such as deer 'freezing' and turtles withdrawing into their shells while still on the road [10,11].

Animal–vehicle collisions, which kill hundreds of millions of birds and other animals each year [12–14], can negatively impact populations [15,16] and pose substantial safety risks to humans [17,18]. Yet, it is unclear what goes wrong when individual animals fail to escape and eventually collide with vehicles [10]. For instance, Legagneux & Ducatez [19] demonstrated that several species of birds escaped earlier from oncoming vehicles as the posted speed limit increased, but the actual speed of vehicles had no effect on escape behaviours. DeVault *et al.* [11] found that near-collisions with turkey vultures (*Cathartes aura*) increased with vehicle speed, suggesting that animals may have difficulty assessing the threat



DeVault et al. 2015.
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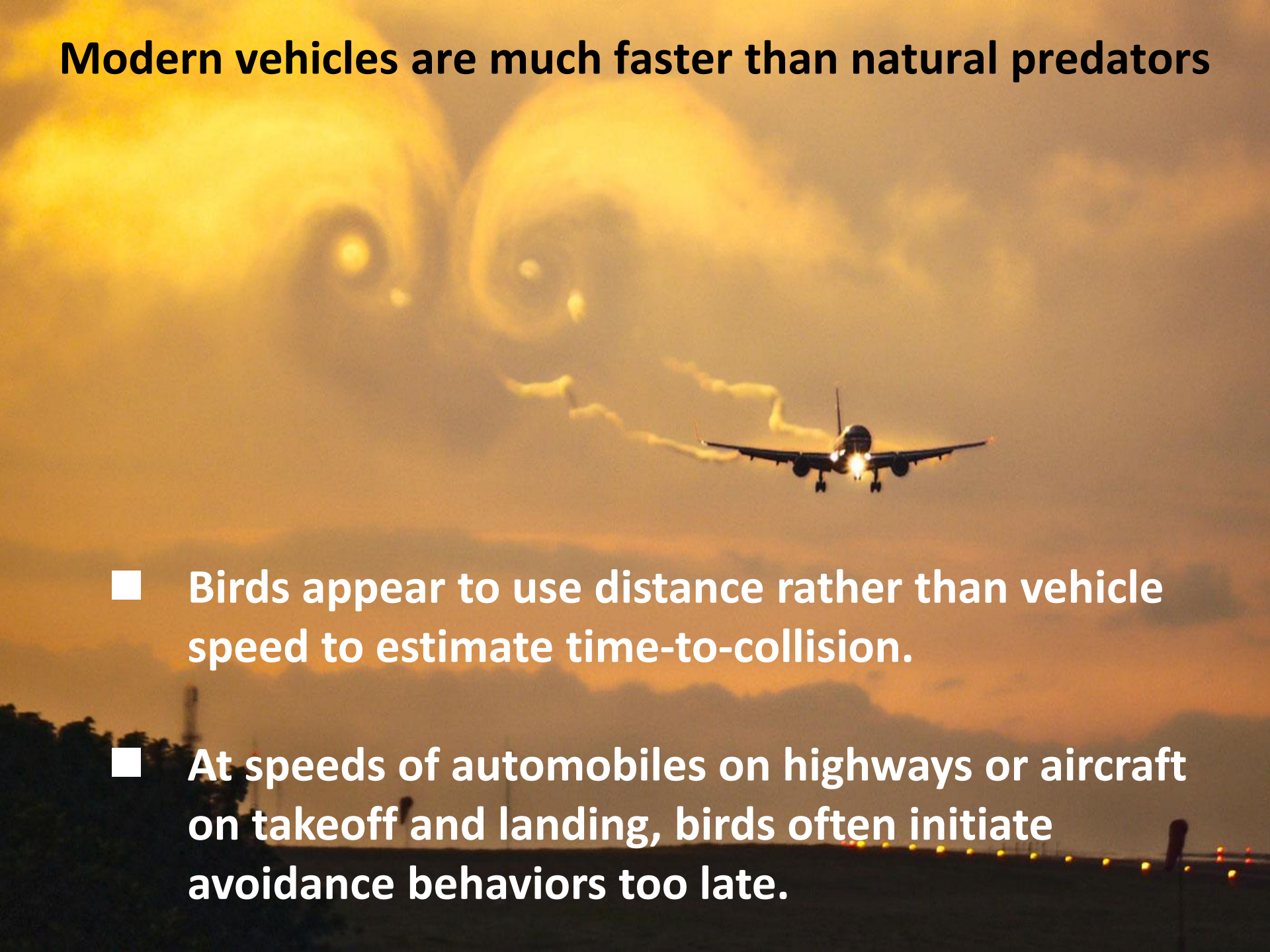
# Modern vehicles are much faster than natural predators



