

PRELIMINARY OBSERVATIONS ON ACOUSTIC PERCEPTION OF ALARM CALLS AND NATURAL SOUNDS BY AUSTRALIAN OWLS AND FROGMOUTHS

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ABSTRACT

Responses to alarm calls and natural sounds were examined in two individuals of four species of Australian nocturnal birds: Barn Owls *Tyto alba*, Masked Owls *T. novaehollandiae*, Southern Boobooks *Ninox novaeseelandiae* and Tawny Frogmouths *Podargus strigoides*. The sounds tested were narrow-band and broad-band alarm calls of Australian honeyeaters, plus sounds of potential prey, mouse squeaks and rustling leaves. All four species of birds had greater difficulty responding correctly (head movement towards the activated speaker) to narrow-band alarm calls than to broad-band alarm calls, mouse squeaks and rustling leaves.

INTRODUCTION

Hearing in nocturnal birds plays an integral role in hunting behaviour and social interactions, and has been studied extensively in the northern hemisphere Barn Owl *Tyto alba* and to a lesser extent in other northern hemisphere owls (for summary see Konishi 1993; Volman 1994; Wagner 1995) and the southern hemisphere Masked Owl *Tyto novaehollandiae* (Baker-Gabb 1993). Most of these studies have tested owls with pure tones and artificial noise, and have shown that owls optimally localise frequencies between 5 and 9 kHz and locate broad-band signals more easily than narrow-band signals. However, few studies have used natural sounds. This study sought to test the hearing of Australian owls and frogmouths with natural sounds. We expected that these birds would have more difficulty locating the narrow-band alarm calls emitted by passerines than broad-band alarm calls or natural prey sounds such as mouse squeaks and rustling leaves (see Jurisevic 1996). Narrow-band alarm calls are so called because they occupy a limited frequency range, for example 2–3 kHz whereas broad-band sounds cover a wide frequency range, typically 1–10 kHz (see Figure 1).

METHODS

Experiments were conducted in 1996

(Swanson 1996) on each of two adult Barn Owls (a breeding pair), Masked Owls (a breeding pair), Southern Boobooks *Ninox novaeseelandiae* (sex unknown) and Tawny Frogmouths *Podargus strigoides* (sex unknown). The Flinders University Bioethics Committee approved the studies, and the birds were returned in good condition to those who had lent them.

The hearing of each bird was tested in a large roofed cage (2.16 m high x 1.95 m wide x 4.15 m long) which had the back and sides covered with underfelt. Sounds were played back from one of two speakers in the back corners of the cage, to a single bird on a perch in the middle of the cage, about 2.5 m from each speaker, with the angle between speakers 45° at the subject. Test sounds were presented in random order from the two speakers, with sound pressure level at the subject 15–20 dB above the ambient sound level of 40–45 dB. The responses of the birds were assessed by watching through a peephole at the back of the cage. The head-turning behaviours of the birds were observed as they turned towards the speaker emitting the sound. To prevent habituation, owls and frogmouths were given small pieces of meat as a positive reinforcement, at random intervals during the trials (see Wagner 1995), irrespective of whether the subject had responded correctly to the sounds. Trials commenced following a training period of about one week.

A set of six sounds, each approximately 1 second long, was prepared for playback (Figure 1), including two narrow-band aerial alarm calls, two broad-band mobbing calls, plus mouse squeaks and mice rustling leaves, both occupying a broad range of frequencies. The birds were also tested with pure-tone stimuli, ranging in frequency from one to 16 kHz. Ten trials of each set of sound stimuli were performed on each bird, with the order of sounds randomised in each set. Testing occurred during the middle of the year, and began each day after 1630 h as dusk was approaching. Each new

