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Duration of the rehabilitation period and familiarity with the prey affect the predatory behaviour of captive wild kestrels (*Falco tinnunculus)*

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Duration of the rehabilitation period and familiarity with the prey affect the predatory behaviour of captive wild kestrels (*Falco tinnunculus*)

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ABSTRACT

A sample of 24 wild kestrels (*Falco tinnunculus*) was tested in captive conditions in order to study their predatory behaviour after a rehabilitation period from injuries. The birds, divided into two groups according to duration of captivity, were tested on three consecutive days with three types of prey: a live mouse, a dead mouse, and a chicken carcass. The results showed a significant interaction between groups and prey with regard to the movements on the perch after the prey's appearance and the exploratory flights above it. The dead mouse constantly elicited more movements in the kestrel, particularly in birds in captivity for less time. The duration between capture and ingestion of the prey in the live mouse tests was longer than in those with a dead prey. The live mouse was bill pecked several times, particularly on the head. Thus, kestrels still maintain a good predatory ability even after prolonged captivity, and they soon become used to the unnatural food provided. The implications from the adaptive and husbandry point of view are discussed.

KEY WORDS: Predatory behaviour - Captivity - Rehabilitation - Raptors - *Falco tinnunculus* - Kestrel.

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INTRODUCTION

The predatory behaviour of the birds of prey has been studied in detail for several years. Much interest has been devoted to the prey selection, particularly the releasing stimuli produced by the prey, such as activity, conspicuousness, and phenotype oddity, which influence the capture readiness by the bird (Snyder, 1975; Curio, 1976; Ruggiero & Cheney, 1979; Ruggiero *et al.*, 1979; Bildstein & Collopy, 1987; Mueller, 1987, for a review). Similar effects were found for the predatory behaviour of the Strigiformes as well (Metzgar, 1967; Kaufman, 1974a, b, c; Marti, 1976; Marti & Hogue, 1979).

The aim of the present study was to investigate the effects of captivity in kestrels (*Falco tinnunculus*) on their predatory behaviour after prolonged inactivity from the predation point of view. Nowadays there are institutions in several countries where raptors are rehabilitated. In fact, the birds are mainly injured by poaching, but there are also those wounded accidentally during flight or that must be hand-raised because they have fallen from the nest as *pullus*. Such birds are then kept in captivity till full recovery and, after a good flying training, are released.

Nevertheless, during the captivity period, that can also be necessarily long, the birds rarely experience the full predatory sequence. This fact is potentially serious for every raptor species, but especially for the hand-raised birds, that are likely to be released without the fully developed capacity of catching wild prey (Llewellyn & Brain, 1983; Llewellyn, 1990).

MATERIALS AND METHODS

The kestrels (*Falco tinnunculus*) studied were all wild individuals recovering from injuries and kept in the Raptor Rehabilitation Centre (RRC) managed in Parma by the Italian Society for the Protection of Birds (LIPU). The birds were all experiencing captivity for the first time. They were housed in a pen with a few other birds of different species, but similar in size. All of them were fed once daily with chicken carcasses throughout the period of their stay at the RRC.

The birds were tested individually shortly before release in order to analyze their predatory behaviour at the end of the captivity period. The test was their first opportunity to feed on a mouse and, moreover, to prey on a live one in captivity. The tests were carried out in an experimental room 4.30 × 2.60 m located in the same building as the maintenance pen. The room was empty save for a perch placed at a height of 1.80 m across the shorter side of the room, and a square wooden platform (60 × 60 cm) with 60-cm wire legs located in the middle of the room at a distance of 2.60 m from the perch.

About 15 min before the test the prey was inserted manually into a sort of elevator, located under the platform itself, and later semiautomatically elevated through a hole to platform level. The prey became then completely visible to the kestrel. Other details about the room and the method used for prey presentation are found elsewhere (Csermely *et al.*, 1989).

The behaviour of the birds was recorded continuously, observing it through a one-way window. The number of tests was kept as low as possible, but compatible with procuring a significant sample, whilst at the same time sacrificing as few mice as necessary, as recommended, for instance, by Huntingford (1984).

Each bird was tested three times on three consecutive days. At testing, one of three types of prey was offered: a live adult laboratory mouse (*Mus domesticus*) with Agouti phenotype (LM), a dead mouse of the same strain (DM), and a chicken carcass similar to the one offered routinely as food (CH). The order of prey presentation was random. The only adjustment was in order to have four birds from each group experiencing a particular prey during the 1st, 2nd, or 3rd test. I chose those types of prey in order to observe the kestrel's reaction when facing either the «prey» more recently experienced in captivity (CH), or a natural one (LM), or else, a natural one (DM), but with the same unnatural lack of movement as the chicken carcass «prey».

