Avian Vision - Seeing Within the Invisible

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SUMMARY

The avian eye includes a various number of unique capacities which have to be considered in keeping pet birds as well as poultry under artificial light sources. The latter is presently a major topic of discussion in europe in terms of animal welfare and the need for updating legislation for keeping commercial kept poultry. Conventional artificial light sources do not meet the requirements of the avian eye clearly differing from the needs of the human eye. Unique features of the avian eye include ultraviolet sensitivity in almost all diurnal species and increased flicker fusion frequency to be considered while keeping birds under artificial light condition.

VISUAL CAPACITIES

In many birds and reptiles the eye is the most important sensory organ. The capacities of the avian and reptile eye are an adaptation to the specific way of life and habitats as well as physical activities that are closely bound to perfectly functioning vision (e.g. flying). Even partial impairment of vision that can. From a practical point of view, keeping birds under artificial light sources two features are of major importance: UV – perception and increased flicker fusion frequency:

- Superior visual acuity mostly exceeding capacities of the human eye
- Pentrachromatic vision: orientation within five colour channels versus three in man
- Ultraviolet perception: visual spectrum 320 – 680 nanometers (see Figure 1)
- Increased flicker fusion frequency

Flicker fusion frequency is the ability of the eye to detect single frames within a certain movement. In the human eye flicker fusion frequency is (depending on light intensity, image contrast and more) 16 to 80 frames per secons (f/s), whereas electroretinograpical (EEG) – studies proof the flicker fusion frequency in many birds, such as chickens, to be as high as 160 f/s.

Anatomical basics include a UV-translucent lens and UV-specific retinal cones enabling the avian eye to perceive within the UV.

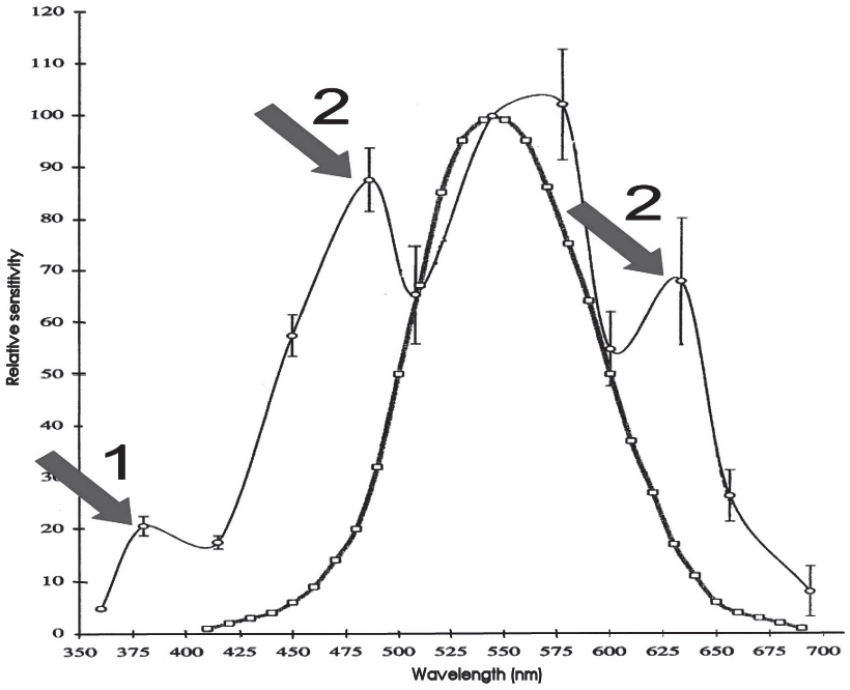

Figure 1: Extended visual light spectrum (320 – 680 nm) showing peaks in the ultraviolet not visual spectrum for the human eye (1) at 375 nm, in the visual spectrum for the human eye (2) within the near blue (475 nm) and red (650 nm) spectrum in the chicken eye compared to the human eye (400 – 680 nanometers, bold line).

VISION RELATED CAPACITIES AND BEHAVIOURAL ASPECTS

A wide variety of specific capacities is closely bound to the visual capacities outlined:

- Intra- and interspecific communication and sexual dimorphism. Intra- and interspecific communication - even in those appearing monomorphic for the human eye takes place within the UV - spectrum. Most psittacine birds appear monomorphic to the human eye, not showing any sexual dimorphism. Birds are able to differ between males and females while detecting sex related differences in the UV-reflection of feathers and cutaneous areas including the beak. Highly reflective UV-areas could be demonstrated for example in the bill of toucans or feathers within the leg area in canaries.

- Crypsis
  Insects using camouflage (green insect on a green leaf) are being detected by the avian eye perceiving within the UV.

- Rearing
  In various bird species, such as zebra finches, the beak includes highly UV-reflective areas within the beak cavity. When opening the beak this is used as an optical signal for feeding.

