

## Does prey size affect predatory behaviour of Kestrel ?

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**Abstract** – A sample of 10 rehabilitated kestrels *Falco tinnunculus* was tested immediately prior to release to ascertain whether their predatory behaviour was modified according to the type of prey the kestrel faced. The tests were carried out individually in captivity conditions, using either one laboratory agouti mouse weighing 12-15 g or one laboratory agouti rat weighing 48-60 g. The size ratio between the prey was then constantly of 1:4.

The behavior displayed by the kestrels before either prey was clearly different, both prior to and after its catching. The rat elicited more conflict patterns, such as preening and movements on the perch, while this was hardly ever recorded during the mouse-tests. There were instead no differences in the latency of predation and the technique used for grasping the prey. In contrast, the rat received more biting than the mouse, and the latency of ingestion, interpreted as the time span necessary to induce the death of the prey, was much longer when the rat was captured. The adaptive implication of such behaviour differences are discussed.

### Introduction

The predatory behaviour of raptors is known to be affected by the prey itself. The American kestrel *Falco sparverius* is very stimulated by prey movement (Sparrowe, 1972), pelage colour, and morphology (Ruggiero *et al.*, 1979). The same is likely to occur in the Eurasian counterpart, the kestrel *Falco tinnunculus*, that is also able to catch dead prey in captivity (Csermely, 1993) and so without any stimulation by movement. Learning is another important aspect for prey recognition and selection (Ruggiero *et al.*, 1979; Mueller, 1987), that, in turn, allow the development of the Specific Searching Image (SSI) (von Uexküll, 1934; Tinbergen, 1960) that is widely displayed in birds of prey (Curio, 1976). Size is another important parameter that potentially affect prey catching. Large size prey animals are more conspicuous, more easily detected, they offer higher energy income as compared with smaller prey. On the other hand, a large prey is also stronger, with efficient defensive weapons, potentially hurting the predator itself, and is less easily subdued, which corresponds to higher energy expenditure till its ingestion (Curio, 1976; Griffith, 1980; Korpimäki, 1985).

Both *Falco tinnunculus* and *F. sparverius* are well adapted to feed on a wide range of prey sizes (Cramp and Simmons, 1980; Johnsgard, 1990), catching

opportunistically many taxa, from small arthropods to young rats and hares (Village, 1990). Bryan (1984) reported a bias in prey selection by male and female American kestrels during the reproductive period. Females caught large mice more often, while males and juveniles chose small ones. Prey size is reported to be an important choice parameter in other raptor species as well. The barn owl *Tyto alba* showed a trend to choose large rodent prey in direct relation to its own body size (Ille, 1991). Nevertheless, the increase of prey body size correlated with the frequency of conflict behaviour patterns, indicating that the barn owl is progressively less confident about the attempt at success and aware of the possibility of being hurt by the rodent.

This study aims to describe in detail the predatory behaviour of the Eurasian kestrel when facing alternatively prey of rather different size and to ascertain whether the predatory behaviour is modified in its performance by such a variable. The kestrel was chosen because of easy management in captivity and its adaptation to prey on a wide range of taxa. It is then possible that, although the predatory behaviour of birds of prey is rather stereotyped (Meyer-Holzappel and Räber, 1976; Csermely *et al.*, 1989, 1991), the kestrel is adapted to modify its behaviour according to the prey to be caught. A less generalist species is in fact expected to have a much more rigid

behaviour sequence, and less drive to catch prey differing from the usual ones.

## Methods

The kestrels *Falco tinnunculus* studied were all wild individuals recovered after several kinds of 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 housed in a large maintenance pen and were all experiencing captivity for the first time. They were fed once daily with chicken carcasses throughout the period of their stay at the RRC. At testing they were all in perfect physical condition and the plumage was fully developed.

