Ibis (2003), **145**, 689–691

Short communication

Olfactory discrimination in Yellow-backed Chattering Lories *Lorius garrulus flavopalliatus*: first demonstration of olfaction in Psittaciformes

T. J. ROPER*
School of Biological Sciences, University of Sussex, Brighton BN1 9QG, UK

The olfactory systems of birds resemble those of amphibians, reptiles and mammals (for reviews see Kare & Mason 1986, Wenzel 1987) but the importance of olfaction in the daily lives of birds remains a matter of controversy (Roper 1999). Nevertheless, there is now good behavioural evidence of olfactory capability in birds of a variety of species and of its use in several different functional contexts including orientation, foraging and reproduction (Jones & Roper 1997, Roper 1999). Thus, it seems increasingly likely that some degree of olfactory sensitivity is widespread in birds.

The present study tests ability to discriminate odour cues in two captive Yellow-backed Chattering Lories *Lorius garrulus flavopalliatus*. I chose this species because it feeds on nectar, flowers and fruit and so may use olfaction for foraging purposes. This is the first behavioural investigation of olfactory capability in any parrot species.

METHODS

The subjects were two hand-reared Lories (male and female) that were on display at Drusilla's Zoo Park, Alfriston, East Sussex, UK, and had been so for 15 months prior to the start of the study. They were housed together in a wire-mesh outdoor aviary measuring 11 × 5 × 3.5 m, containing shrubs, a small waterfall, a nestbox, and perching facilities such as ropes and ledges. Water was continuously available and food (artificial nectar and fruit) was presented at about 10:00 and 14:00 hours each day.

The apparatus comprised of five plastic water dispensers of a type commonly used for caged birds, consisting of a 125-mL vertical cylindrical reservoir connected at its base to a horizontal spout. They were painted uniform matt grey in order to conceal the contents and make them as visually identical as possible. Two 2-mL opaque white plastic Eppendorf tubes, open at the top, were taped vertically to the base of each dispenser (one on either side) and filled with cotton wool. In order to provide an odour cue, 0.2 mL of colourless olfactant (palmarosa *Cymbopogon martinii*, patchouli *Pogostemon cablin* or geranium *Pelargonium graveolens*, purchased in the form of essential oils from an aromatherapy shop) was added to each of the two Eppendorf tubes attached to 'scented' dispensers, and 0.2 mL of water to the tubes attached to 'unscented' dispensers. Dispensers were presented to the birds one at a time by placing them in a steel clip fixed to the outside of the aviary at a height of 1.5 m, so that only the spout protruded into the aviary through the wire mesh. Fresh olfactant was added before each daily session.

Prior to the start of the experiment proper, an unscented dispenser containing artificial nectar was made available to the Lories for 1 h per day for 5 days. From day 2 onwards, both birds readily approached this dispenser and drank from it. The experiment proper (see Table 1) consisted of three separate phases during which the birds were trained to distinguish nectar from water using a successive-discrimination procedure with (a) palmarosa, (b) patchouli and (c) geranium odour as a cue. Each phase consisted of a sequence of daily training sessions in which the birds were trained to distinguish a scented dispenser containing a solution of artificial nectar (160 g/L) from an unscented dispenser containing water. This was followed by a single extinction session in which both dispensers contained water. Each training session consisted of 16 trials, separated by 2-min inter-trial intervals. Extinction sessions consisted of only 10 trials because the birds soon lost interest, and ceased responding to either dispenser, when there was no reward. In each trial, one of two dispensers (scented or unscented), presented randomly with the constraint that each was presented eight times in each session, was clipped to the side of the aviary and left in place for 2 min, while an observer recorded whether or not either bird drank from it. Sessions began at 08:30 hours so as to be completed before the birds received their morning feed.

The birds were considered to have learned when they had made significantly more correct than incorrect responses (binomial test, $P < 0.05$ two-tailed) in three successive training sessions. In both training and extinction, a response was categorized as 'correct' if the bird either drank from the scented dispenser or failed to drink from the unscented dispenser; and vice versa for an 'incorrect' response. In extinction trials, a different pair of dispensers was used in order to control for the possibility that the birds had learned to discriminate the two training dispensers using incidental cues; and both dispensers were filled with water to control for the possibility that the birds were detecting the nectar directly, rather than responding to the odour cue.

RESULTS

Behaviour was recorded separately for the male and female but, because their responses could not be assumed to be

*Email: T.J.Roper@sussex.ac.uk

Table 1. Performance in a nectar vs. water discrimination test with either (a) palmarosa, (b) patchouli or (c) geranium odour as the discriminative stimulus.