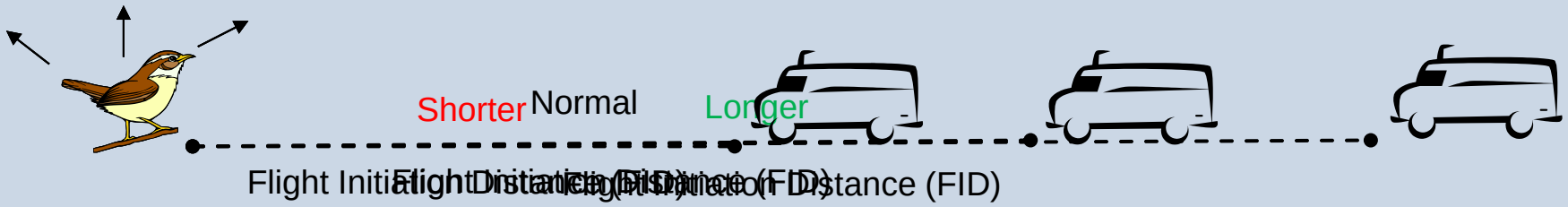
- Birds appear to use distance rather than vehicle speed to estimate time-to-collision.
- At speeds of automobiles on highways or aircraft on takeoff and landing, birds often initiate avoidance behaviors too late.

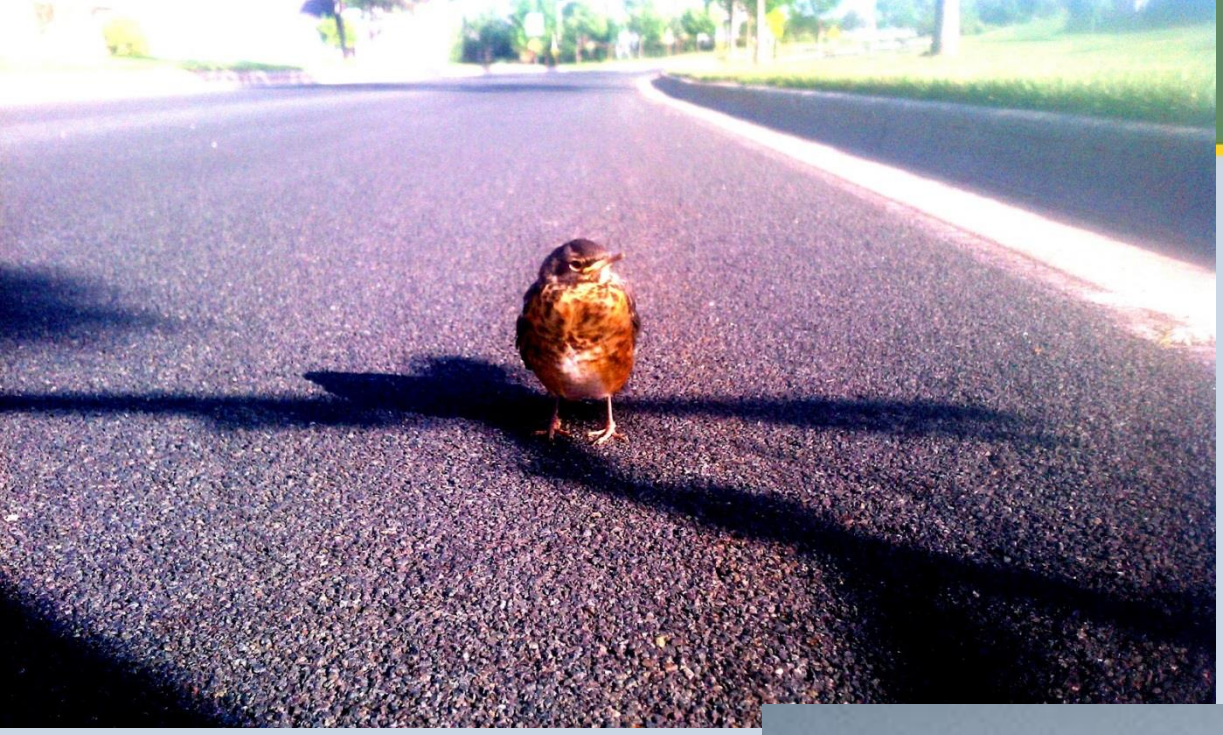
# Can birds use experience to mitigate the effects of vehicle speed?

