SCIENTIFIC CORRESPONDENCE

Territory, size and weight gain

SIR — A recent paper by Carpenter et al.[1], on territory size and weight gain, has been received with enthusiasm by Diamond[2]. One must share his attitude towards their elegant experimental technique for weighing birds undisturbed in the wild. However, I believe more caution should be exercised with regard to their results and interpretation. Diamond quotes the example of bird WP whose rate of weight gain was measured at three territory sizes and found to be greatest at the intermediate and final size. "The results with WP and other rufous hummingbirds", Diamond says, "reveal that the birds adjust their territory size until they have maximized the rate of weight gain". But WP was in fact the only individual bird observed to have a higher rate of weight gain for an intermediate territory size and even in this case there is no direct evidence that the rate of weight gain achieved was a maximum. The justification for concluding that the birds did maximize their energy input was that in four out of five cases the highest weight gains achieved were on the last day or days of the birds' stay on the study site. Clearly this only demonstrates a level at which birds no longer attempt to increase their net energy input, not that that level is a maximum. The argument for a general "humped" relationship between territory size and weight gain is that some birds showed increases in weight gain with increasing territory size and some with decreasing territory size — a much weaker case than that implied by using the example of WP alone.

Alternative explanations for the observations are possible. For example, suppose that the rate of weight gain is related to the bird's body weight. The observed increase in rate of gain towards the end of each bird's stay is predicted, but is independent of territory size. This would also explain the unusually high rate of weight gain of bird BGR — the bird with the highest initial body weight.

A further problem arises with the proposed adjustment of territory size by "trial and error". Suppose a bird has a suboptimal energy gain from its initial territory size. Given a bell-shaped relationship between territory size and weight gain, how does the bird decide in which direction to alter its territory size? Even after one alteration made in a random direction the bird still has no good grounds on which to make its next decision.

Apart from the valuable technical innovation, the most important point which comes out of this work is, surely, that the birds do not behave optimally. On arrival at the study site, they do not know and cannot know what the optimum territory is. It depends on many unknown factors, such as nectar production by the flowers and the number and quality of the birds'

neighbours. They spend at least the first few days, if not all of their stay, in territories that are either too large or too small and the best they can do is to try to increase their efficiency as time goes on.

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Pigeons, canaries and problem-solving

SIR — I regret that I must question the accuracy of Pastore's[1] recent letter concerning my report of problem-solving behaviour in pigeons[2]. He suggests that I was remiss in not citing his early studies in which a canary was confronted with several Köhler-type problems. He implies that the canary solved both Köhler's one-box problem and Köhler's stacking problems in an "insightful" fashion, but the original reports of this work[3,4] do not confirm that.

The single canary that Pastore confronted with a variant of the one-box problem required 25 reinforced trials before it could move its box (a cardboard "prism") smoothly to the correct position on the floor of the chamber. So the behaviour that superficially resembled that of Köhler's chimps was, as Pastore originally reported, learned in virtually the same haphazard fashion as the escapes of Thorndike's[5] cats. Ironically, the performance of the canary was exactly that which Köhler dismissed as mere "trial and error". By no reasonable criteria could the canary's performance be considered "insightful".

On the stacking problem, in which stacking behaviour is also established haphazardly after many reinforced trials, Pastore[3] originally reported that "in the crucial trial, when both prism and box were out of position, the canary seemed to be unable to stack them in a meaningful way. Actually, the canary did stack prism and box appropriately in only 10 of 100 trials" (p. 289). No mention is made of success in stacking a larger number of boxes, contrary to Pastore's[1] recent statement. A second canary could not complete even the preliminary stages of the experiment. Praxists and psychologists long ago passed judgment on these modest demonstrations: they are almost universally uncited in the literature relevant to my research.

In contrast, my colleagues and I reported a systematic study with 11 pigeons in which all 3 with relevant training histories solved the box-and-banana problem in a dramatic human-like fashion the first time they were confronted with it. The performances satisfied all of the traditional criteria of "insight": periods of apparent confusion were followed by sudden, rapid, and entirely appropriate performances. By

systematically varying the training histories of other birds, we also determined the possible contributions that a variety of different experiences had made to success in the problem. Finally, we offered a running account of the novel performances in terms of empirically validated principles.

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DNA sequence selection by eye

SIR — The recent correspondence concerning various ways of representing DNA sequences[1,2] prompts me to describe a simple method for finding sequence overlaps by eye. Using the 4,361-nucleotide sequence of the plasmid pBR322 as a test system, it is possible with a little practice to locate a randomly selected sequence of about 100 nucleotides in less than 2 minutes.

The method requires four ballpoint pens of different colours and the sequence (or collection of sequences) with which the test sequence is to be compared is coded as follows. Every time the sequence AG (an arbitrary choice) occurs, the next base is coloured, the colour used depending on the next base again (G green, A blue, C black, and T red). Thus AGCT appears as a red C, AGGG appears as a green G and so forth. This process takes about 10 minutes per kilobase, but it only has to be done once for each new sequence determined.

To locate the test sequence, an AG is selected at random and about ten adjacent downstream bases are written with a sharp pencil on the edge of a piece of paper. The appropriate base adjacent to the G is coloured and the sequence is checked against each occurrence of that coloured letter, on average four times per kilobase.

If two AG sequences are close together on the test sequence, the pattern of two coloured letters separated by a certain number of bases makes searching faster and also highly specific. Such a pattern would only occur at random three times in the entire Epstein–Barr virus sequence.

If the sequence is not found, the complementary strand is searched by locating one or more CT sequences, writing down the ten or so downstream bases on the complementary strand and proceeding as before.

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