BIRD AIRCRAFT INTERACTIONS IN RELATION TO AMBIENT LIGHT CONDITIONS

Gavin Fennessy Dr[1], Thomas C. Kelly Dr[1,4]*, Michael J.A. O'Callaghan Dr[3], Patrick D. Bourke Prof.[2], Sorcha Sheehy[1], Ray Bolger[4]
[1]Department of Zoology and Animal Ecology, National University of Ireland Cork, Ireland
[2]Statistics Department, National University of Ireland, Cork
[3]Department of Applied Mathematics, National University of Ireland, Cork
[4]Aer Rianta, Dublin Airport, Dublin, Ireland
*Corresponding author: Tel: +353214904188, fax:+353214270562
E-mail: t.kelly@ucc.ie

Abstract

The response of birds to visual cues may be affected by ambient light conditions. In poor light the bird may be slower to detect a moving aircraft. However, in very bright light critical visual cues such as the landing lights may not be readily discernable. Previously a relationship was established between barometric pressure and the frequency of bird strikes. Thus more strikes occur on days with lower than average barometric pressure but there is also a small peak at very high atmospheric pressure levels. This study will establish the relationship between ambient light conditions and the avoidance behaviour of birds to moving aircraft. An Extech datalogging light meter was used to measure ambient Lux values under contrasting conditions. At the same time detailed observations of bird-aircraft interactions were recorded. Most observations concerned the rook (*Corvus frugilegus*) but data were also collected on other species commonly over-flying the active runways at Dublin Airport, Ireland. The results are discussed in the overall context of birds' ability to predict the time to collision (TTC).

Key words: ambient light, avoidance behaviour, visual cues, TTC

1. Introduction

For any animal, risk is an inherent part of life. Failure to detect a predator can be fatal and predation is a major selective force in nature (LIMA & DILL, 1990). Most birds evade predators and threatening situations by being able to fly and by relying on superior aerial manoeuvrability. Most bird species can fly and so, they operate in a three-dimensional environment.

Perception of 3-D space is believed to involve three key processes:

(i) Accomodation (or Convergence) is the oculomotor adjustment of the eye(s) to keep an image in sharp focus on the retina
(ii) Multiple sampling of the image from different positions in space (*stereopsis*) or time (*motion parallax*)
(iii) Cognitive interpretation of the image based on experience

In recent years the importance of monocular cues to animals' space perception has begun to be recognized (ZEIGLER & BISCHOF, 1993). Indeed there is some evidence to suggest that binocular stereopsis in species like many birds, that have their eyes set relatively laterally on the head, may be restricted to near range activities (MCFADDEN, 1993).

Birds need to be able to detect potentially dangerous situations and to respond according to the level of risk that is faced. It has been shown for instance, that several avian species alter their avoidance response depending on the attack strategy of a predator (CRESSWELL, 1993; LIND et al., 2002). The ability to estimate time to collision (TTC) far enough ahead of a potential event to allow an appropriate motor response is vital to birds navigating a busy and potentially hazardous environment like an airfield (KELLY et al., 2000a).

There has been a great deal of debate about how birds estimate TTC. One theory is that the rate of expansion of a retinal image (sometimes known as *looming*) can trigger a behavioural response (LEE, 1976; SCHIFF & DETWILER, 1979). The timing of this response is controlled by a variable known as τ (Tau) where Tau is equal to the inverse of the relative rate of expansion of the looming object on the retina (SUN & FROST, 1998). The idea of a "looming image" providing a bird with an estimate of TTC is an appealing one. There is some compelling evidence to suggest that Tau may indeed be an important cue in avian visual perception. Experiments on pigeons (Columbiformes) have revealed neuronal mechanisms that appear to be important in estimating TTC (WANG & FROST, 1992; SUN & FROST, 1998). However, TRESILIAN (1999) strongly argues that Tau is only one of an array of potential perceptive cues that are used by birds to estimate time to collision.

When assessing the risks involved in traversing an airfield, a bird must seek information from the environment. It has been shown that prevailing weather conditions may affect bird strike rate at airfields (GABREY & DOLLBEER, 1996; KELLY et al., 2000b; MANKTELOW, 2000). It is supposed that such environmental factors perhaps make it more difficult for birds to correctly gather and process auditory (e.g. HEFFNER, 1998) and visual information from their surroundings.