- Across much of the developed world, birds observe many vehicles each day.
  - Cars, aircraft, trains, boats, etc.
- These vehicles don't pursue the birds, but instead travel predictably along roads, flight lines, and railroad tracks.
- How do birds use experience with vehicles to decide on a flight response when a collision is imminent?

# Three hypotheses on the role of experience

1. Birds might differentiate between direct and tangential approaches; thus repeated exposure to passing or distant vehicles might have **little effect on FID**.
2. Experienced birds might learn to **increase FID** in response to vehicles over those normally used to escape slower predators, thereby increasing their likelihood of successful avoidance.
3. Experienced birds might habituate to repeated observations of passing or distant vehicles and **decrease FID**, thereby decreasing their likelihood of successful avoidance.





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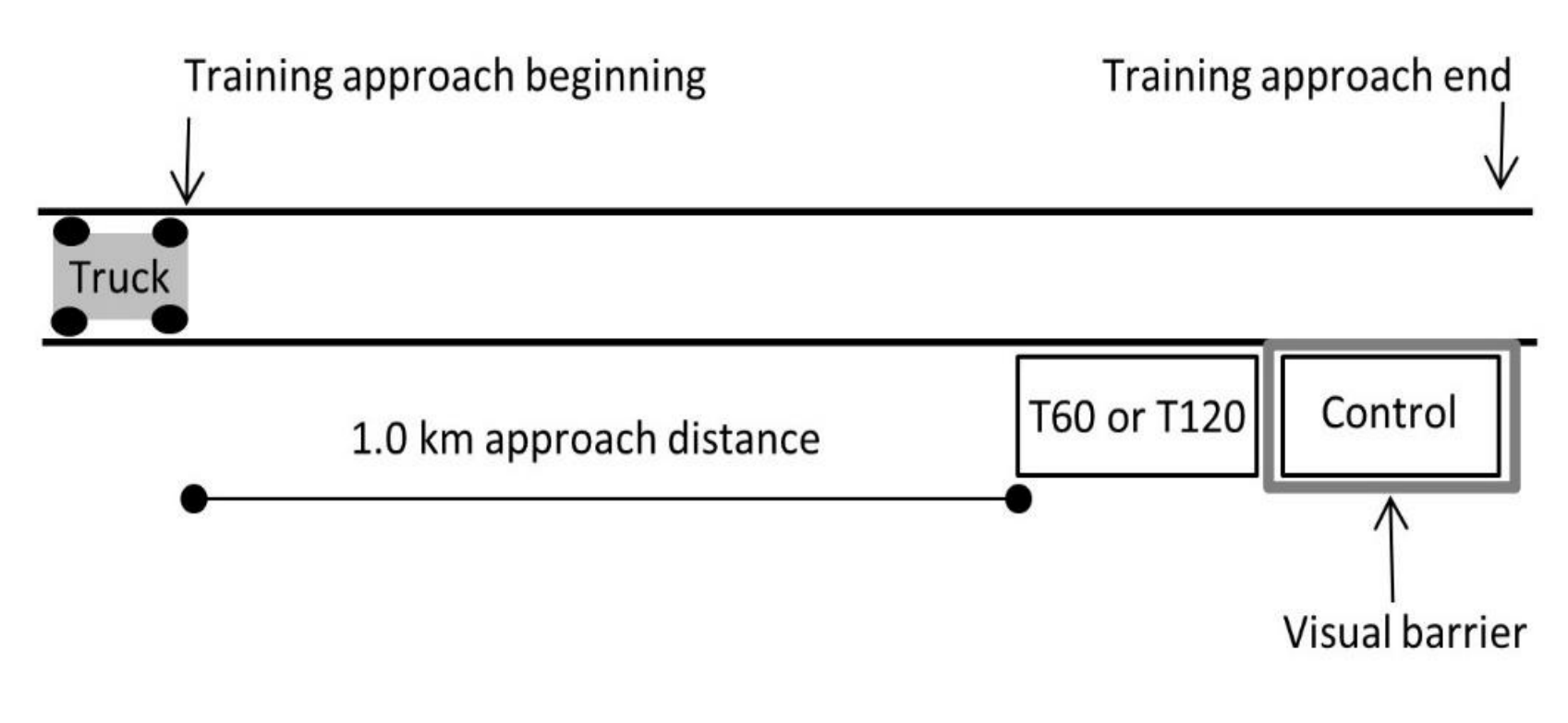
# Methods—Training