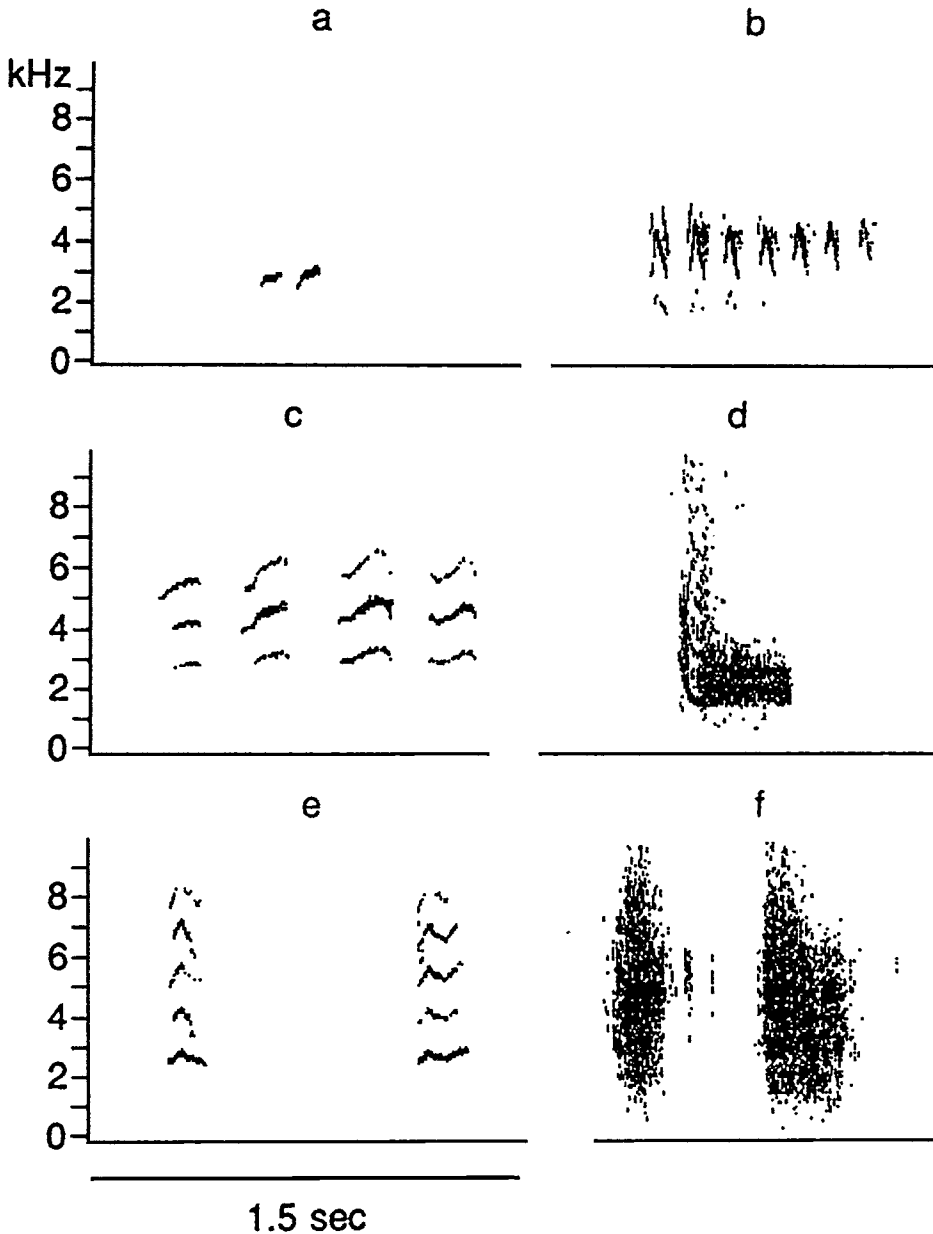


Figure 1. Alarm calls and natural sounds used as stimuli to test the hearing of owls and frogmouths. Sonograms are: (a) aerial alarm call of Noisy Miner *Manorina melanocephala*; (b) aerial alarm call of White-plumed Honeyeater *Lichenostomus penicillatus*; (c) mobbing alarm call of Noisy Miner; (d) mobbing alarm call of Red Wattlebird *Anthochaera carunculata*; (e) squeaks of Mouse *Mus musculus*; (f) rustling leaves caused by mice.

sound was presented only when the bird was stationary and looking straight ahead, which involved at most an occasional delay of several seconds, as the preferred normal head position of the birds was straight ahead.

We were aware of the possibility that owls might respond to weak sounds, such as the switching noises of electrical equipment or tape hiss, and used various tactics to minimise this potential problem, including the use of carefully prepared sounds without obvious artefacts, presentation of sounds 15–20 dB above background, the masking of potential cuing noises with low level background noise, and careful observation of birds to ensure that their responses were not linked to switching noises.

Head movement towards the activated speaker was scored as a 'correct response', away from the activated speaker as an 'incorrect response', and absence of head movement during a stimulus presentation was classified as 'no response'. Each bird was tested over a period of several weeks. Statistical analyses used SPSS for Windows.

