The Higher the Better: Sentinel Height Influences Foraging Success in a Social Bird

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SUPPLEMENTARY MATERIAL AND METHODS

(a) Study site and species

The study area consists of stretches of dry river-bed with vegetated dunes on either side, covered with a combination of annual and perennial grasses interrupted by dispersed *Acacia* and *Boscia* trees (for full details, see Raihani & Ridley 2007). The study population of pied babblers has been habituated to the close presence of humans and can be observed from c. 2–3 m away. Fledglings were classified as independent once they obtained 95% of their food from self-feeding; prior to this they were termed dependent. Adults were individuals older than 12 months, and were divided into dominants (the putative breeding pair) and subordinates (the remainder of the adults). Breeding females always incubate the eggs overnight; breeding males were identified from mid-air courtship chases and copulations with breeding females.

(b) Observational data collection

We collected observational data during the 4–5 h following dawn and the 2–3 h before dusk between November 2006 and June 2007 and between March and July 2008. Group spread was defined as the estimated distance between the two foragers furthest apart multiplied by the distance between the two foragers furthest apart on a perpendicular axis. Individuals were considered to be either foraging in the open (clearly visible) or under cover (for example, foraging at the base of a bush). A group scan, where we recorded group spread and the exposure (open, cover) of each forager, was conducted as soon as a sentinel changed its height in the same tree by at least 1 m, and as long as it had previously been in place for at least 2 min. To assess the impact of the change in height (either up or down), we collected the same data 2 min later, as long as the sentinel had remained at the new height during that time. Height was estimated to the nearest metre and we discarded any pairs of scans in which the number of foragers changed within the 2-min period.

Focal watches on individual foragers (median length of focal watch = 2.37 min, range 0.22–17.42 min, n=417 watches; median number of focal watches per individual = 8, range 1–38, n=36

individuals) continued until an alarm call occurred, the group moved to a new habitat (dune, open, grass, thicket), or the focal individual flew off, became a sentinel, or started resting, preening or playfighting. At least 1 h was left between focal watches on the same individual to increase the independence of sampling. During focal watches, we recorded the behaviour of individuals as: (a) foraging (whenever it was pecking or probing); (b) vigilant (whenever it had its head raised); or (c) moving. We also recorded each successful foraging attempt and the size of prey captured, which was converted to a biomass score (see Radford & Ridley 2006), and each change in sentinel status (presence, absence) and sentinel height (estimated to the nearest metre). All data were recorded onto a Palm TX PDA (Palm Inc., Sunnyvale, CA, USA), which automatically noted the time of each event. We extracted data from any focal watch in which there had been a 2-min period both before and after a change of at least 1 m in sentinel height (either up or down) in the same tree, and as long as there was no change in the number of foragers during that 4-min period.

(c) Acoustic recordings and analysis

Recordings of the watchman's song of sentinels were made using a Sennheiser MKH416T microphone and a Marantz PMD670 hard-drive sound recorder, following at least 5 min without any major disturbance (for example, alarm calls by babblers or other species). We conducted a 512-point fast Fourier transformation (Hamming window; time step: 1 ms; overlap: 98.43%; frequency range: 8 kHz; frequency resolution: 16 Hz) of all recordings using AVISOFT-SASLab pro 4.40 (R. Specht, Berlin). We then used LMA 2005 (developed by K. Hammerschmidt; see Schrader & Hammerschmidt 1997) to extract the following parameters from five randomly chosen calls from the low and high-position recordings of each individual: fundamental frequency (Hz), peak frequency (Hz), first quartile energy (Hz) and duration (s). Mean values of the five calls from each recording were used in statistical analyses. We also calculated call rate (calls per min) from the original sound files.

(d) Playback experiment

Each group received one playback of the watchman's song for 5 min from 2.5 m and one playback of the same watchman's song for 5 min from 5 m. Playbacks were from a Sony SRS-A35 speaker positioned on a pole placed next to a tree in the middle of the foraging group. Trials to the same group were on separate days, with the order of trial presentation counterbalanced, and occurred when foraging group size and habitat type (dune, open, grass, thicket) were the same. Playbacks were of the same sound intensity as natural watchman's

songs (as determined by a Tandy sound-level meter) and took place when no sentinel had been present for at least 5 min and there had been no alarm calls for at least 10 min.

(e) Statistical analysis

Mixed models were used for observational data analysis because these allow the inclusion of random as well as fixed terms and can thus take account of repeated measures of the same group and individual. All models had a normal error structure (Linear Mixed Model), except those examining the proportion of individuals foraging in the open, which had a binomial error structure and a logit link function (Generalised Linear Mixed Model). In all models, variance components were estimated using the Restricted Maximum Likelihood (REML) method, and random terms were retained unless the variance component was found to be zero (and hence their removal did not influence the findings reported). The significance of fixed terms was determined using the Wald statistic, which approximates the χ^2 distribution.

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