Short Communications

Variation in Domestic Cat Behaviour Towards Humans: a Paternal Effect

Domestic cats show considerable individual variation in how they behave towards human beings. Feaver et al. (1986) recently reported that persons familiar with the cats in a research colony, when asked to make their own assessments of the cats' 'friendliness to people', showed high inter-observer correlations on the rank order in which they placed the individuals ($N = 14$, $r_s = 0.91$, $P < 0.005$). Friendliness was defined simply as 'willingness to initiate proximity and/or contact'. Such global assessments of friendliness also correlated well ($N = 14$, $r_s = 0.69$, $P < 0.01$) with the rank order resulting from measured behaviour towards humans (approaches by the cat, sniffing the person, head- and body-rubs); the latter data were analysed after rating the personality traits to reduce biasing.

Such ratings of friendliness to people, defined as above and based on impressions gained over time, are therefore reliable and can be used to differentiate one cat from another. Once individuals can be classified in this way, it is possible to search for sources of variation which give rise to the individual differences. We have found preliminary evidence for one source of variation on this trait, and present our results here to stimulate further research on this particular aspect.

We used ratings of friendliness towards and by familiar persons to differentiate adult female cats and their 3–4-months-old offspring at the Cambridge cat colony. There, common domestic varieties of cats live in social groups in pens with outdoor runs; kittens are raised by their mothers in individual pens. The first author was especially interested in any association between mother- and offspring-friendliness. He asked three persons who knew the cats well to independently rank six mothers and 10 juveniles separately along ordinal scales for friendliness towards humans. The persons rating the cats were not informed of the purpose of their endeavours. Names of the animals to be ranked were presented in alphabetical order; lists for mothers and lists for juveniles were presented several weeks apart, again to reduce biasing.

The relative orders each person assigned to the mothers and the juveniles were highly consistent. Kendall's concordance tests showed significant associations between the three rankings for mothers as well as between those for their juveniles ($r_{d\bar{x}} = 0.96$, $W = 0.975$, $P < 0.01$; $r_{d\bar{x}} = 0.90$, $W = 0.933$, $P < 0.01$); the best indication of true rank is then the rank sum for each animal (Kendall 1948).

For a Spearman correlation test between mother and offspring rank, the latter was defined as the average of two rank sums when both littermates were involved. But tests using the rank sum for just one juvenile per mother yielded the same result: friendlier mothers did not tend to have friendlier offspring amongst this group (Spearman $r_d = -0.31$, $P > 0.2$).

We later compared paternity of these juveniles with the friendliness assessments. Two unrelated fathers had sired all of the ranked juveniles over a 2-month period, but none of the juveniles had ever seen the fathers. The friendly-ranked young were disproportionately distributed between the two fathers, assuming expected values intrinsic to the data ($G_{1df} = 10.612$, $P < 0.01$).

The first author returned to Zurich and asked four persons familiar with the cats in that colony to independently rank the eight mothers and 35 juveniles there along ordinal scales for friendliness as used at Cambridge. Neither a potential father-, nor mother-effect was mentioned. Here the cats also live in mother–offspring social groups and have regular access to an outdoor enclosure.

Since there were minor differences in the numbers of cats known by each person, analysis procedures were modified in Zurich. Rank lists were compared to determine whether all four persons assessed friendliness along similar lines, which they did: UK, BH and KG ranked 25 (of 35) juveniles at 8 months of age and these rank orders were all significantly correlated (Spearman: r_d UK-KG $= 0.74$, $P < 0.001$; r_d UK-BH $= 0.43$, $P < 0.025$; r_d KG-BH $= 0.48$, $P < 0.01$); BS ranked all 35 juveniles at 3 months of age. Twenty-two juveniles were ranked by all four persons and Kendall's concordance test yielded a significant association between the four rank lists ($r_{d\bar{x}} = 0.47$, $W = 0.60$, $\chi^2_{21df} = 50.5$, $P < 0.001$). This is a first indication that behaviour of cats towards humans, after an initial socialization period described by Karsh (1983), is relatively constant; Meier & Turner (1985) found further evidence for this in a free-ranging adult population.

Differences in the number of persons ranking an animal prohibited use of the rank sums for an overall rating. When a majority of persons placed a cat in the friendlier half of their lists, the animal was classified as such. Only three of 35 juveniles could not be classified using this definition (ties). The same procedure was followed for the eight Zurich mothers, whereas only three persons knew and were able to rank these animals. Kendall's concordance test showed a significant association between these rankings ($r_{d\bar{x}} = 0.72$, $W = 0.81$, $\chi^2_{7df} = 17.0$,

Table I. Ordinal rankings of friendliness for 10 juveniles at Cambridge with parental information

| Juvenile | Ranked by * | | | | | | |
	JF	PH	MM	Rank sum†	Mother	Rank sum‡	Father
Ptolemy	2	2	1	4	Penelope	17	T
Paul	5	1	2	6	Penelope	17	T
Androcles	1	5	3	6	Ariadne	9	T
Tonto	3	4	4	7	Ariadne	9	T
Rhona	4	3	—	7	Rhoda	3	T
Calico	6	6	5	12	Calypso	12	S
Randolf	8	7	7	15	Raina	16	S
Rudolf	7	8	6	15	Raina	16	S
Percy	9	9	8	18	Pippen	6	S
Patrick	10	10	9	20	Pippen	6	S

Rank 1 was assigned the friendliest animal.

* Spearman rank correlations: $r_{d\ JF\text{–}PH} = 0.78$, $P < 0.01$; $r_{d\ MM\text{–}JF} = 0.92$ and $r_{d\ MM\text{–}PH} = 0.95$, $P < 0.001$.

† Since MM could not rank one juvenile, rank sum is based on the JF and PH rankings, and the latter two correlations are from nine rankings.

