Observer effects occur when estimating alert but not flight-initiation distances

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Observer effects occur when estimating alert but not flight initiation distances

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Running Head: Observer effects in estimating flight distances

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Abstract.

Context. The estimation of alert (vigilance) and flight-initiation (escape) distances (AD and FID) has underpinned theoretical and applied studies of the escape behaviour and management of disturbance to wildlife. Many studies use multiple observers, and some conduct meta-analyses; these efforts assume no observer effects in the estimation of these distances.

Aims and methods. We compare the estimates of FID and AD under ideal conditions (i.e. of black swans *Cygnus atratus,* a large species with obvious behaviour, and at a location where swans allowed close approaches in open habitats), by one experienced and four inexperienced observers.

Results. FID did not differ between observers but AD differed between the experienced and all inexperienced observers, and among inexperienced observers. Thus, FID estimates appear more repeatable than those of AD. Experience apparently results in more conservative estimates of AD.

Implications. We recommend the use of FID rather than AD for comparative analyses which involve multiple observers, since FID is more reliably measured.

Introduction

The disruption of behaviour or physiology in the presence of a threatening stimulus, such as a person, is known as disturbance (Hill *et al.* 1997). The distance at which an animal becomes vigilant is known as 'Alert Distance' (AD; Blumstein 2006) and the distance at which it flees from a threat is known as the 'Flight-initiation Distance' (FID; Hediger 1934; Stankowich and Blumstein 2005). These distances are usually highly correlated and they describe an escalation in response to threat (Eason *et al.* 2006; Weston *et al.* 2012). ADs and FIDs offer insights into the behavioural and evolutionary ecology of escape, threat perception, and options for managing disturbance, for example, through designating buffers (Rodgers and Smith 1997; Weston *et al.* 2012; Guay *et al.* In Press-b).

Recently, detailed summaries of FIDs for many bird taxa have been published, with a call for more publication of raw data to facilitate enhanced management of disturbance, and to aid comparative studies of FID. Additionally, recommendations for standard data collection have been made (Weston *et al.* 2012). Inevitably, these summaries contain data from multiple observers, and given that some subjectivity may be expected in judging the exact moment at which vigilance or escape is initiated, inter-observer variation in estimating ADs and FIDs may exist. However, escape may be more detectable to observers than more subtle behavioural responses such as alertness. Observer differences have been documented in aspects of ornithological field work, including surveys (Cunningham *et al.* 1999), mapping (Verner and Milne 1990), estimates of abundance (Van Der Meer and Camphuysen 1996), reporting of tag numbers on birds (Mulder *et al.* 2010), and estimating prey size (Goss-Custard *et al.* 1987). However, we are unaware of any studies of observer effects in estimating the distance at which behaviours, such as alertness and flight, occur. If inter-observer variation exists in estimating these distances, then analysis of AD or FID data should account for the influence of observer.

This study examines whether inter-observer effects exist in estimating ADs and FIDs using a system where both alert and flight behaviours were easily observable, thus minimising the impact of subjective interpretation of behaviour on the measurements. We also used accurate methods of measuring distance, thus discounted the effect of distance perception on our measurements. The system we examine thus represents a ‘best case’ situation with respect to the collection of ADs and FIDs.

Methods

Study species

The black swan (*Cygnus atratus*), a large waterfowl endemic to Australasia, was selected as the model species. We selected this species because swans are large and obvious, with readily observable behaviours, and they forage in short grass without visual obstruction, in an easily accessible urban location.

Study site

The study was conducted within Melbourne's inner urban matrix, at Albert Park Lake (37º50'S, 144º58'E; Victoria, Australia) between 17 July and 30 August 2012. The 225 ha parkland contains a 48.5 ha artificial lake with a concrete edge. The lake harbours a large and apparently highly habituated population of *C. atratus* which forage on the extensive grassy verges and frequently encounter pedestrians (see Weston *et al.* 2012 for a discussion of other possible explanations of shorter FIDs in areas where people are common). Habituation, the processes whereby animals learn to reduce responses upon exposure to a stimulus, is thought to reduce FID, and is one possible explanation of the particularly short FIDs we report here. Despite the high density of people, swans still avoid pedestrians and display increased stress-induced corticosterone levels in reaction to handling (Monie 2011; Payne *et al.* 2012). Most swans in the population have been marked with a neck collar allowing identification from a distance (Guay and Mulder 2009; Mulder *et al.* 2010).

