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Research article

Response of predatory birds to varying levels of difficulty in obtaining food

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Abstract

This study investigated the development of the ability to obtain food in predatory wild birds (*Ardea cinerea*, *Accipiter gentilis*, *Milvus migrans*, *Athene noctua*, *Strix aluco* and *Bubo bubo*) in a wildlife rehabilitation centre. Birds were stimulated to find/capture food, dead or alive, at five levels of increasing difficulty, and compared with controls. Each level of difficulty lasted about a week for each animal. They were only moved to the next level if they did not lose weight and did not show signs of loss of physical abilities. Weights were obtained about once every seven days. The mean time taken to reach the highest level of difficulty was shorter for Strigiformes (16.6 ± 8.8 days) – especially *Athene noctua* – when compared to Falconiformes (54.1 ± 10.2 days). When compared to control birds, the animals tested did not show significant weight loss. The time to reach prey competence (number of days a bird needed to attain the last level and stay there at least a week) ranged between 10 and 47 days. The time that the test birds needed to reach the last level (and full recovery) was not significantly different from the time controls took to recover. The number of weights (the total number of times a bird was weighed until it reached the final level and stayed there, reflecting the number of manipulations to which individuals were subjected during the recovery process) ranged from five to 10, while the average for controls was 5.9 ± 1.87. We conclude that adding some degree of difficulty to the feeding of captive birds of prey recovering at wildlife centres does not seem to have negative effects on the recovery process itself or on the centre's routine work, and can contribute to improving birds' physical and psychological health as it stimulates movements and skills that, apart from the recovery process itself, may increase the chances of survival when the birds are released.

Introduction

Animal welfare can be defined in various ways according to the emphasis that is placed on the different characteristics of animals (Duncan & Fraser, 1997). However, the fundamental goal of welfare is to keep animals in good health, both physical and psychological (Young 2003). An approach that brings together both components of animal welfare is environmental enrichment (Forthman-Quick 1984). Within the five sub-types of environmental enrichment (Bloomsmith et al. 1991), emphasis is often put on food enrichment that takes into account the ecological characteristics of species in relation to their diet and feeding habits (Arent 2007).

Birds of prey are a highly ecologically sensitive group with an increased risk of extinction, because they occupy the top position in the food chain (Cabral et al. 2005). It is on this group that most rehabilitation efforts for wild animals in the Portuguese countryside are centred (Horta et al. 2009). This research aimed to study responses to varying difficulty in obtaining food by predatory wild birds held in rehabilitation centres, with the goal of improving the overall recovery process.

Methods

The work was done with birds held at a recovery centre for wildlife (CERVAS – Centro de Ecologia Recuperação e Vigilância de Animais Selvagens), located in Gouveia, Portugal. The methodology used was based on stimulating the birds to overcome each of five levels of difficulty in getting food (see Table I) and to find/capture food supplied dead and alive in a variety of ways (Table 2). The tests took place between 7 September 2008 and 30 June 2009. Birds were exposed to each level of difficulty for about a week, but only moved to the next level if they did not lose weight and showed no decline in their physical condition. Whenever they did not meet the above criteria, the animals were kept at the same level or put back to lower levels of difficulty. The species studied were grey heron *Ardea cinerea* (1 animal), goshawk *Accipiter gentilis* (1 animal), black kite *Milvus migrans* (6 animals), little owl *Athene noctua* (7 animals), tawny owl *Strix aluco* (7 animals) and eagle owl *Bubo bubo* (2 animals), which were compared with control animals kept in the same conditions but fed in the standard way (food supplied on a single tile placed on the floor of the cage). Each of the 24 birds studied was weighed every

Table 1. Levels of food enrichment and descriptions.

Food enrichment level	Description
Level 1	Dead food (cut into pieces, placed on a single tile)
Level 2	Dead food (cut into pieces) placed on several tiles, at different places and heights
Level 3	Dead food (cut into pieces, placed at different places and heights but not on tiles), at equal amounts with and without fur/scales
Level 4	Equal weights of dead food (cut into pieces, placed at different places and heights but not on tiles, with fur/scales) and live prey
Level 5	Equal weights of dead food (cut into pieces, placed at different places and heights but not on tiles, with fur/scales) and live prey hidden with the help of specific structures (e.g. mouse shelters)

7.4 (± 4.94) days. Timing of weight recording depended on the capacity and logistical requirements of the recovery centre, the need to ensure that clinical recovery, either of the animals under study or others, was not called into question, and the balancing of the various tasks.