- Naïve rock pigeons
  - Birds only saw vehicles we wanted them to see
- 32 vehicle approaches over 4 weeks
- 3 groups of 35 birds each
  1. Trained at 120 km/h
  2. Trained at 60 km/h
  3. Control

# Field setup


Training approach beginning
Training approach end
Truck
1.0 km approach distance
T60 or T120
Control
Visual barrier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# Methods—Measuring FID

- Video lab
  - Allowed simulation of head-on approaches
  - Allowed high-speed approaches
- 1 km vehicle approach at 120 or 240 km/h
  - 30 birds from each training group tested, one at a time
  - Visual only
- Recorded behavior with 4 cameras
- Quantified FID to nearest 1/15 sec


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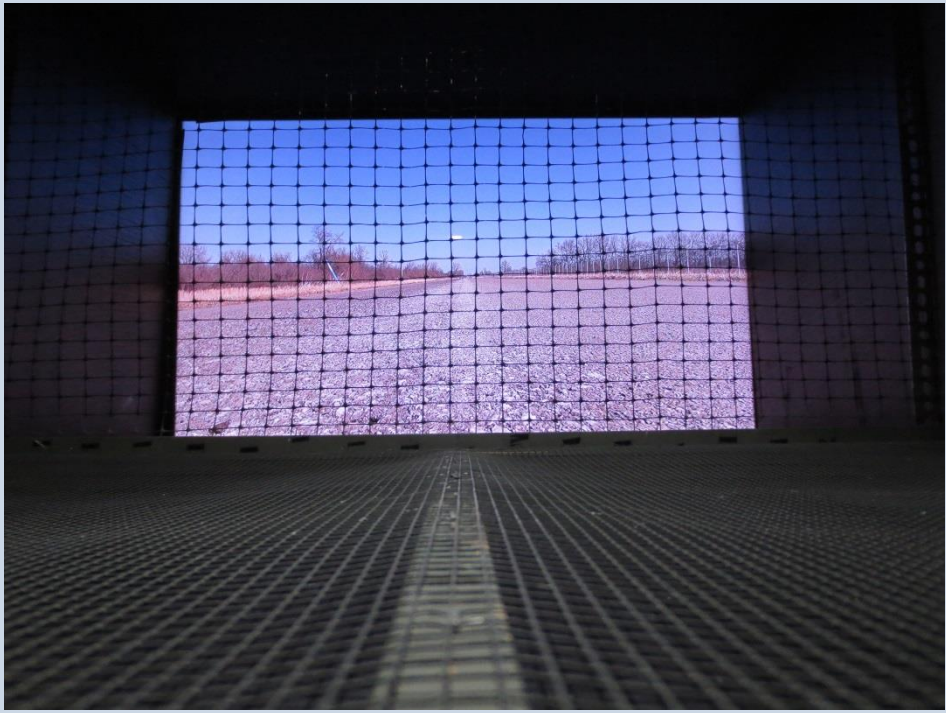


# Analyses

- General Linear Model
- DV = FID (square-root transformed)
- IVs = training group (T120, T60, control), virtual vehicle approach speed (120, 240 km/h), interaction
- Post-hoc analysis with LSD tests