Volunteers

Four university students or recent graduates were recruited for this project. All students had some experience working with wildlife, but none had ever measured

FIDs or ADs. Prior to the start of the project, each observer received a 2-hour training session, at the study site, with one experienced observer who had measured in excess of 700 FIDs in various species of birds including *C. atratus*, and who also collected FIDs and ADs for this study. Training involved learning the basic protocols, then conducting approaches in conjunction with the experienced observer, to standardise protocols and agree which behavioural cues constituted alertness and flight. Training of this type has been suggested for studies where new observers are recruited (Fernández-Juricic *et al.* 2001). Following the training session, each observer was provided with all required equipment (see below) and instructed to return to the site and measure between 40 and 50 FIDs and ADs for *C. atratus* in their own time. Fieldwork was scheduled to ensure that no two observers were present at the field site simultaneously.

Measurements of FID and AD

Alert distance was defined as the distance between an observer and a swan at which a foraging or resting swan raised its head and looked at the observer (after Fernández-Juricic *et al.* 2002). FID was defined as the distance between an observer and a swan at which time the swan initiated escape behaviour either through walking, running or flying away (Weston *et al.* 2012).

Swans to be observed ('focal' swans) were selected as follows: a haphazard starting point was selected on the lake shore and the lake was circumnavigated in a randomly selected direction determined by coin toss. Only collared swans standing up and foraging on land were studied and they were targeted as they were encountered. Additionally, we selected only individuals not currently disturbed, and situated further than 10 m away from other park users. Typically, the observer would walk alone along the path around the lake until a group of swans was detected. The approach was then started from the point where the swan was identified. We recorded neck collar identification to determine sex (white collars for females, black for males; Guay *et al.* 2009), using binoculars or the range finder, either from a distance before the approach or after the approach was complete. We avoided repeat sampling of individuals on the same day. The closest swan to the observer at the start of the approach was always selected for observation (i.e. was the focal bird). Non-focal swans located further from the observer that had been disturbed during an experimental approach were excluded as candidates for following approaches.

All approaches were made parallel to the shore of the lake because angle of approach can influence response in birds (Burger *et al.* 2010). All approaches were conducted at standard walking speed (*c.* 1 m sec^{-1}; Glover *et al.* 2011). We used a Bushnell® Elite 1500 Laser Rangefinder to record FID (± 1 m). Start Distance (SD), the distance from the focal bird at which the experimental approach is started, is an important parameter influencing the response of birds (e.g. Blumstein 2003). Given the difficulties of standardising SD as part of our experimental design, we measured SD and controlled for it by including it as a covariate in our analyses. Measurements were conducted as follows: the initial distance between the bird and the observer (SD) was measured directly using the range finder. A marker was then left at the starting point. Following the alert and flight responses (i.e., the target swan taking a step or flying), separate makers were placed on the ground. Flight can be confused with foraging movements in some species, which can lead to an overestimate of FID

(Chamaillé-Jammes and Blumstein 2012). However, *C. atratus* adopt an alert posture with the neck raised high before initiating escape behaviour, which permits unambiguous identification of flight. This simplifies the analyses of the relationship between SD and FID and allows the use of ordinary least-squares regression rather than quantile regression (Chamaillé-Jammes and Blumstein 2012). At the completion of the approach, the observer moved to the initial position of the swan and measured the distance to the different markers using the rangefinder. The perpendicular distance between the initial position of the swan and the edge of the lake was also measured using a range finder because distance from shore has been shown to influence FID in *C. atratus* (Guay *et al.* In Press-a). For each approach we also recorded potential covariates, namely sex and group size (number of swans within 10 m of the focal bird).

Statistical analyses

Data were analysed using General Linear Mixed Models (GLMM) on IBM SPSS (v. 20, IBM Corporation, Armonk, NY, USA) with a random factor of swan identity included to account for the influence of multiple sampling of the same collared swan on different days. All two-way interactions were included in the model. All distances and group size were $\log_{10}$ transformed prior to analysis to improve normality (Blumstein 2006). For significant factors, we calculated pairwise comparisons based on estimated marginal means to determine where significant differences resided. Summary statistics are presented as means ± one standard deviation and include the range and sample size in brackets.

Results

Overall, AD was 28.2 ± 15.9 m (3 – 85; n = 218; 38 – 50 per observer) and FID was 13.9 ± 10.8 m (0.2 – 63; n = 225; 40 – 50 per observer). As expected, AD was highly correlated with FID ($R^2 = 0.342$, $F_{1, 216} = 112.3$, $P < 0.001$) and was recorded in 96.9% of approaches. GLMM results revealed an observer effect for AD but not FID, no effect of group size for either response distance, a significant effect of distance from shore for FID but not AD and an effect of start distance on FID and AD (Table 1). Pairwise comparisons revealed that estimates of AD were higher for inexperienced observers than for the experienced observer. Although three of four inexperienced observers did not differ from one another, inexperienced observer 1 differed from inexperienced observer 2 (p = 0.003; see Figure 1) and inexperienced observer 3 (p = 0.043; see Figure 1). Thus, FID estimates appear more reliable than those of AD.

