Are vehicles 'mobile bird hides'? A test of the hypothesis that 'cars cause less disturbance'

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Abstract
We test the 'cars cause less disturbance' hypothesis by comparing the flight-initiation distance (FID) evoked by a car versus a single walker for 38 species of waterbird (n = 657 standardised approaches). For the 15 species where we had sample size adequate for statistical testing (n ≥ 5), we found that cars elicited shorter responses after controlling for starting distance. Within-species analyses revealed that this difference was significant in 8 of 15 species. Although mean FIDs for car approaches were always shorter than FIDs toward single walkers in the remaining species (7), the tests in those species lacked sufficient power to draw meaningful conclusions. Our results provide support for the hypothesis that birds respond to cars at shorter distances. The wide taxonomic breadth of species investigated suggests that this principle may be broadly applicable, at least in waterbirds. The results of this study and the FID estimates we present will allow development of meaningful stimulus-specific buffer zones to protect waterbirds from disturbance. (*The Victorian Naturalist* **131** (4) 2014, 150-155)

Keywords: Flight-initiation distance, disturbance, wetlands, vehicles, motorised transport

Introduction

'Disturbance' is the disruption of the normal activity or physiology of wildlife, such as birds, in the proximity of an agent such as a person or vehicle (i.e. a stimulus; Weston *et al.* 2012). One broadly accepted metric used to describe disturbance is flight-initiation distance (FID), the distance between a stimulus and a bird when an escape response is initiated (Blumstein 2003). While a range of internal and external factors influence FID (Guay *et al.* 2013a, Guay *et al.* 2013c), the type of stimulus is a little studied but important one (Mcleod *et al.* 2013). For example, birds alter aspects of their responses including their FIDs when presented with different stimuli (Miller *et al.* 2001, Glover *et al.* 2011; Schlacher *et al.* 2013b; Mcleod *et al.* In Press). The type of stimulus which is permitted in a given area is often under the influence of land managers (e.g. Antos *et al.* 2007), and given that disturbance is regarded as a conservation problem in some circumstances (e.g. Schlacher *et al.* 2013a), understanding which stimuli are associated with which responses will aid the management of disturbance (Weston and Elgar 2005, 2007, Weston *et al.* 2012). Theoretically, managers could permit only certain stimuli, or prescribe stimulus-specific buffer zones to minimise disturbance (Weston *et al.* 2009; Weston *et al.* 2012; Mcleod *et al.* 2013). Currently, the vast majority of avian FIDs available worldwide are elicited by single walkers, thus there is a dearth of available information on other, common, stimuli (Mcleod *et al.* 2013).

One commonly held but little tested belief is the somewhat counter-intuitive idea that birds can be approached more closely in vehicles (henceforth 'cars') than on foot i.e. the 'cars cause less disturbance' hypothesis. Many birdwatchers and photographers use cars to approach birds because they believe this allows them to approach the birds more closely than would otherwise be possible on foot (authors, pers. obs.). However, this hypothesis has only rarely been tested, and the available results vary between species, with cars evoking shorter, similar, and longer FIDs compared with single walkers (reviewed in Mcleod *et al.* 2013). This study aims to test whether FIDs evoked by vehicles are shorter than those evoked by a single walker on foot by examining a greater taxonomic breadth of comparisons, and by carefully conducting experimental 'approaches' to birds.

Methods

Fieldwork was conducted at the Western Treatment Plant (WTP), Werribee, near Melbourne, Victoria (38°01'S, 144°34'E). Access to the plant is restricted; visitors are required to obtain a permit and register each visit. The common birdwatching areas of the WTP comprise various ponds and lagoons and the coastline, all of which are easily accessible via car or foot from the roads and paths that run throughout the plant, usually between every pond. The waterbirds at the WTP are thus exposed to some human activity, by cars and humans on foot, which is less than that evident in unrestricted areas such as urban parks (Glover *et al.* 2011).