We calculated number of weighings (the average number of weighings that each species was subjected to up to and including reaching and staying at the last level of difficulty, which reflects the manipulations to which the individuals are subjected and is related to the total recovery time in captivity), and time to prey competence (number of days a bird needed to attain the last level and stay there for at least a week, i.e. the point at which the birds were able to search for and capture live food).

Results

Strigiformes, particularly *Athene noctua*, reached the highest level of difficulty faster than Falconiformes (Table 3). The average number of days that these birds took to reach the highest level of enrichment was significantly lower than the average number of days that Falconiformes took to reach the same level (16.6 ± 8.75 and 54.1 ± 10.20, respectively; $t = 9.01$, $p < 0.001$, $df = 21$). As a consequence the Strigiformes were subjected to fewer manipulations than the Falconiformes (weighings: 3.9 ± 1.0 and 4.9 ± 0.4, respectively; $t = 2.44$, $p = 0.024$, $df = 21$).

The grey heron was also slower than the nocturnal species ($t = 3.83$, $p = 0.002$ and $t = 12.20$, $p < 0.001$, respectively) (Table 3). However, among the diurnal birds, the grey heron proved to be significantly faster than the Falconiformes ($t = 7.56$; $p < 0.001$). Among the birds studied black kites were the slowest, taking about 58 days to reach the highest level (Table 3).

Comparing the controls and experimental birds revealed no major weight differences, and only the grey heron showed a small weight loss in the early stages of the enrichment programme (Fig. 1).

Time to prey competence

Of the test birds, 75% reached the last level and stayed on it, i.e. began to capture live prey that had the opportunity to hide, with no decline in their condition. The time to prey competence was shorter or very close to the average recovery time of the control birds, but not statistically different (Table 4).

The time to prey competence was shorter for the nocturnal birds of prey (29.1 ± 17.90 days) than for the diurnal birds (92.6 ± 24.20 days) ($t = 7.1$, $p < 0.001$). The duration of the period to prey competence ranged between 10 and 47 days. However, black kites never managed to capture live food during the 102 days of the study (Table 4).

Number of weighings

Table 5 shows that the number of weighings of test birds was only significantly higher than the controls in the case of black kites. As also shown in Table 5, black kites never reached the highest level of difficulty. The number of weighings of each individual test bird ranged from five to 10 (average 7.2 ± 1.9) and was not statistically different from the average number of times that the controls were weighed (5.9 ± 1.9) (Table 5).

Discussion

Our results show that it is possible to introduce some degree of difficulty in the feeding of birds of prey kept in wildlife rehabilitation centres without negative consequences for the recovery process or for the birds' condition. Neither the weight nor the condition of the test birds differed from those of controls. However, in some cases the procedure may increase the number of times a bird is handled for weighing, which on the one hand may be harmful because of the increased stress imposed by capture, but on the other hand enables greater control of the clinical and physical condition of the animals.

The results also suggest that Strigiformes responded faster than Falconiformes. This may be due mainly to better physical condition of these birds upon arrival at the centre and to their metabolic needs. On the other hand, black kites never captured live prey; their necrophagous habits may contribute to explaining this (Cramp and Simons 1980).

Table 2. Type of dead food, dead food covering and live food, used to feed the different species in the study.

Species	Dead food	Type of dead food covering	Live food
Ardea cinerea	Small pieces of fish without scales (approx. 6 × 2 × 2 cm)	Scales	Small fish
Accipiter gentilis	Small pieces of rabbit without fur (approx. 4 × 4 × 4 cm)	Fur	Small mice
Milvus migrans	Small pieces of rabbit without fur (approx. 4 × 4 × 4 cm)	Fur	Small mice
Athene noctua	Small pieces of rabbit without fur (approx. 2 × 2 × 2 cm)	Fur	Small mice
Strix aluco	Small pieces of rabbit without fur (approx. 3 × 3 × 3 cm)	Fur	Small mice
Bubo bubo	Small pieces of rabbit without fur (approx. 4 × 4 × 4 cm)	Fur	Quails and rats (1:1 proportion)

Table 3. Number of weighings and time (in days) necessary for individuals of each species to achieve different levels of enrichment.