- Assessment of food
  Various fruits (such as grapes) differ in the abilty to reflect within the UV depending on the status of ripeness. Birds are assessing food using this principle.

- Detection of prey patches
  Various raptor species (such as common kestrels) are choosing prey patches detecting the UV-reflection of the urine of mice, indication, that an intense UV-reflection is indicative for a dense mouse population.

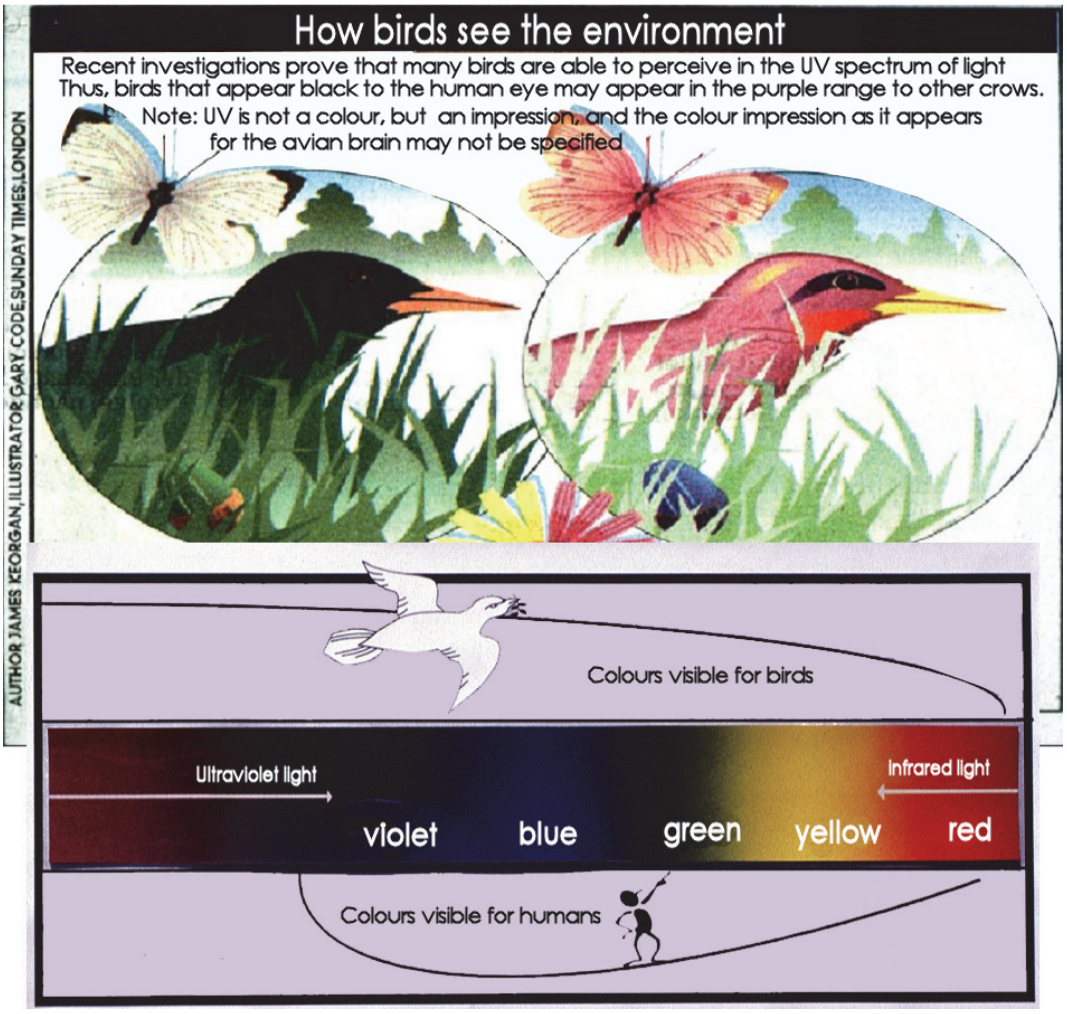

Figure 2: Ultraviolet vision in birds: Black birds (*Merula merula*) and certain environments (grass, flowers), as they may appear for the human eye (left) and for the avian eye within the UV (right), showing the extended visual light spectrum in the avian eye (320 nm – 680 nm) compared to the human eye (400 – 680 nm) (bottom image).

CONSEQUENCES

It has to be stressed, that conventional light sources are designed for human vision not meeting the requirements of the avian eye. Thus keeping pet birds and poultry under artificial light conditions and meeting animal welfare aspects requires light sources emitting within the UV – spectrum (320 – 380 nm) using so-called “full spectrum” or “true light” light sources at the same time emitting flicker free light, to be realized using a socalled electronic control gear (ECG) or dimmer converting alternate current (AC) to decent current (DC).

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