There has been little contemporary research on the potential effects of ambient light conditions on bird strike risk. During the course of our research we aim to examine the role of ambient light on the avoidance behaviour of birds at Dublin Airport in Ireland.

2. Methods

2.1 Site Description

Dublin Airport (EIDW), is situated in north County Dublin (53'25.87N 006'15.20W), on the east coast of Ireland. It is an international commercial airport which carries 15-20 million passengers annually. It has two principal runways: 10/28 (2637x61m) and 16/34 (2073x61).

There is an active 'bird patrol' at the airport seven days a week. Cadavers of suspected strike victims are frozen for post mortem analysis. Bird strikes are classified according to the criteria specified in Kelly, MURPHY & BOLGER (1996).

In October, 2002, four members of our research group completed safety training, at Dublin Airport, to be permitted airside access. Members of the bird patrol 'ferry' the researchers to the selected vantage points on the perimeter roads around the airfield.

2.2 Equipment and Baseline Survey Work

Our initial aim was to become familiar with the layout of the airfield. Much of the previous work had been conducted in the central area around and including the main runway 10/28. In order, to build upon the store of historical data available it was decided to concentrate bird recording efforts in this central 'box' which encompasses all but the extremes of the main runway. We adapted the survey methodology which had been previously used at the site. This involved using a series of landmarks, clearly visible from either side of 10/28, to formulate a rudimentary grid system to classify observations of birds over flying the site. Thus we divided the survey area into a grid with large boxes – boxes that run from runway or taxiway margin as far as the airfield fence, and other boxes that encompass portions of the runway and taxiway. We used a small number of vantage points along the airfield perimeter roads to note our observations in the field. Data collection began in early January, 2003.

Given the large 'volume' that this main survey area encompasses it was imperative to find a way of quickly recording our observations. Therefore a Sony Digital Voice Recorder ICD-BP150, with two external Sony microphones (ECM-TS125) was employed. Using a microphone jack adapter with the voice recorder allows two observers to document their field observations, which are later analysed using Sony Digital Editor Software. All observations are made with the aid of Carl Zeiss 8x30 *Diafun* binoculars.

Ambient light levels (Lux) are measured every 15 seconds using an Extech 401036 datalogging light meter with PC interface software.

Our aim is to develop further and build upon the earlier work carried out at the airport. We collect information on all birds that enter the airfield within the current survey area. In this manner we gather data on the species, flocking behaviour, flight direction, times and locations for all birds observed and, crucially, we carefully detail any avoidance behaviour of birds in response to aircraft.

3. Results

The selection of preliminary graphs presented here are intended to serve as an illustration of some of the ideas we plan to develop during the course of our research.

Light intensity can vary dramatically in a short period of time while at other times the pattern is very stable. *Figures 1-3* illustrate the varied nature of light intensity in a sample of survey days.

Thus, the 23rd January, 2003 is used to illustrate the proportion of birds actively avoiding aircraft during periods of different light intensities [*Figure 4*].

Two pie charts illustrate the relative proportion of each class of avoidance manoeuvre performed during different levels of light intensity [*Figures 5 and 6*]. Classification of avoidance response follows KELLY et al., (1999). Multiple response refers to occasions where an individual bird performs several successive avoidance manoeuvres.

It must be stressed, that these data are preliminary and based on a few months survey effort.

4. Discussion

The ability of birds to perceive and react to stimuli may be affected by light intensity (ZEIGLER & BISCHOF, 1993; KELLY et al., 2000ab). There is a growing body of research that suggests that birds may be equipped with neurons that are responsible for estimating time to collision (e.g. SUN & FROST, 1998). The stimulation of these neurons in the nucleus rotundus can be associated with definite physiological responses including an increase in heart rate (WANG & FROST, 1992).

Visual perception is crucial in TTC calculations. Whatever are the precise processes that are involved; an estimate of arrival time (interceptory arrival) must be gleaned from some combination of binocular and monocular looming information. As such, it is surprising that not more contemporary field-based research has been conducted into the potential role of ambient light conditions on bird avoidance behaviour.

Preliminary analysis of our field-data has highlighted potentially interesting patterns. It may be that there is a different profile of avoidance response at different light intensity levels [*Figures 4-6*]. There may be several patterns and trends in bird avoidance behaviour that vary or co-vary with some measure of ambient light. It is hoped that ongoing research will yield some of these answers.

