# Individual Recognition Between Mother and Infant Bats (*Myotis*)

**DENNIS TURNER**
**ANNA SHAUGHNESSY**
**EDWIN GOULD**
***The Johns Hopkins University***

INDIVIDUAL RECOGNITION AMONG BIRDS has received a great deal of attention (refs. 1 to 6), while among mammals the literature on this subject is relatively sparse. Marler (ref. 7) noted individual differences in a typical call pattern of wild chimpanzees. Bartholomew (ref. 8) described individual recognition between mother and infant Alaskan fur seals. Bowers and Alexander (ref. 9) demonstrated that olfactory cues were used by laboratory mice to discriminate between individuals. Human mothers can identify their own infant's hunger cry from those of other infants (ref. 10).

Individual recognition is ultimately based on some form of communication; visual, olfactory, auditory, tactile and/or gustatory stimuli provide the cues for identification. Animals tend to emphasize one avenue of communication more than others, and the kinds of stimuli utilized depend on the habitat and mode of life of the species (ref. 11). Thus with the nocturnal bats, one might expect auditory and/or olfactory stimuli to take precedence over visual cues. In the few genera of bats that have been studied, the mother selectively nurses only her own young, i.e., *Eptesicus* (ref. 22), *Pteropus* (ref. 13), *Nycticeius* (ref. 14), and *Tadarida* (ref. 15). Selective nursing implies individual recognition. Mohres (ref. 16) and Kulzer (ref. 15) have suggested that bat ultrasonics may function in communicating as well as sensing. Several authors have described the continuous nature of calls emitted by infant bats and concluded that they serve to attract the mother to the infant (refs. 12, 14, 15, 17, and 18). Novick (ref. 19) has suggested that the diverse echolocation sounds in different species of bats may be correlates of different sonar systems. But these differences in duration, intensity, and frequency could also contribute to the uniqueness of the sounds as communicative signals. Marler and Hamilton (ref. 20) and Mohres (ref. 16) suggest that the pulse characteristics could serve as a cue for localization by the mother. Individual recognition based on auditory stimuli could prove very useful to the bat. When the mother returns to the nursery colony after her daily feeding excursion, she must locate her own infant. The colony is increasing in

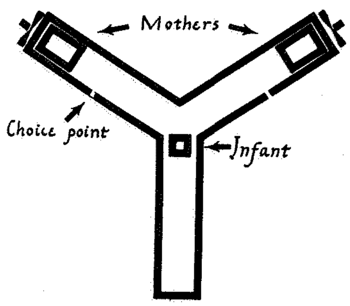


**FIGURE 1. Diagram of Y maze apparatus.**

numbers daily, and her infant becomes more mobile with maturation. There is evidence[1] that the infant's voice characteristics change as it grows, and this may provide the individuality necessary for recognition. This remains to be seen. In this paper, the authors have attempted to determine whether individual recognition occurs in the little brown bat (*Myotis lucifugus*), and if so, what the basis for that recognition is.

## *METHODS*

Mother-infant pairs of *Myotis lucifugus* were captured from Baltimore nursery colonies and brought into the laboratory in June 1970. When captured, infants ranged from 1 to approximately 4 days old. Cornell mosquito cages, 30½ $cm^3$, contained the bats in a room held at 32° C. with circulating air. Humidity was maintained by placing several large evaporation trays on the floor. The bats were fed and watered once a day but otherwise disturbed as little as possible. Bats were identified by bands and toe clips. For other details on care and feeding, see Gould.[1]

The experiments were conducted in a second room, kept at the same temperature and removed from the animal room by still a third room. An aluminum sided Y maze was used to test the ability of the infant to recognize its mother on the basis of auditory communication (fig. 1). Each arm of the maze measured 65 × 14 × 17 cm. The top of each arm was covered by a sliding plexiglass sheet. Guarded fans (10 cm diam), which moved 50 cfm/fan, were placed on two arms of the Y to draw air out of the chamber. The maze was positioned so that varying conditions in the room, such as overhead lights, would be accounted for.

Two mothers were separated from their infants and each one randomly placed in a holding box, 17 × 10 × 12.5 cm, at the end of an arm. These cardboard holding boxes had double screening on the end facing the junction of the maze; fine screen was used to eliminate the use of vision by the infant. The opposite end of the box had a single layer to allow the air to be drawn out of the chamber. The infant to be tested was placed under a ¼-in. hardware cloth cover at the junction of the arms where its mother and an alien mother were located. The alien mother's infant was removed to the animal room. After a 10-min waiting period, the cover on the test animal was gently lifted and the infant's movement recorded. This waiting period was designed to allow ample time for the infant to calm down and for communication between the bats to occur. A point 35 cm down each arm was arbitrarily taken to be the "choice" point, although in every case, the infant went all the way to a box holding an adult.