INSERT TABLE 1 AND FIGURE 1

Discussion

While some studies of FID and/or AD involve only one observer (e.g. Møller and Erritzøe 2010; Glover *et al.* 2011; Guay *et al.* In Press-b), those conducted over large geographical or taxonomic scales inevitably use multiple observers (e.g. Blumstein 2006; Weston *et al.* 2012). Variation between observers can result in poor precision, thus requiring increased sample sizes or statistical control of bias (Verner and Milne 1990; Cunningham *et al.* 1999). We found consistent estimates of FID among observers, suggesting that inter-observer differences are negligible, at least for the species and observers we tested. It appears that the training we provided to novice observers was adequate to ensure consistency in FID estimates.

Alert distances have been proposed as a way of defining buffer distances to manage disturbance to birds; unlike setting buffers using FIDs, buffers set using ADs may additionally reduce behavioural disruption associated with vigilance (Fernández-Juricic *et al.* 2001). Several workers have also studied tolerance of birds to people, using the difference between AD and FID as a measure (Fernández-Juricic *et al.* 2001; O'Neal Campbell 2006). However, inter-observer differences were evident in the estimation of AD, and the difference between AD and FID varied dramatically between the observers we used; FID was estimated to be between 30 - 60% of AD among observers. Experience apparently results in more conservative estimates of AD, estimates of which apparently vary between inexperienced observers. AD is arguably more difficult to define and detect than FID, and several of the novice observers apparently used different behavioural cues to determine alertness or were less able to detect it. In general, vigilance in birds involves a greater variety of behaviours and postures than escape, these are often subtle, and vigilance may occur more frequently than escape, making the clear definition and recognition of alertness difficult. Birds often display alert behaviour even in absence of humans. *C. atratus* on land spend 8.2% of their time alert (unpubl. data). Failure to discriminate general alert behaviour from alertness directed toward the approaching investigator may result in overestimated AD. Additionally, birds may not necessarily become alert before initiating escape behaviour and vigilance may occur before birds adopt behaviours which observers recognise as alertness (Lima and Bednekoff 1999), which is not the case when measuring escape. Indeed, Weston *et al.* (2012) separately defined Detection Distance from AD. In our experience, AD is less efficient to measure than FID (AD is often not discernible during an approach); in a study of shorebird flight behaviour, AD's were reported by one experienced observer in only 23.8% of 753 approaches (unpubl. data) and in a study of waterbirds an experienced observer recorded AD in 14.6% of 245 approaches (unpubl. data), either because alertness was sometimes difficult to detect or did not always occur. In this study we recorded AD on almost every approach, a reflection of the study species and site. Thus, AD is less reliable, and sometimes less reliably recorded, than FID.

As for any study of ADs and FIDs, the applicability of these results to other species, habitats, and circumstances (e.g. observers, training regimes) remains to be examined (see Fernández-Juricic *et al.* 2001). However, repeatability of both AD and FID warrants consideration when analysing multi-observer datasets, and applying their findings to the management of disturbance. Where multiple observers are used, it may sometimes be appropriate to report inter-observer reliabilities in estimating FIDs.

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Table 1. General Linear Mixed Model results of the logged Flight-initiation and Alert Distance against observer identity, log of swan group size, log of starting distance, and log distance from shore. * indicate parameters which have been $\log_{10}$ transformed, ** indicated significant results.

Parameter	Flight-initiation Distance*	Alert Distance*	Qualitative results the same?
Observer identity	$F_{4,216.525}$ = 0.620, p = 0.649	$F_{4,208.428}$ = 8.476, p < 0.001 **	No
Starting distance*	$F_{1,213.609}$ = 6.402, p = 0.012 **	$F_{1,205.803}$ = 39.295, p < 0.001 **	Yes
Group size*	$F_{1,216.771}$ = 0.688, p = 0.408	$F_{1,208.848}$ = 0.383, p = 0.537	Yes
Distance from shore*	$F_{1,172.814}$ = 12.066, p = 0.001 **	$F_{1,187.303}$ = 0.019, p = 0.891	No

Figure 1. The Alert (triangle) and Flight-initiation (circles; both logged) Distances for one experienced and four inexperienced observers who approached *C. atratus*. Estimated marginal means and 95% confidence intervals are shown.