RESULTS

Australian owls were generally similar in their ability to locate broad-band natural sounds such as rustling leaves (RL) and mice squeaks (MS) more accurately than narrow-band stimuli (NM1, WPH; Figure 2). The frogmouths also located the broad-band natural sounds more readily than the narrow-band stimuli, apart from the mouse squeaks, which elicited fewer responses than did the rustling leaves. It can be seen that generally the owls were more responsive to the sounds than were the frogmouths (Figure 2). A two-way analysis of variance showed significant differences in the responses of the different species ($F_3 = 30$, $P = 0.001$) and in their responses to the different sounds ($F_5 = 9$, $P = 0.001$). The interaction between species and sounds was not significant ($F_{15} = 1.2$, $P = 0.345$), indicating that the different bird species responded to the different sounds in a similar way. Scheffe's posthoc test showed that the responses of frogmouths were significantly less than those of all owls across all stimuli ($P = 0.001$), and among owls, the responses of Boobooks were significantly greater than those of Masked Owls across all stimuli ($P = 0.001$). In addition the responses to narrow-band stimuli

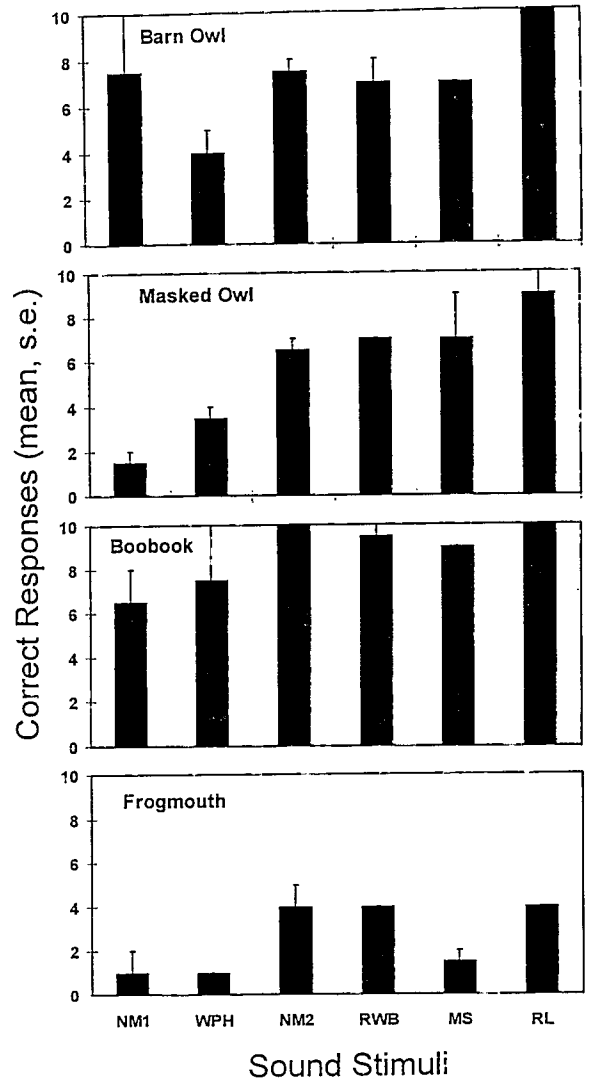


Figure 2. Responses of owls and frogmouths to natural stimuli shown in Figure 1. Stimuli are: NM1, Noisy Miner aerial alarm; WPH, White-plumed Honeyeater aerial alarm; NM2, Noisy Miner mobbing alarm; RWB, Red Wattlebird mobbing alarm; MS, mouse squeaks; RL, mice rustling leaves. The black bars show the correct responses of birds to stimuli, where the birds looked directly at a speaker producing the sounds, indicating correct location of sounds.

(NM1, WPH) were significantly less than the responses to rustling leaves (RL) across all species ($P = 0.001$).

Incorrect responses were recorded on <10% of trials, and there were no significant differences between species for the incorrect responses to any natural stimuli. 'No responses' made up the balance of trials (total trials minus correct and incorrect responses), and for the different stimuli constituted 35–80% of trials in frogmouths and 0–80% of trials in owls. Thus for example the 60 presentations of the sound of rustling leaves to six owls elicited 58 correct responses, one incorrect response and one 'no response', whereas the 20 presentations of the same sound to two frogmouths elicited eight correct responses, three incorrect responses and nine 'no responses'.