The kestrels were tested individually shortly before release in an experimental pen 4.30 x 2.60 m located in the same building as the maintenance pen. The pen was empty save for a perch placed at a height of 1.80 m across the shorter side of the pen, and a square wooden platform (60 x 60 cm) with 60 cm wire legs located in the middle of the pen at a distance of 2.60 m from the perch. The reader is referred elsewhere for further details regarding the pen (Csermely *et al.*, 1989).

At testing the prey was inserted manually into a pipe, running from outside the experimental pen to the platform edge and at the same height of it (Fig. 1). Once at the end of the pipe, the prey became then completely visible to the kestrel. The behaviour of the birds was recorded continuously through a one-way window located just above the insertion of the pipe in the side wall. The number of tests was kept as low as possible, but compatible with procuring a significant

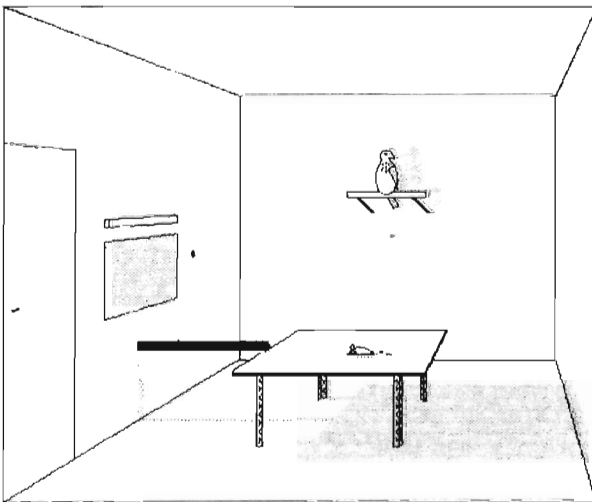


Fig. 1. A prospective view of the predation pen.

sample, whilst at the same time sacrificing as few prey as necessary, as recommended by Still (1982), Huntingford (1984), and A.S.A.B. and A.B.S. (1991). Each bird was tested only twice, on 2 consecutive days. One of two kinds of prey was offered at each test: a live adult laboratory mouse *Mus domesticus* with agouti phenotype, C3H strain, or a live adult laboratory rat *Rattus norvegicus* with the same phenotype, Brown-Norway strain. The order of prey presentation was random. The size ratio between prey was constantly 1:4; in fact, the mice weighed 12 to 15 g, while rats weighed 48 to 60 g. Although wild individuals have been proved to prey adult rats easily (Southern, 1974; Shrubbs, 1993), heavier rats were not used because previous preliminary tests revealed that kestrels facing rats greater than 60-70 g either had difficulty in catching them or refused to prey at all.

The tests were carried out between 10.00 am and 2.00 pm. They started when the rodent 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 2 days of fasting in order to enhance and equalize the predatory motivation for all birds. In any case 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).

All the kestrels were chosen randomly among the sample present at the RRC and ready for release. The birds' sex and age, i.e. adult or sub-adult, were not taken into account, since another study (Csermely *et al.*, 1989) did not reveal any difference in the predatory behaviour.

The time latencies and durations of the behaviour patterns recorded were analyzed with the Mann-Whitney *U*-test, while the frequencies were analyzed with the Permutation test (Siegel, 1956). Means are given  $\pm$  SE, and the probability is always given as one-tailed.

## Results

Ten kestrels were used in this study and most of them ( $n=8$ ) preyed on both the mouse and rat. The remaining two caught the mouse only. The prey appearance on the platform elicited invariably the kestrel's attention. Nevertheless some activities were performed. A couple of these, movements on the perch and preening, were recorded much more often with the rat present (Table 1) (Movements on the

Table 1. The mean ( $\pm$  SE) latency (in seconds) and frequency for three patterns considered prior to the predation attempt, during each mouse- and rat-tests ( $n = 10$  for both). Figures bearing the same suffix letter are significantly different ( $p < 0.05$ ).