Acknowledgements

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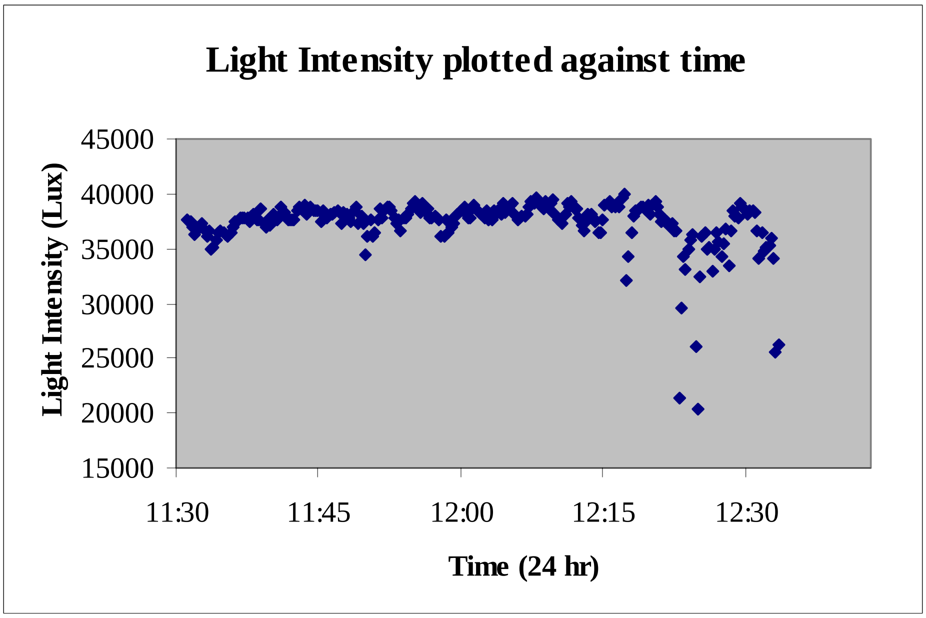

Figure 1. *This scatterplot shows the relatively stable light intensity readings over the course of one hour on 17th February 2003 at Dublin Airport*

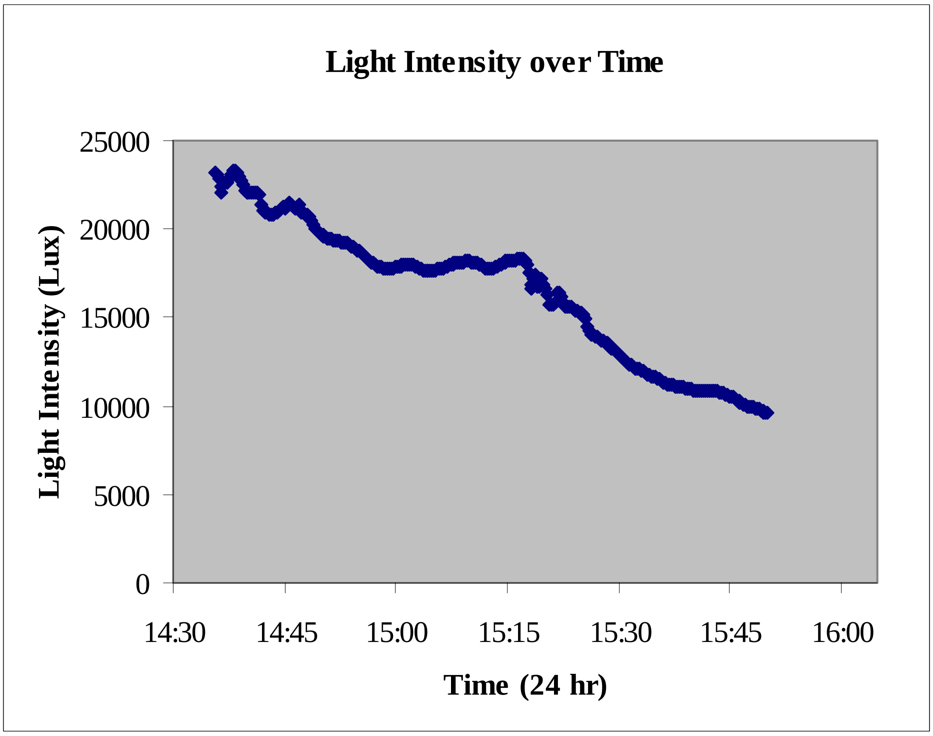

Figure 2. *This scatterplot shows the pattern of light intensity over time at Dublin Airport, 13th February, 2003*