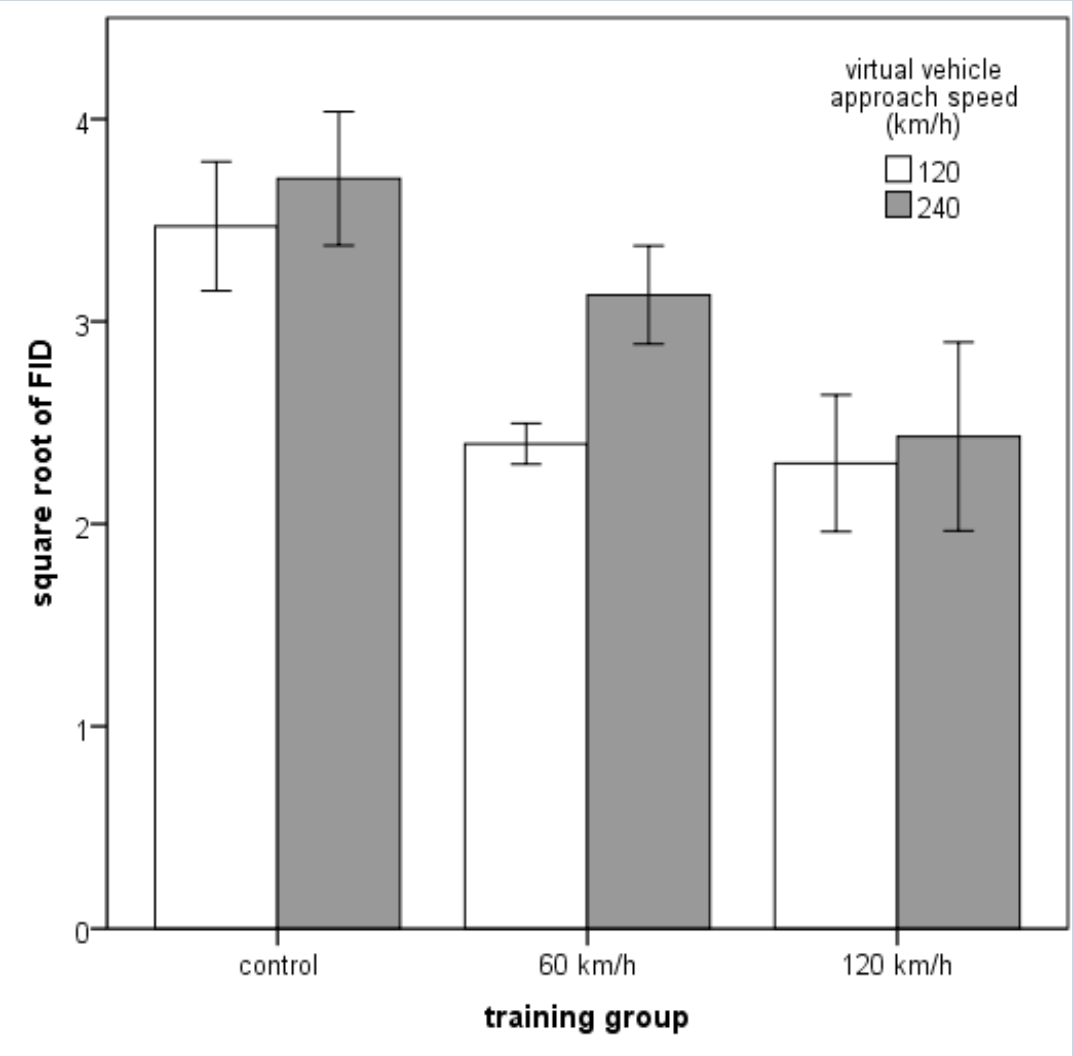
# Results

- Pigeons showed very little reaction to vehicle approach during training
- During video playback, avoidance response evident in 83 of 90 virtual vehicle approaches
- Training group: $P = 0.001$
  - Naïve (control) group had longer FID than T60 or T120 groups
  - No difference ($P = 0.217$) between T60 and T120 groups
- Virtual vehicle approach speed ($P = 0.162$) and interaction ($P = 0.602$) nonsignificant

# Results

| Training group | Virtual vehicle approach speed | Mean (m) | SD (m) |
|---|---|---|---|
| Control | 120 km/h | 13.46 | 10.47 |
| | 240 km/h | 15.27 | 9.84 |
| T60 (60 km/h) | 120 km/h | 5.88 | 1.98 |
| | 240 km/h | 10.63 | 5.70 |
| T120 (120 km/h) | 120 km/h | 6.89 | 4.67 |
| | 240 km/h | 8.96 | 9.00 |

# Results


virtual vehicle approach speed (km/h)
120
240
square root of FID
0
1
2
3
4
control
60 km/h
120 km/h
training group

# Primary finding

- Inexperienced birds had longer FIDs in response to direct vehicle approach than experienced birds
  - Experienced birds evidently learned that vehicles do not pose a threat
  - Habituation?

# Conclusions

- Habituation could contribute to many bird-vehicle collisions
  - Resident raptors on airfields?

# Questions or comments?

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