Between each run, papers were laid down to minimize the possible effect of a scent trail. Several infants were used more than once, but only after a minimum 72-hr interval between runs. In all cases, the adults were randomly placed at the maze arms. However, it should be noted that when the alien moth-

[1] GOULD, E.: Studies of Maternal–Infant Communication and Development of Vocalizations in the Bats *Myotis* and *Eptesicus*. Commun. Behav. Biol. (in press).

er's infant was tested, the random placing of the two mothers was sometimes such that their positions remained the same as when the first infant was tested.

Twenty runs were completed in this manner using 13 mother-infant pairs. The last nine runs were recorded at 30 ips using a Precision Instrument Tape Recorder No. 202, modified Granath ultrasonic microphone system, to test whether the bats were emitting ultrasonic communication signals. The recorder was turned on after the adults were in position and just before the door was opened to permit entry with the infant to be tested. Later, the recordings were slowed 16 times, played through a Tektronix Type 503 Oscilloscope, and filmed with a 35 mm Kymograph Camera Model C4–K. The communication signals were first described by Gould,[2] who listened to the slowed sounds of isolated infants and isolated adult mothers. He was able to distinguish the mother and infant when they called simultaneously on the same tape, and his description of the vocalizations was used in this experiment. The total number of antiphonal chirps from each mother was tabulated. Isolation call-antiphonal chirp pairs were randomly selected from the tapes and filmed for duration analysis. A standardized technique was used to measure the length of the *i* call, and then the span from the end of the *i* call to the beginning of the *A* chirp. The interval from the beginning of the *i* call to the beginning of the *A* chirp was also measured.

TABLE 1.—*Results of the Y Maze Test*

| Date | Infant number | Mother number | Alien mother | Choice |
|---|---|---|---|---|
| 21 June | a | 1 | 6 | Mother |
| 22 | b | 2 | 3 | Mother |
| 22 | c | 3 | 2 | Mother |
| 24 | d | 4 | 5 | Mother |
| 24 | e | 5 | 4 | Mother |
| 25 | f | 6 | 1 | Mother |
| 25 | a | 1 | 6 | Mother |
| 25 | g | 7 | 14 | Alien |
| 26 | h | 8 | 9 | Mother |
| 29 | f | 6 | 4 | Mother |
| 29 | d | 4 | 6 | Mother |
| 30 | e | 5 | 2 | Alien |
| 1 July | i | 9 | 10 | Mother |
| 1 | j | 10 | 9 | Mother |
| 1 | a | 1 | 2 | Alien |
| 1 | b | 2 | 1 | Alien |
| 2 | k | 11 | 7 | Mother |
| 2 | g | 7 | 11 | Mother |
| 2 | l | 12 | 15 | Alien |
| 6 | m | 13 | 9 | Mother |

## *RESULTS AND DISCUSSION*

It can be seen from table 1 that infants chose their own mothers in 15 of the runs and the alien mothers five times. Isolation calls were emitted by infants during all of the nine recorded runs, but mothers answered these vocalizations with antiphonal chirps in only eight runs. One notes from table 2 that ultrasonic communication occurred during several runs in which the infant made an incorrect choice. Also, there were no antiphonal chirps emitted during run number 15, an incorrect choice.

From this experiment, the authors have concluded that individual recognition between mother and infant did occur. However, it cannot be determined at this time if the recognition was based on ultrasonic communication or olfactory stimuli. The infant was prohibited from receiving odors of either adult, yet it is possible that the mother recognized the odor of her infant in the air being drawn past her. She may have then called in response to the olfactory stimuli and/or the

[2] GOULD, E.: Studies of Maternal-Infant Communication and Development of Vocalizations in the Bats *Myotis* and *Eptesicus*. Commun. Behav. Biol. (in press).

TABLE 2.—*Analysis of Recorded Runs*

| Run number | Approximate age (days) | *i* calls | *A* chirps | Number *A* chirps | Choice |
|---|---|---|---|---|---|
| 12[a] | 23 | yes | yes | 96 | 2×Mother 1×Alien |
| 13 | 13 | yes | yes | 388 | Mother |
| 14 | 7 | yes | yes | 106 | Mother |
| 15 | 12 | yes | no | none | Alien |
| 16 | 17 | yes | yes | 7 | Alien |
| 17 | 9 | yes | yes | 8 | Mother |
| 18 | 23 | yes | yes | 7 | Mother |
| 19 | 5 | yes | yes | 115 | Alien |
| 20 | 15 | yes | yes | 654 | Mother |

[a] Twice during this run, the infant pushed the hardware cloth cover toward the mother's arm of the maze. When released after 10 min., the infant chose the alien mother.

infant's isolation calls; and the infant, in turn, chose the only arm of the Y maze carrying auditory stimuli. However, it is significant that the infant responded to the mother's vocalizations. As for the five incorrect choices, it is possible that the system is only 75-percent efficient. At this time, we are unable to determine whether one or both adult mothers responded to the infant calls. Several of the incorrect choices were made in unrecorded runs and may or may not have involved antiphonal calling by the mother.