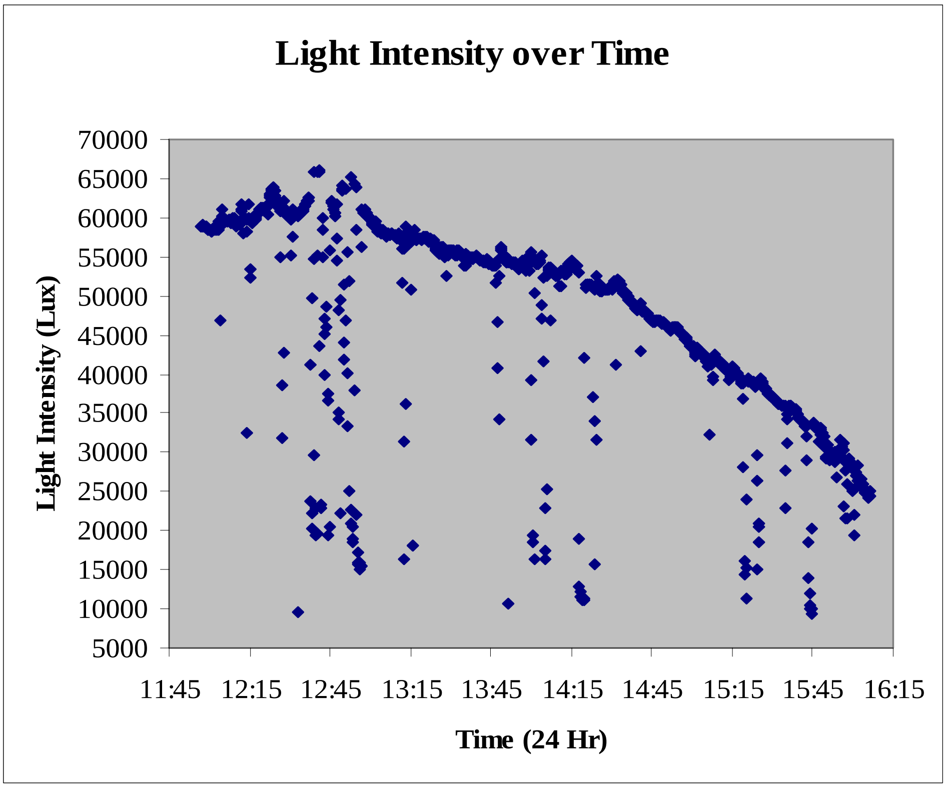

Figure 3. *This scatterplot show the pattern of light intensity over time on March 12th, 2003. Note the high Lux values and the many 'outliers'*