	Food enrichment level					
	3		4		5	
	Days	Weights	Days	Weights	Days	Weights
A. cinerea	4	3	7	4	25	7
A. gentilis	1	1	16	3	31	4
M. migrans	27	2	49	4	58	5
A. noctua	2	1	4	2	8	3
S. aluco	6	1	19	4	26	5
Bubo bubo	4	1	9	2	14	3

Table 4. Time to prey competence (Tcomp) for experimental group, and length of conventional recovery process (CRP) for control group (in days).

	Tcomp (test group)	CRP (control group)	Statistical result
Ardea cinerea	31 ± 0.0	49 ± 0.0	$\chi^2_1 = 3.61$; $p > 0.05$
Accipiter gentilis	38 ± 0.0	34 ± 0.0	$\chi^2_1 = 0.13$; $p > 0.05$
Milvus migrans	– (102 ± 0.0)	22.5 ± 6.5	$t = 25.04$; $p < 0.001$
Athene noctua	10 ± 0.0	35.0 ± 20.1	$t = 2.49$; $p = 0.089$
Strix aluco	47 ± 0.0	50.3 ± 14.8	$t = 0.44$; $p = 0.690$
Bubo bubo	33 ± 0.0	30 ± 0.0	$\chi^2_1 =$; $p > 0.05$