Pattern	Mouse-Tests		Rat-Tests	
	Frequency	Latency	Frequency	Latency
Movem. on perch	5.5 $\pm$ 3.5 <sup>a</sup>	262.50 $\pm$ 74.5	7.0 $\pm$ 2.4 <sup>a</sup>	581.40 $\pm$ 156.6
Preening	2.0 $\pm$ 0.0 <sup>b</sup>	114.00 $\pm$ 0.0	3.4 $\pm$ 1.1 <sup>b</sup>	601.60 $\pm$ 163.4
Flights	5.3 $\pm$ 4.3	73.67 $\pm$ 71.7 <sup>c</sup>	6.0 $\pm$ 2.2	680.33 $\pm$ 145.0 <sup>c</sup>

perch: Permutation test,  $p < 0.05$ ; Preening: Permutation test,  $p < 0.05$ ).

The kestrel did sometimes perform one or more flights too: it started from the perch, flew over the platform and then returned to the perch itself. Even this pattern was elicited more often but not significantly ( $\alpha = 0.05$ ) when the kestrel was facing the rat (Table 1). While the latency of the first movement on the perch and the first preening action after prey appearance in both tests were not statistically different, the first flight was, on the other hand, recorded earlier during the mouse tests (Table 1) ( $Z = 1.936$ ,  $n = 9$ ,  $p < 0.05$ ). A clear association between flights and movements on the perch during the rat-tests was also noted. In fact, in all but one test the birds either performed both flights and movements at least once or did not display them at all (Fisher's test,  $p = 0.02$ ). Such an association did not occur during the mouse-tests.

In addition to eliciting more conflict patterns, the rat induced a trend for a greater latency to predation (494.60 $\pm$ 84.65 sec for the mouse vs 776.88 $\pm$ 273.71 sec for the rat). However, such values did not differ significantly ( $\alpha = 0.05$ ), maybe due to the small sample of data. Two types of attack to the prey were recorded: *direct*, i.e. the kestrel flew from the perch and landed directly on the prey's body, and *indirect*, i.e. the kestrel landed on the platform and blocked the prey after a few steps. While the mouse was always caught on the platform, irrespectively of the attack type, the rat sometimes jumped down during the indirect attack and was consequently captured on the floor of the pen. The types of attack in the mouse-tests were recorded almost equally (6 vs 4), while the rat-tests scored more indirect attack (6 vs 2).

The prey was always caught with only one foot in both direct and indirect attacks, without preference for either foot in both rat (4 left vs 4 right) or mouse-tests (5 left vs 5 right). No predation with both feet was observed. Six kestrels out of the 8 preying both prey used the same leg (left or right) to catch both the mouse and the rat, while the remaining 2 birds used different feet. The prey was invariably caught on the trunk and almost always with the same orientation as

the bird, i.e. the rodent had the head facing away from the kestrel. When this did not occur the kestrel turned the prey soon after blocking and took it in the "correct" position.

After capture the kestrel stood in the same posture for some time, holding firmly the prey with the foot, squeezing its trunk. There was no indication of talon use during this phase or at catching. Such a posture lasted till ingestion started, determining the so-called "latency of ingestion". It was much longer during the rat-tests (350.63 $\pm$ 54.53 sec) than in the mouse-tests (148.40 $\pm$ 55.58 sec) ( $Z = 2.443$ ,  $n = 18$ ,  $p < 0.01$ ). Some bill strikes were carried out on the prey with opened mandibles, and were much more similar to real bites than to peckings. The strength of these bites to the rats was subjectively judged similar to the mice. The bites were directed invariably to head (occipital and ocular regions) and every kestrel performed them much more frequently to the rat (46.0 $\pm$ 6.5 mean bites/rat vs 6.9 $\pm$ 0.6 mean bites/mouse; Permutation test,  $n = 8$ ,  $p < 0.01$ ). Even subtracting tentatively a frequency of 25 bites from each rat, the 2 samples still remained significantly different (Permutation test,  $n=8$ ,  $p < 0.02$ ).