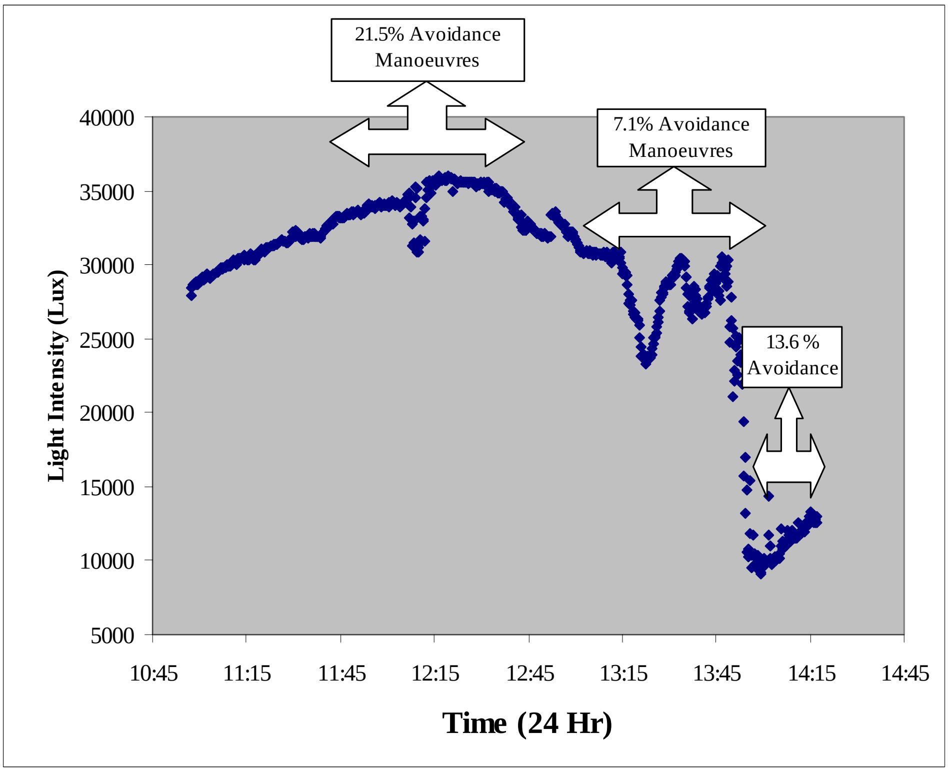

Figure 4. *Pattern of light intensity during survey day on 23rd January, 2003 and percentage of birds actively avoiding aircraft during three periods of the survey day*

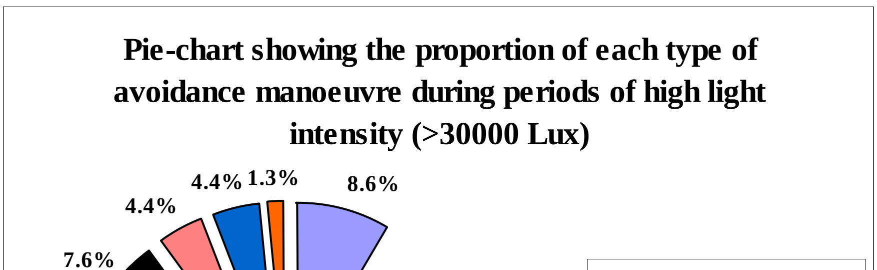

Figure 5. *This pie-chart show the proportion of each type of avoidance behaviour initiated during periods of high light intensity (>30000 Lux)*

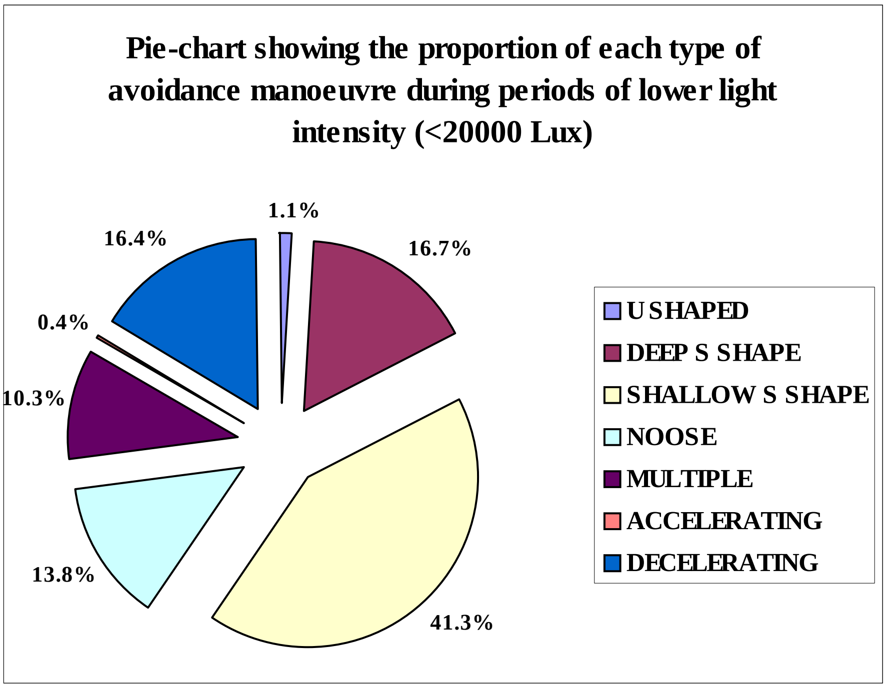

Figure 6. *This pie-chart show the proportion of each type of avoidance behaviour initiated during periods of lower light intensity (<20000 Lux)*