Measuring Flight-Initiation Distances

Fieldwork took place between January 2011 and January 2012. All fieldwork was conducted between 0730 and 2100 hours, and as is customary and practical, only when it was not raining and in no stronger than moderate winds. We presented two types of stimuli to waterbirds within the WTP: single walker (1.4 m/s) and car (2.8 m/s). A stimulus type was randomly selected for each fieldwork day. For each stimulus type, we recorded FID rather than Alert Distance (AD) as it is a more reliable measure of response when multiple observers collect data (Guay *et al.* 2013b). FID was assessed by moving towards the focal bird at a constant pace. While approach speeds can influence FIDs (Glover *et al.* 2011) we used approach speeds which were typical of the stimuli being tested; our aim was to mimic realistic behaviour of each stimulus type. During the approach the observer/s were silent and made no sudden body movements. The distance at which we started an approach was recorded as the Starting Distance, and was maximised i.e. we used the longest Starting Distance possible (Blumstein 2003). The distance at which the bird walked, swam, dived, or flew away in response to the approach was recorded as the FID. Approaches were included only if the bird's response was determined to occur as a result of the approach. When a flock was approached, the FID was taken from the point at which the first individual showed a response to the approach. An approach was abandoned if it was unclear whether the bird was responding to the observer or to another potential stimulus, such as a bird of prey. Depending on the target bird's original location, we approached either directly or tangentially. All distances were measured using a laser rangefinder.

For all walking approaches the observers wore standard clothes (dark pants and a dark long-sleeved top). Different vehicles (from small hatchback to 4WD twin cab) were used for car approaches. All approaches were conducted on non-breeding adult waterbirds and only single-species flocks were approached. We attempted to avoid resampling individuals by closely monitoring where birds flushed to after an approach, before moving on to the next site.

Statistical analysis

For tangential approaches, FID was calculated as the Euclidian distance between the observer and the subject at the time escape behaviour was initiated by taking into account the bypass distance, the minimum distance between the focal bird and the path of the observer (Cooper 1997). Data for both approach types were pooled for further analysis.

We restricted our statistical analyses to 15 species for which we obtained at least five FID estimates per stimulus. We used a General Linear Model (GLM) to investigate the effect of species, stimulus type and their interaction. Starting Distance, which influences FID in birds (Blumstein 2003), varied between species ($F_{38, 595} = 5.13$, $P < 0.001$) but not between stimuli ($F_{1, 595} = 2.42$, $P = 0.120$). We controlled for the difference in Starting Distance between species by including it in our models. We further used GLMs to compare responses between stimuli for all 15 species individually. All distances were Log_{10} transformed prior to analyses. Summary statistics are presented as mean ± standard errors.

Results

We collected data for 657 approaches from 38 species (car, n=269; walker, n=388; Appendix 1). Results of the GLM for the 15 species for which we had five or more approaches for

each stimulus (11 to 85 FIDs per species; car, 66.3 ± 2.6, n = 246; walker, 74.9 ± 2.3, n = 311) (adjusted $R^2 = 0.57$) revealed significant effects of Starting Distance (logged; $F_{1,526} = 333.68$, $P < 0.001$), stimulus (car vs. walker; $F_{1,526} = 53.36$, $p < 0.001$), and species ($F_{14,526} = 6.27$, $p < 0.001$); the interaction between species and stimulus was not significant ($F_{14,526} = 1.57$, $P = 0.084$) but was associated with high power (0.87). Within-species GLMs (Table 1) revealed that in every case cars had shorter FIDs compared with walkers. Eight of these fifteen comparisons were significantly different with the remaining seven having low statistical power.

Discussion

Few general principles are available to help explain FID in regard to environmental or internal factors (Weston *et al.* 2012), and here we have shown that the 'cars cause less disturbance' hypothesis has at least broad, and possibly universal, relevance across species. From a conservation management perspective, in no case were cars associated with longer FIDs, suggesting that at the WTP cars are effective mobile hides for observing many waterbirds. Additionally, cars can carry multiple people, thus arguably reduce the number of stimuli in an area (Mcleod *et al.* 2013). Birds at the WTP are exposed to many cars and perhaps fewer people on foot (though workers and birdwatchers are not uncommon on foot as they move around the vicinity of their cars; authors, pers. obs.). As for any behavioural study, confirmation of these results at different sites, with different prevailing regimes of cars and walkers, would be useful. Such a study could disentangle local learning on the part of the birds from perception and innate risk judgement of birds. It is important to note that many of the species involved in this study are migratory or nomadic and move in and out of the WTP every year (Hamilton and Taylor 2004; Hamilton *et al.* 2004). In particular, Australian Shelducks *Tadorna tadornoides* come to the WTP only during summer, thus limiting the opportunity for local adaptation.