Session	Condition[a]	Correct	Incorrect	% correct	P^b
(a) Palmarosa					
1	T	8	8	50	ns
2	T	8	8	50	ns
3	T	10	6	63	ns
4	T	7	9	44	ns
5	T	11	5	69	ns
6	T	12	4	75	ns
7	T	14	2	88	**
8	T	14	2	88	**
9	T	12	4	75	ns
10	T	15	1	94	***
11	T	15	1	94	***
12	T	14	2	88	**
13	E	9	1	90	*
(b) Patchouli					
1	T	12	4	75	ns
2	T	14	2	88	**
3	T	13	3	81	*
4	T	12	4	75	ns
5	T	12	4	75	ns
6	T	14	2	88	**
7	T	15	1	94	***
8	T	14	2	88	**
9	E	9	1	90	*
(c) Geranium					
1	T	13	3	81	*
2	T	12	4	75	ns
3	T	14	2	88	**
4	T	15	1	94	***
5	T	14	2	88	**
6	E	10	0	100	**

[a]T = training; E = extinction.
[b]ns = non-significant; *= $P < 0.05$; **$P < 0.01$; ***$P < 0.001$ (binomial tests, two-tailed).

independent, data were combined for purposes of analysis. In practice, both birds contributed approximately equally to the result (male: 231 trials; female: 199 trials; binomial test, $z = -1.69$, $P = 0.134$ two-tailed).

In phase 1 (palmarosa) the performance of the Lories during the first four sessions was close to chance but improved rapidly thereafter (Table 1a). The learning criterion was reached in session 12 and the number of correct responses significantly exceeded the number of incorrect responses during five of the last six sessions. The birds also made significantly more correct than incorrect responses in the extinction session (binomial test, $k = 1$, $N = 10$, $P < 0.05$). In phases 2 and 3 (patchouli and geranium, respectively: Table 1b,c) performance began at a high level and the learning criterion was reached more rapidly. With both odours the birds again made significantly more correct than incorrect responses in the relevant extinction session (binomial tests: patchouli, $k = 1$, $N = 10$, $P < 0.05$; geranium, $k = 0$, $N = 10$, $P < 0.01$).

DISCUSSION

On anatomical grounds, parrots would be expected to have a sense of smell because their olfactory lobes and olfactory epithelium, although relatively small in size by avian standards, qualitatively resemble those of other birds (Bang & Cobb 1968). However, an early attempt to record physiological responses to odours in a single Yellow-headed Amazon Parrot *Amazona ochrocephala* was unsuccessful (Wenzel & Sieck 1972). The present study, showing that Yellow-backed Chattering Lories can discriminate a dispenser containing artificial nectar from one containing water, using three different plant odours as cues, is the first behavioural evidence of olfactory capability in any parrot species. Although the responses of both birds were combined for purposes of analysis, the fact that the male and female completed approximately equal numbers of trials suggests that both learned the discrimination.

Little is known about the extent to which birds use olfaction in the wild, but field observations and experiments indicate that some corvids, New World vultures, procellariiforms and honey-guides use olfactory cues to locate food (see review by Roper 1999). There is experimental evidence that hummingbirds can learn an olfactory discrimination (Goldsmith & Goldsmith 1982, Ioalè & Papi 1989) but it seems intuitively more likely that they and other nectar-feeding birds locate suitable flowers visually. Nectar-feeding birds might, however, use olfaction to evaluate individual flowers from relatively close range, a situation mimicked by the present experiment. Alternatively, olfaction might combine with gustatory sense to enable birds to distinguish between different types of nectar.

As the experiment progressed, different olfactory discriminations were learned progressively more rapidly. This suggests transfer of learning to each new odour, although it is also possible that the odours differed in their salience.

I thank Drusilla's Zoo Park, Alfriston, for allowing me to test the birds and Dr D.G.C. Harper and the referees for comments on the manuscript.

REFERENCES

Bang, B.G. & Cobb, S. 1968. The size of the olfactory bulb in 108 species of birds. *Auk* **85**: 55–61.

Goldsmith, K.M. & Goldsmith, T.H. 1982. Sense of smell in the Black-chinned Hummingbird. *Condor* **84**: 237–238.

Ioalè, P. & Papi, F. 1989. Olfactory bulb size, odor discrimination and magnetic insensitivity in hummingbirds. *Physiol. Behav.* **45**: 995–999.

Jones, R.B. & Roper, T.J. 1997. Olfaction in the Domestic Fowl: a critical review. *Physiol. Behav.* **62**: 1009–1018.

Kare, M.R. & Mason, J.R. 1986. The chemical senses in birds. In Stuckie, P.D. (ed.) *Avian Physiology*, 4th edn: 59–73. New York: Springer-Verlag.
Roper, T.J. 1999. Olfaction in birds. *Adv. Stud. Behav.* **28**: 247–332.
Wenzel, B.M. 1987. The olfactory and related systems in birds. *Ann. N.Y. Acad. Sci.* **519**: 137–149.
Wenzel, B.M. & Sieck, M.H. 1972. Olfactory perception and bulbar electrical activity in several avian species. *Physiol. Behav.* **9**: 287–293.

Received 29 April 2002; revision accepted 15 October 2002.