The tests were carried out between 11.00 a.m. and 3.00 p.m. They started when the prey emerged on the platform and lasted till its ingestion by the kestrel, or for 60 min if no predation occurred. The birds were tested after two days of fasting in order to enhance and equalize the predatory motivation for all birds. On the other hand it has already been demonstrated that hunger is correlated with prey killing in captive raptors, such as the broad-winged hawk (*Buteo platypterus*), the American kestrel (*Falco sparverius*) (Mueller, 1973), and the screech-owl (*Otus asio*) (Marti & Hogue, 1979).

Two groups of kestrels were considered: birds in captivity for less than three months, and for more than four months hereafter indicated as 3M and 4M birds, respectively. All of them were chosen randomly among those present at the RRC ready for release. The age of the birds, i.e. adult or sub-adult, and their sex were not taken into account, since another study (Csermely *et al.*, 1989) did not reveal any difference in the predatory behaviour.

The hierarchically organized experimental design allowed an analysis of the frequencies of behaviours recorded before predation with the Split-Plot design, processed with the standard SAS Institute (1985) procedure. The random sequence of prey presentation, similar to a Latin-square design, allowed the tests to be considered independently. The time latencies and durations as well as the data for behaviours connected with predation were analyzed with the Kruskal-Wallis one-way ANOVA (Siegel, 1956), or the Chi-square test when necessary. The probability level is always given as P two-tailed.

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RESULTS

A total of 24 kestrels, equally split over the two groups, was studied. Following the prey appearance, the birds performed several movements on the perch. Most of these were lateral, i.e. along the perch, but sometimes the kestrel turned towards the room wall. There was a significant interaction between groups and prey (F = 3.37, P < 0.05) (Table I). The dead-mouse (DM) constantly elicited more movements (F = 6.94, P < 0.01) in both groups. This is particularly true in 3M birds where the frequency was much higher than that in the tests with the live-mouse (LM). During the same tests, the 3M birds showed also a greater latency to display the first movement on the perch (H = 7.57, P < 0.05).

TABLE I - *ANOVA for the frequency of movements of the perch for each test in both groups calculated with the Split-Plot design.*

	DF	SS	MS	F	*P*
Groups	1	2189.01	2189.01	4.04	> 0.05
Birds within groups	22	11921.53	541.89		
Prey	2	2126.08	1063.04	6.94	< 0.01
Groups × prey	2	1031.03	515.52	3.37	< 0.05
Prey × birds	44	6738.22	153.14		

DF, degrees of freedom; SS, sum of squares; MS, mean square

Sometimes the kestrels performed one or more flights in the test room, starting from the perch and returning to it. Those flights showed the same distribution as and a similar frequency to the movements on the perch. Nevertheless, I found only significant effect related to the prey within groups (F = 4.04, P < 0.025) (Table II). In contrast, the various types of prey did not elicit any difference in the latency to perform the first flight in any group.

TABLE II - *ANOVA for the frequency of flights in the room for each test in both groups calculated with the Split-Plot design.*

	DF	SS	MS	F	*P*
Groups	1	3872.00	3872.00	3.85	> 0.05
Birds within groups	22	22146.61	1006.66		
Prey	2	3059.36	1529.68	4.04	< 0.025
Groups × prey	2	2163.58	1081.79	2.86	< 0.05
Prey × birds	44	16651.05	378.43		

DF, degrees of freedom; SS, sum of squares; MS, mean square

I also considered the frequency of preening and its latency from the start of the test, but the data did not reveal any effect of prey or group. In contrast with the previous patterns, in each group the preening movements were performed most often during the LM tests.

Most kestrels tested preyed successfully in both groups, with a frequency of at least 8 out of 12 birds. Only the 3M kestrels rarely caught the DM (4 predations out of 12 tests). The predation occurred in both groups earlier, but not significantly so, with LM (399.4 ± 97.9 sec [SE] in 3M and 493.8 ± 230.6 sec [SE] in 4M) than with the other preys. There was a clear characterization of predating or not predating kestrels in the 4M group about the frequency both of the movements on the perch and flights. Those that did refuse to catch the prey performed invariably far more movements on the perch ($\chi^2_{(2)}$ = 42.54, P < 0.001) (Fig. 1) and flights in the room ($\chi^2_{(2)}$ = 31.98, P < 0.001) (Fig. 2) in each test. The 3M kestrels showed a similar difference only for the movements on the perch ($\chi^2_{(2)}$ = 14.70, P < 0.001). That statistical calculation was carried out adjusting the observed frequency to the same number of predating birds in that group. This number was the lowest recorded in the group for a certain prey (i.e. 4 in the 3M birds and 8 in the 4M birds).