Our observations with natural stimuli (Figure 2) suggest that Australian *Tyto* and *Ninox* owls can hear sounds at least within the range 1–8 kHz, and this was confirmed by the tests with pure-tone stimuli. The owls responded to tones of higher frequencies; the upper frequency limit of owl hearing was not precisely determined. The frogmouths responded to tones of frequency 1–4 kHz, with very little response to tones of higher frequencies.

DISCUSSION

The results confirm the proposition that broad-band stimuli are more easily located than narrow-band stimuli, since broad-band sounds provide a maximum number of acoustic cues (such as direction and distance) for detection and localisation (Marler 1955, 1957). The sounds of rustling leaves are particularly rich in frequencies (see Figure 2), thus the *Tyto* and *Ninox* owls' ability to correctly locate these sounds is particularly high. A similar study conducted on southern hemisphere hawks and falcons (Jurisevic 1996) also showed that raptors locate broad-band alarm calls of passerines more readily than narrow-band alarm calls.

We had anticipated that there might be some differences in the hearing abilities of *Tyto* owls, with asymmetrical ears (Norberg 1977), which should convey an advantage in sound localisation, and *Ninox* owls, which have symmetrical ears (Burton 1973). However, in this study the hearing performance of Boobooks was similar to that of the Barn Owls and significantly better

than that of the Masked Owls. Whether there are more subtle differences in the auditory performances of *Tyto* and *Ninox* owls awaits elucidation in more sophisticated testing programs.

From a functional point of view some of our observations correlate well with the known behaviour and ecology of the birds. Since *Tyto* and *Ninox* owls take rodents as prey (Hollands 1991) and may hunt partly by sound (Payne 1971) their good responses to mouse sounds and rustling leaves (Figure 2) are no surprise. In addition owls are sometimes mobbed by honey-eaters and other birds (Jurisevic and Sanderson 1994) and might be expected to respond well to mobbing calls. By contrast, frogmouths, which were least responsive to sounds, have large eyes, hunt invertebrates by night (Hollands 1991) and avoid daytime discovery by cryptic behaviour, and are seldom mobbed. Frogmouths might therefore be expected to respond less to sounds of mice, which they don't hunt, and to calls of mobbing birds.

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REFERENCES

- Baker-Gabb, D. 1993. Auditory location of prey by three Australian raptors. In *Australian raptor studies, proceedings 10th anniversary conference Australasian Raptor Association*. P. Olsen (ed.). Australian Raptor Association, RAOU, Melbourne, pp. 295-298.
- Burton, J.A. 1973. *Owls of the world*. Peter Lowe, London.
- Hollands, D. 1991. *Birds of the night: owls, frogmouths and nightjars of Australia*. Reed Books, NSW.
- Jurisevic, M.A. 1996. *Acoustic perception of alarm and distress calls by raptors*. Ph.D. Thesis, Flinders University, Adelaide.
- Jurisevic, M.A. and Sanderson, K.J. 1994. Alarm vocalisations in Australian birds: convergent characteristics and phylogenetic differences. *Emu*, 94, 69-77.
- Konishi, M. 1993. Listening with two ears. *Scientific*

- American*, 268, 66-73.
- Marler, P. 1955. Characteristics of some animal calls. *Nature*, 176, 6-8.
- Marler, P. 1957. Specific distinctiveness in the communication signals of birds. *Behaviour*, 11, 13-39.
- Norberg, R.A. 1977. Occurrence and independent evolution of bilateral ear asymmetry in owls and implications in owl taxonomy. *Philosophical Transactions of the Royal Society of London*, 280, 375-408.
- Payne, R.S. 1971. Acoustic location of prey by barn owls (*Tyto alba*). *Journal of Experimental Biology*, 54, 535-573.
- Swanson, M. 1996. *Acoustic perception of alarm calls and natural sounds by Australian owls and frogmouths*. BSc Honours Thesis, Flinders University, Adelaide.
- Volman, S.F. 1994. Directional hearing in owls: neurobiology, behaviour and evolution. In *Perception and Motor Control in Birds: An Ecological Approach*. M.N.O. Davies and P.R. Green (eds). Springer-Verlag, Germany, pp. 292-314.
- Wagner, H. 1995. Sound-localization experiments in owls. In *Methods in Comparative Psychoacoustics*. G.M. Klump, R.R. Dooling and W.C. Stebbins (eds). Birkhauser Verlag Basel, Switzerland, pp. 183-194.

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