‡ Spearman rank correlations between the original rank lists: $r_{d\ JF\text{–}MM} = 1.00$, $P < 0.005$; $r_{d\ MM\text{–}PH}$ and $r_{d\ JF\text{–}PH} = 0.94$, $P = 0.01$.

$P < 0.02$) and here the rank sums were used to divide the mothers into a friendlier and less-friendly class (four each).

Two unrelated fathers had also sired all of the Zurich offspring within a period of 1–1·5 weeks and had left the colony before the first litter arrived. Among the 32 offspring that could be assigned to the friendlier or less-friendly class, again we found that the friendly young were disproportionately distributed between the two fathers ($G_{1df} = 7.985$, $P < 0.01$). Male and female offspring were proportionately distributed among the friendlier and less-friendly classes ($G_{1df} = 1.851$, $P > 0.10$). When we considered only the rankings of the person who did not know the fathers and could not rank the mothers, we found the same results.

We also found a significant mother effect in Zurich when we examined the proportion of friendly young produced and raised by each half of the mothers ($G_{1df} = 7.501$, $P < 0.01$). Here about an equal number of kittens per litter and mother may have inflated the sample size, but due to the nature of the data, no other test was applicable. A correlation analysis between mothers and offspring could not be made due to the lack of rank sums for the juveniles. To ensure that the lack of mother effect at Cambridge was not due to the more rigorous correlation test, Cambridge data were reanalysed using the same classification procedures as in Zurich. Again we found no mother effect there ($G_{1df} = 0.201$, $P > 0.5$).

The difference between the two colonies in the maternal influence on the young might have arisen because four of the six Cambridge mothers were closely related, whereas, as far as is known, none of the eight Zurich mothers was. Even assuming two sisters and two daughters among the Zurich mothers, the coefficients of relatedness for the two colonies are quite different: Cambridge, $r = 0.142$; Zurich, $r = 0.076$. And a significant mother effect could only be demonstrated in Zurich where we assume that the mothers were more variable.

Each female was mated with a male without regard to his characteristics, and in neither colony were the females related to either of the stud males. Nor were the young of a particular male (or female) treated differently from those of the other male (or females). Therefore, it is very unlikely that the differences in the offspring arose from breeding policies of the two colonies. The two males at Cambridge had very distinct personalities with the friendlier male producing the friendlier offspring. This was not the case in Zurich where friendliness of the fathers was less clear. Even if the friendlier male at both colonies had produced the friendlier young, evidence for direct inheritance of the behaviour involved would be weak. It is just as likely that shared genes from the father could generate common personality characteristics in the off-spring through an effect on e.g. the growth rate, which probably matters in terms of socialization to humans in a colony situation.

Nevertheless, our results indicate that male cats may exert some influence over the behavioural traits of their offspring without ever coming into social contact with them. Specifically, they demon-

strate that offspring from a particular male are reliably different from those of another particular male; variability on the trait 'friendliness towards humans' is at least partly explained in terms of who their fathers were. Studies on larger colony populations, including matings of the same female with different males, are recommended to tease apart the father (genetic) and mother (genetic/modificatory) effects on their offspring.

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Scanning, Pecking and Alarm Flights in House Sparrows

One of the benefits to animals that forage in groups is the lower investment in the time spent scanning the environment, presumably for predators (Pulliam 1973; Elgar & Catterall 1981), and numerous studies have demonstrated a negative relationship between flock size and scanning rate (see Barnard & Thompson 1985). This relationship is often characterized by the considerable variation in scanning rate for each flock size, but so far it is not clear whether this is due to variation within, or between flocks. Furthermore, it is widely assumed that individuals that scan less frequently benefit by spending more time in other activities, such as pecking for food (see Pulliam & Caraco 1984 for a review). For example, Caraco (1979) and Barnard (1980a) reported a positive correlation between flock size and pecking rate and a negative correlation between flock size and scanning rate. However, there was no experimental control for seed density in these studies and larger flocks were generally found in areas of higher seed density. Consequently, the causes of the changes in pecking rate were not apparent, but may have been due to seed density, flock size, scanning rate, aggressive interactions or any combination of these variables. Although low scanning rates may allow more time to be spent foraging, it also increases the risk of failing to detect predators. But there may be further costs to low scanning rates: an individual with its head down may react more slowly when the group leaves in an alarm flight, and hence may be more vulnerable to predation. This paper aims to (1) investigate the source of variation in scanning rates for a given flock size, (2) demonstrate a direct correlation between scanning rate and pecking rate, and (3) examine the relationship between individuals' scanning rate and their reactions to alarm flights.

We observed the behaviour of house sparrows *Passer domesticus* foraging at a feeder (1 m by 1 m) on the roof of the Department of Zoology building in Downing Street, Cambridge. The feeder was placed adjacent to a low parapet, and an ample supply of seed (300 ml) was constantly available in the feeder. This ensured that aggressive interactions between individuals were rare. Sparrows alighted on the parapet before hopping down to the floor and foraging in the feeder, and would return to the parapet from the feeder either individually or as a group. The time from when a bird landed at the feeder to when it left is termed a foraging bout. A video-camera recorded the sparrows' behaviour in the absence of human observers, and an event-recorder was used to derive scanning (Elgar & Catterall 1981) and pecking rates over a foraging bout for every member of the flock.

Measurements of the sparrows' behaviour were made for individuals foraging in flocks of eight or nine only, since this flock size provided the most data on large flocks that remained the same size for a reasonable time. The data were drawn from foraging bouts where arrivals and departures were reasonably synchronous; bouts were excluded if not all the members of the flock landed on the feeder within 3 s of the first arrival, or not all of the individuals left the feeder within 6 s of the first