## Discussion

The size of the prey used in this study was found to affect the predatory behaviour greatly. Such an effect was found not only for the attack itself, but also for the preceding activities. The rat elicited more conflict patterns as well as exploratory flights. These are likely to be caused patterns as well as exploratory flights. These are likely to be caused by the conflict between the motivation to catch the rat after its recognition as a prey and the evaluation of the possible damage from retaliation. In fact, retaliation of the rat while struggling to escape from the kestrel's grip can result in very painful bites and dangerous wounds. This suggestion is in full accord to what Ille (1991) found in the barn owl preying small or large rodent prey. In fact, when catching rats of more than 80 g (large prey) the birds displayed many more

conflict patterns. Besides, the greater the body size of the rodent the higher its speed is.

Probably, the kestrel also evaluated the probability the rat had of escaping safely when perceiving the bird approach. The higher frequency of flights performed during the rat-tests are likely to indicate such an evaluation. The lack of confidence is indicated also by the trend to increase the latency of predation. The more frequent use of indirect attack when preying the rat supports the awe it may feel. Nevertheless, the motivation to grasp the prey was always greater than the possible costs of its retaliation and damage. In contrast to Village (1990), the kestrel's bites of the prey inhibit the quarry's movements and escape attempts by damaging the central nervous system and are not a tool for killing. The bites recorded in this study are performed exactly in the same way as observed previously against mice only (Csermely *et al.*, 1989; Csermely, 1993), confirming the same hypothesis raised there about their meaning. Assuming a similarity in bite strength, as shown above, the rat received many more bites just because of its greater skull thickness. The kestrel then requires repeated peckings to damage severely its central nervous system, while the same results is obtained with a smaller number of strikes to the thinner skull of the mouse.

In case the kestrel used the talons as a weapon to kill the prey one must assume that both the rodents die by those wounds and then within similar amount of time. It is then expected to record a few bites and, moreover, a similar frequency between the two prey. However, this did not occur at all.

The longer latency of ingestion during the rat-tests is a direct consequence of the repeated biting carried out to the rat itself. Such a latency is likely to represent the time span necessary to fully subdue the rodent prey and to induce death. In fact, the kestrel continued to remain in the same posture and never stopped squeezing the prey during that phase. Such behaviour is indirect evidence of a lack of talons too, since we would expect a much quicker death and a shorter latency of ingestion if they were inserted in the quarry's body.

In conclusion, this study shows how prey size can greatly modify the several patterns of the kestrel's predatory sequence, but only quantitatively. Given a certain level of motivation to prey, the kestrel is readily able to catch a small-medium size rat although it induces more conflict behaviour patterns and a trend to increase the latency of predation.

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**Riassunto** - È stato studiato un gruppo di 10 gheppi *Falco tinnunculus* riabilitati e pronti per la liberazione in natura, al fine di valutare se il comportamento predatorio in generale o qualche aspetto dell'intera sequenza predatoria variavano in rapporto al tipo di preda. I tests sono stati condotti in cattività sottoponendo i gheppi individualmente a 2 prove di predazione, in 2 giorni consecutivi, nei confronti di un topo di laboratorio di manto agouti e di peso compreso tra 12-15 g, o di un ratto di laboratorio di 48-60 g, anch'esso di manto agouti. Il rapporto mole tra i due tipi di preda è, quindi, rimasto costantemente di 1:4.

Le risposte date dai gheppi nei confronti delle prede sono state nettamente diversificate, sia prima che dopo la cattura. In presenza del ratto si sono osservate molte attività conflittuali, quali preening e spostamenti sul posatoio, mentre esse non sono state quasi mai effettuate durante i tests con il topo. Non sono emerse differenze per quel che riguarda la latenza di predazione o la tecnica di cattura della preda. Al contrario, il ratto ha ricevuto un maggior numero di morsi rispetto al topo e la latenza di ingestione, interpretata come il tempo occorrente per causare la morte della preda, è stata nettamente maggiore quando era catturato il ratto. Le implicazioni adattive di tali differenze comportamentali sono discusse in dettaglio.

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