Several caveats exist regarding the implications of the finding that cars reduce FIDs. Firstly, shorter FIDs in response to cars may not be adaptive in all circumstances. Cars cause direct bird mortality throughout the world and in Australia (Taylor and Mooney 1991; Schlacher *et al.* 2013a), presumably because responses are inadequate, absent or initiated too late. Such mortality can influence roadside bird populations (Bujoczek *et al.* 2011). The vehicle we used moved at slow speeds to mimic the prevailing speed of cars at the WTP; however, high vehicle speeds require earlier flight responses for successful evasion, and faster stimuli are associated with longer FIDs (Glover *et al.* 2011). At least some European birds apparently adjust their FIDs in regard to prevailing speed limits for traffic, but not to car speed *per se* (Legagneux and Ducatez 2013). Thus, the average speed of vehicles may influence FID and there may be a speed above which FIDs exceed those associated with walkers.

Table 1. Results of within-species GLMs for each species where at least five approaches were recorded for each stimulus. We report degrees of freedom (d.f.), F-value, P-value and observed power (Power). Species are presented alphabetically, by common name (BirdLife 2012).

Species	d.f.	F-value	P-value	Power
Australian Shelduck *Tadorna tadornoides*	1, 82	12.11	0.001	0.930
Australian White Ibis *Threskiornis molucca*	1, 26	0.53	0.475	0.108
Black Swan *Cygnus atratus*	1, 55	10.39	0.002	0.886
Chestnut Teal *Anas castanea*	1, 76	14.80	<0.001	0.967
Eastern Great Egret *Ardea modesta*	1, 18	17.35	0.001	0.976
Eurasian Coot *Fulica atra*	1, 16	2.22	0.155	0.289
Hardhead *Aythya australis*	1, 28	3.42	0.075	0.431
Little Black Cormorant *Phalacrocorax sulcirostris*	1, 8	0.06	0.816	0.055
Little Pied Cormorant *Microcarbo melanoleucos*	1, 60	6.56	0.013	0.712
Masked Lapwing *Vanellus miles*	1, 9	10.84	0.009	0.833
Pacific Black Duck *Anas superciliosa*	1, 34	2.33	0.136	0.317
Pied Cormorant *Phalacrocorax varius*	1, 15	5.14	0.039	0.564
Purple Swamphen *Porphyrio porphyrio*	1, 34	8.03	0.008	0.786
Straw-necked Ibis *Threskiornis spinicollis*	1, 31	0.83	0.369	0.143
White-faced Heron *Egretta novaehollandiae*	1, 20	0.00	0.986	0.050

Secondly, while cars may decrease FIDs among many species, they still have profound ecological effects on birds and their habitats (e.g. Reijnen and Foppen 1994) and can cause substantial levels of disturbance to birds especially when they are driving at speed and are common (e.g. Schlacher *et al.* 2013a; Schlacher *et al.* 2013b). Roads and tracks can cause a range of negative ecological effects (Forman and Alexander 1998), and the high mobility of cars means that the 'human footprint' is more expansive than for walkers alone, at least in many areas (Mcleod *et al.* In Press). Clearly all impacts need to be considered by managers before the decision to promote a 'disturbance mediation by stimulus' strategy occurs.

The underlying mechanisms involved in birds discriminating between cars and walkers in terms of response remain unknown (see Weston *et al.* 2012). Each stimulus is associated with different visual and auditory cues, with cars being relatively novel evolutionarily. If size, colour and noise are used by birds to judge risk, then responses may vary with stimulus types (e.g. hybrid versus internal combustion cars), and this would be a useful subject of future study.

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Appendix 1. Raw FID data for all 38 species studied. We report sample size (n), mean start distance (± one standard deviation) and mean FID (± one standard deviation) for each stimulus separately. Blanks indicate no data were collected. Taxa are presented in alphabetical order by common name, and scientific names follow BirdLife (2012).