The prey was almost always taken with only one foot, but without preference for the left or the right one. Both feet were used only once. After the predation, the kestrels remained standing for a variable time, keeping the prey within the toes. The ingestion occurred at the end of that period, but probably only after the LM's death. In fact the latency of ingestion shown by 3M kestrels in the LM tests was much longer in comparison to the birds that captured DM or CH prey (H = 6.15, P < 0.05), when the duration was shorter and similar (Fig. 3). The 4M birds showed similar differences, but the

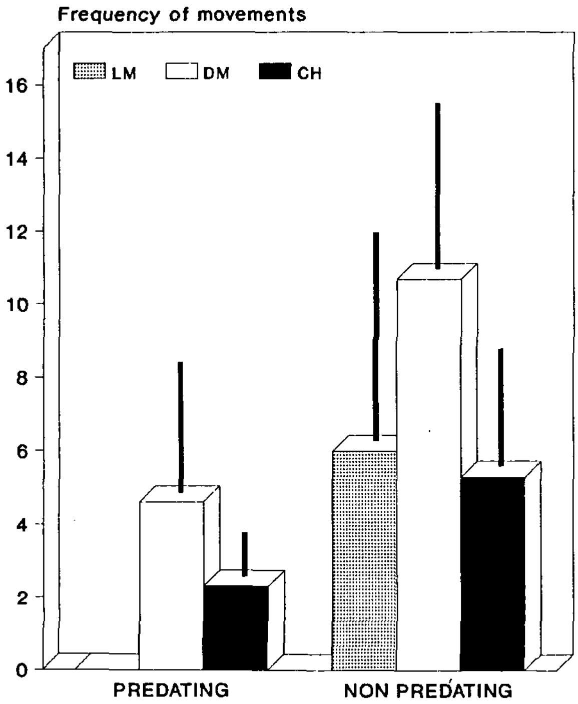

Fig. 1 - Mean frequency (+ SE) of movements on the perch for each kestrel in the 4M group that eventually caught, or not, the prey.

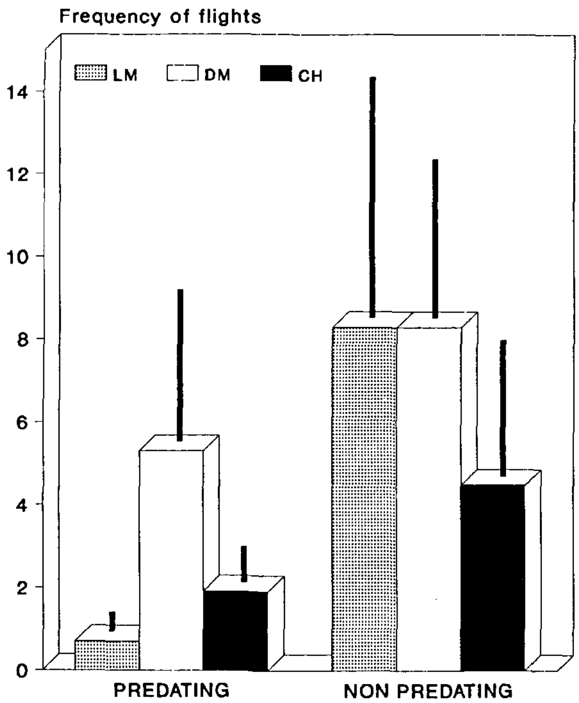

Fig. 2 - Mean frequency (+ SE) of flights for each kestrel in the 4M group that eventually caught, or not, the prey.

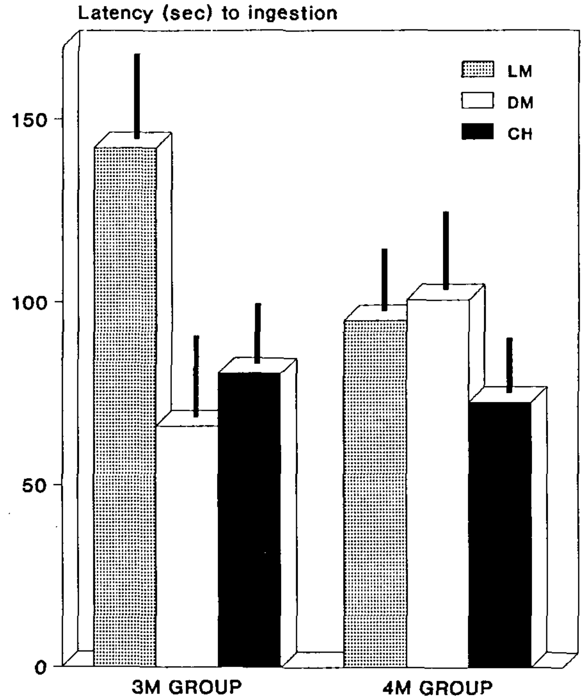

Fig. 3 - Mean latency (+ SE) between the capture of the prey and its ingestion in each test in both groups.