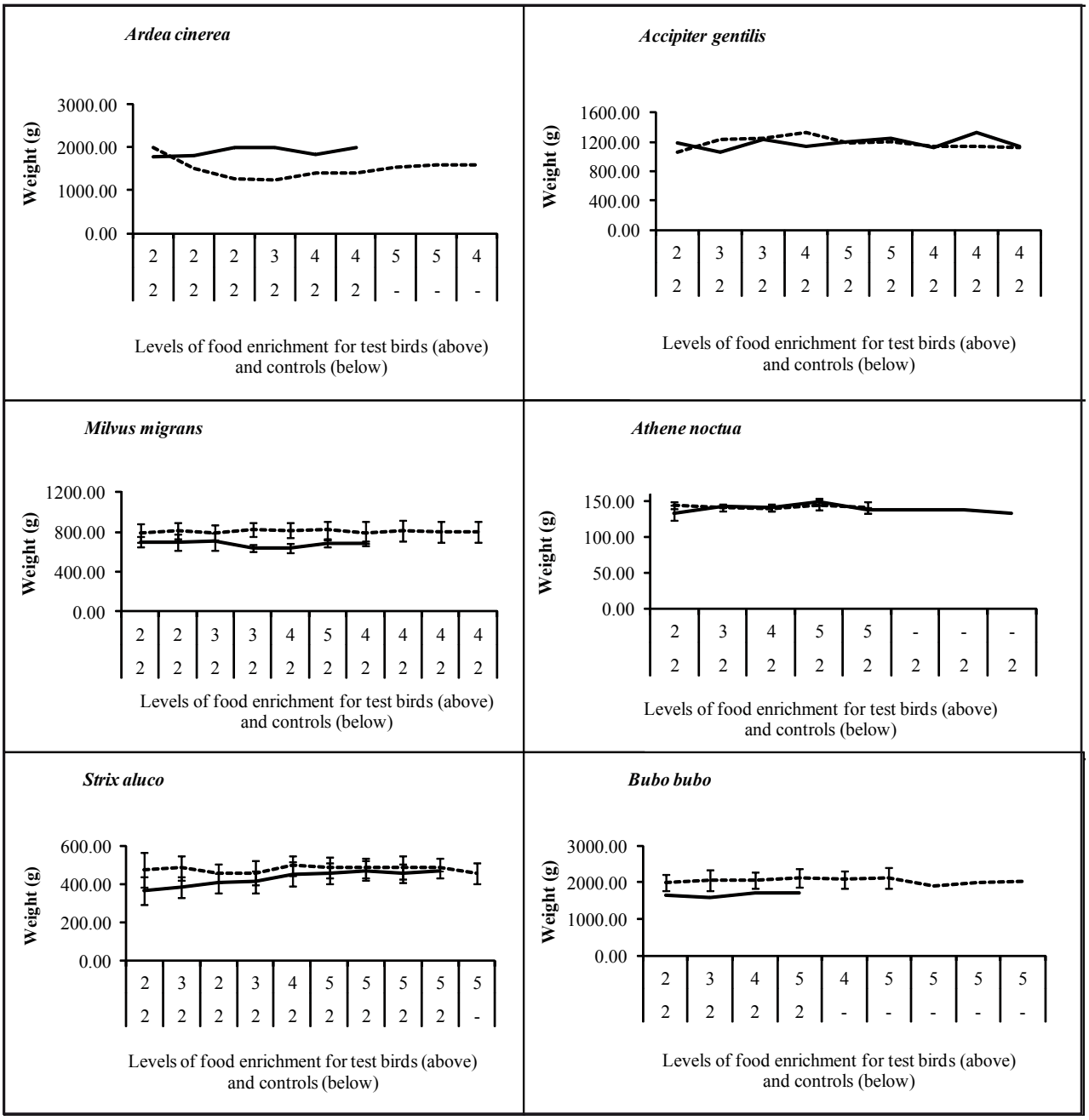

Figure 1. Weight variation in individuals of *A. cinerea*, *A. gentilis*, *M. migrans*, *A. noctua*, *S. aluco* and *B. bubo* over the food enrichment levels compared to controls. Dotted lines represent test birds, solid lines control birds.

Table 5. Number of weighings during the time to prey competence (test birds) and during recovery time (control birds).

	Test birds	Control birds	Statistical result
Ardea cinerea	8	6	$\chi^2_1 = 0.07$; $p > 0.05$
Accipiter gentilis	6	6	$\chi^2_1 = 0.08$; $p > 0.05$
Milvus migrans	– (10)	5.3 ± 2.06	– (t = 4.61; p = 0.019)
Athene noctua	5	5.3 ± 1.89	t = 0.26; p = 0.809
Strix aluco	7	7.8 ± 1.25	t = 1.19; p = 0.319
Bubo bubo	7	4	χ^2_1=0.36; p > 0.05
Total	7.2 ± 1.90; *n* = 24	5.9 ± 1.87; *n* = 15	t = 1.98; p = 0.055

Some birds seem to respond faster than others to the difficulties created in response to their conditions, either physical – nutritional status and cause of admission to the rehabilitation centre (fall from nest, electrocution, etc) – or ecological, e.g. predation techniques (Nieuwenhuyse et al. 2008). It is to be expected that animals that suffered less trauma and that started the enrichment process in a good nutritional state would progress better in their ability to obtain food, but conditions in captivity may also influence the fitness of predatory birds. The size of cages relative to the size of the birds can affect prey competence, as can the existence of support structures such as perches and shelters (Schmidt-Nielsen, 1984). The fact that the birds are confined to outside cages means that the climate could also influence the results of food training, and we might expect seasonal variation in the results, particularly for migratory birds such as the black kite.

Overall, this process may contribute to improving rehabilitated birds' physical and psychological health as it stimulates movement and skills and, apart from the recovery process itself, this may increase the changes of survival once the birds are released. The effect of such a feeding regime on actual survival after release should be investigated.

Conclusions

1. Adding some degree of difficulty to the feeding of captive birds of prey recovering in wildlife centres does not seem to have negative effects on the recovery process.
2. The food enrichment strategy adopted here did not result in weight loss and/or decline of the birds' condition.
3. In most species, regular monitoring of weight during the experiment did not indicate an increase in the stress of handling or capture.
4. Some birds seem to respond faster than others to the difficulties created in response to their physical and ecological conditions and the characteristics of captivity.
5. Clearly more work is needed on this subject but the adoption of food enrichment strategies in predatory birds undergoing rehabilitation may prove to be very important in captivity and also after release.

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