Species	Car			Walker		
	n	SD	FID	n	SD	FID
Australasian Darter *Anhinga novaehollandiae*				2	108.5 ± 19.0	77.4 ± 0.6
Australasian Grebe *Tachybaptus novaehollandiae*	1	30.5	17.7	3	70.6 ± 10.9	53.5 ± 2.2
Australian Pelican *Pelecanus conspicillatus*	4	208.1 ± 122.3	114.6 ± 51.7	9	212.5 ± 123.7	123.9 ± 104.9
Australian Shelduck *Tadorna tadornoides*	43	277.5 ± 154.5	106.9 ± 48.4	42	219.2 ± 131.2	122.3 ± 59.7
Australian White Ibis *Threskiornis molucca*	17	142.8 ± 78.7	56.2 ± 20.3	12	93.9 ± 41.2	48.6 ± 24.8
Black Swan *Cygnus atratus*	18	147.6 ± 89.4	66.4 ± 59.4	40	124.1 ± 97.0	78.3 ± 51.1
Black-tailed Native-hen *Gallinula ventralis*				6	85.0 ± 40.2	52.7 ± 16.8
Blue Billed Duck *Oxyura australis*				3	85.1 ± 54.7	68.3 ± 36.1
Cape Barren Goose *Cereopsis novaehollandiae*				5	119.6 ± 58.5	82.6 ± 40.3
Cattle Egret *Bubulcus ibis*				1	26.9	23.4
Chestnut Teal *Anas castanea*	33	148.6 ± 71.3	65.1 ± 29.4	46	149.7 ± 71.1	80.1 ± 19.9
Dusky Moorhen *Gallinula tenebrosa*	1	16	14			
Eastern Great Egret *Ardea modesta*	5	121.2 ± 119.4	32.8 ± 18.5	16	86.1 ± 51.1	57.0 ± 29.4
Eurasian Coot *Fulica atra*	14	142.0 ± 74.8	74.3 ± 47.6	5	92.0 ± 29.2	72.8 ± 30.5
Glossy Ibis *Plegadis falcinellus*	1	114.4	22.9	1	68	45
Great Cormorant *Phalacrocorax carbo*	2	100.8 ± 0.7	23.5 ± 8.2	6	92.2 ± 26.0	74.0 ± 20.7
Grey Teal *Anas gracilis*	2	191.5 ± 153.4	61.6 ± 9.4	6	145.0 ± 97.4	82.8 ± 30.8
Hardhead *Aythya australis*	13	129.6 ± 62.0	64.6 ± 24.0	18	160.3 ± 93.1	87.2 ± 44.8
Hoary-headed Grebe *Poliocephalus poliocephalus*	1	47.3	29.9			
Intermediate Egret *Mesophoyx intermedia*	1	210	20	1	27	13
Little Black Cormorant *Phalacrocorax sulcirostris*	6	102.4 ± 66.5	38.8 ± 22.3	5	119.1 ± 106.7	57.3 ± 69.5
Little Egret *Egretta garzetta*				1	39	35
Little Pied Cormorant *Microcarbo melanoleucos*	19	106.6 ± 52.3	33.9 ± 14.9	44	97.7 ± 57.4	46.1 ± 28.8
Masked Lapwing *Vanellus miles*	6	189.8 ± 96.8	40.8 ± 24.2	6	142.0 ± 97.8	79.7 ± 18.0
Musk Duck *Biziura lobata*	3	101.5 ± 77.3	34.1 ± 19.1	7	107.1 ± 42.7	69.9 ± 28.8
Pacific Black Duck *Anas superciliosa*	20	159.2 ± 80.9	72.0 ± 40.2	17	189.6 ± 89.7	89.1 ± 31.4
Pied Cormorant *Phalacrocorax varius*	5	202.4 ± 150.8	50.0 ± 14.0	13	144.8 ± 113.7	77.9 ± 57.9
Pink-eared Duck *Malacorhynchus membranaceus*				12	96.2 ± 60.4	67.1 ± 27.2

Appendix 1 continued.

Species	Car			Walker		
	n	SD	FID	n	SD	FID
Plumed Whistling Duck *Dendrocygna eytoni*				1	178	130
Purple Swamphen *Porphyrio porphyria*	15	89.2 ± 29.8	43.2 ± 32.2	22	90.2 ± 47.1	57.9 ± 26.6
Red-necked Avocet *Recurvirostra novaehollandiae*				1	104.6	32.5
Red-necked Stint *Calidris ruficollis*	1	29.3	26.3			
Royal Spoonbill *Platalea regia*	2	56.0 ± 26.4	46.0 ± 34.9	9	73.7 ± 42.9	48.8 ± 27.9
Silver Gull *Larus novaehollandiae*	3	87.4 ± 19.0	17.4 ± 3.2			
Straw-necked Ibis *Threskiornis spinicollis*	22	222.6 ± 146.3	81.8 ± 38.3	12	164.4 ± 96.1	84.9 ± 40.0
White-faced Heron *Egretta novaehollandiae*	10	143.5 ± 84.5	63.0 ± 31.6	13	77.4 ± 31.4	46.4 ± 19.6
White-necked Heron *Egretta novaehollandiae*	1	116.7	26.4	2	71.2 ± 2.5	63.4 ± 7.6
Yellow-billed Spoonbill *Platalea flavipes*				1	38.4	24.7