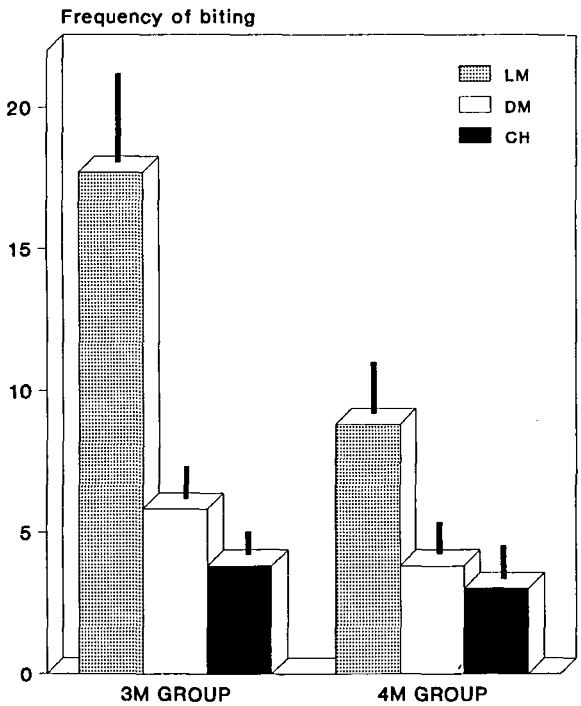

Fig. 4 - Mean frequency (+ SE) of biting the prey for the predating kestrels in each test in both groups.

latency was slightly longer when they captured the DM ($H = 21.35$, $P < 0.001$).

During the time interval between capture and ingestion, the prey was bitten several times with the bill (Fig. 4). The target of bites was almost invariably the head region, but sometimes the trunk. The bites were much more frequent on LM than on DM or CH ($H = 14.58$, $P < 0.001$ in the 3M group; $H = 8.32$, $P < 0.02$ in the 4M

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group), and occurred in both groups, although 4M kestrels bit the mouse a little less frequently than the 3M birds did.

DISCUSSION

This experiment shows that kestrels still maintain a good predatory ability even after prolonged captivity. Nevertheless, the duration of the captivity has a limited effect on the readiness to catch the prey. In fact, it is evident that in both groups the movements as well as the flights are the result of a conflict situation when facing the DM, i.e., a natural prey but with an unnatural lack of movement. This conflict is particularly evident in 3M birds when facing either of the dead prey.

The predatory behaviour is therefore not necessarily released by the prey's movements, a cue that was claimed to be greatly important for releasing predatory behaviour (Kaufman, 1974; Snyder, 1975; Curio, 1976). Once the kestrel is used to the captivity conditions it creates a sort of searching image even to an unnatural prey like CH, turning to induce a quick predation also towards it. In contrast, DM is unusual and different from both the LM and CH. Thus, having not yet created its searching image, the DM elicits more conflict in the birds, a sort of neophobia.

The 3M birds are likely to have a greater response to the natural prey (LM) than those of the other group, since they had experienced it more recently. In contrst, 4M kestrels are already almost used to the chicken carcass (CH), but still show a strong investigation of an «odd» prey, such as DM. Nevertheless, the birds in captivity for a short time are becoming used to feeding on the prey offered daily, although they are still in conflict when facing a new type of prey, a natural one without any movement.

It is interesting to note that, regardless of the duration of captivity, the birds much more in conflict in the early minutes of the test are those that are less likely to show the predatory behaviour. Thus it is probable that the kestrel takes the decision to prey soon after the prey's appearance. The movements on the perch and the flights are probably used for a better exploration and for the creation of a searching image of the prey, in order to recognize it immediately on another occasion.

The shorter latency of ingestion performed by 4M birds in LM tests probably indicates their being used to feeding on an immobile prey, paying no more attention to its possible movements. In fact, those birds started to ingest the mouse without waiting for the fading out of any little movement. The alternative explanation that 4M kestrels are better killers than 3M birds seems not realistic, since it is improbable that birds with more recent experience of natural predation are less clever than birds in captivity for a longer time.

Finally, the high frequency of biting and its target, the head, is an indication that this behaviour is principally released by prey movements, and that it functions as an inhibitor of further movements, preventing in the prey any possibility to escape. However, since biting was recorded also on dead prey, it is possible that this pattern has a stereotyped basis. The movements of the prey are a releasing stimulus for additional biting, until the movements fade out completely.

In conclusion, I suggest that prolonged captivity in the rehabilitation context has only minor effects on the kestrel from the predatory efficiency point of view. Nevertheless, it would be better to keep up regular training on live prey, compatibly with ethical recommendations. More important, the need for the captivity period to be as short as possible is confirmed (Llewellyn & Brain, 1983; Llewellyn, 1990).

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