If the basis for recognition is ultrasonic vocalization, one must assume that there is sufficient variability in individual calls and that this variability is utilized by the bat. Bateson (ref. 21) in discussing dolphin vocalization suggests that we will not know much about the communication process until we know what one dolphin reads in another dolphin's signals. The same holds for bat communication. The literature on the individuality of bat vocalizations is sparse, but the authors have found statistical differences (99-percent level of significance, parametric analysis of variance) between the different mother-infant pairs in the duration of an infant's *i* call, the interval from the end of the *i* call to the beginning of the *A* chirp, and the interval from the beginning of the *i* call to the beginning of the *A* chirp.

Overlaps occur between *i* call durations of different infants (fig. 2) and between intervals of different mother-infant pairs (figs. 3 and 4). One might argue that because of these overlaps, *i* call duration would be a poor substrate for individual recognition. However, in a large nursery colony, any clue might help the mother locate her infant. Perhaps at least a portion of the population could be eliminated by hearing *i* calls of vastly different duration than those of her own infant. Final recognition may be based on olfactory cues as in *Rousettus* (ref. 22). There appears to be no apparent relation between the *i* call duration and the age of the infant. Nor can any conclusions be drawn concerning the numbers of antiphonal chirps required for the infant to localize the mother. Since differences between mother-infant pairs

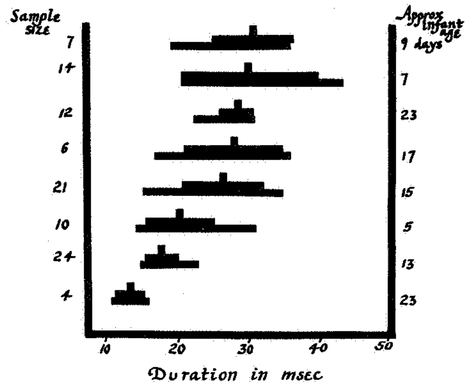


FIGURE 2. Duration of isolation call. Lower bar of each triplet shows range data for each infant. Center bar shows ±1 standard deviation from the mean. Upper bar represents mean duration of that infant's call.

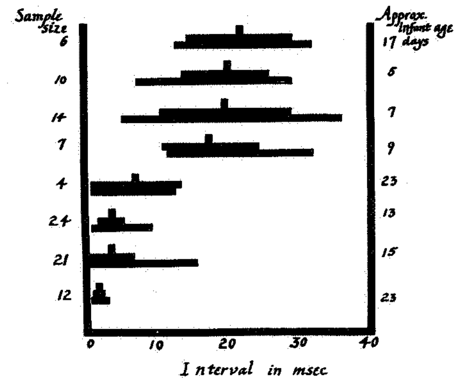


FIGURE 3. Interval from end of isolation call to beginning of antiphonal chirp. Lower bar of each triplet shows range of intervals for each mother-infant pair. Center bar shows ±1 standard deviation from the mean. Upper bar represents mean of the intervals.

in the interval from the end of an *i* call to beginning of the *A* chirp exist, it is possible that the infant may utilize this information and crawl toward the mother or modify its vocalizing pattern. Therefore, at least two possible variables in the vocalizing behavior of *Myotis* exist: *i* call duration and interval length. The use of these variables by the bat has not been demonstrated. Nor does this finding obviate the possibility that harmonics unique to each individual are used as a basis for recognition.

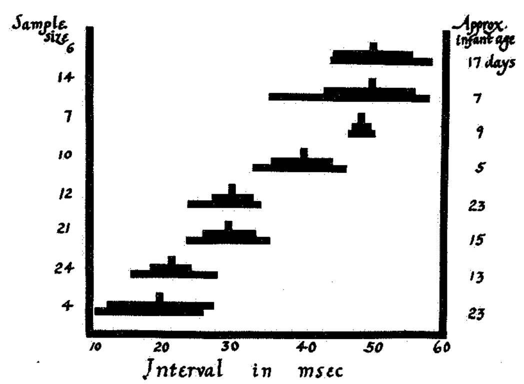


FIGURE 4. Interval from beginning of isolation call to beginning of antiphonal chirp. Symbols as in figure 3.

## *SUMMARY*

Mother-infant pairs of *Myotis lucifugus* were tested for individual recognition using an aluminum sided Y maze. Two mothers were randomly placed at the ends of two of the arms of the maze and the infant was placed at the junction of these arms. The infant's use of vision was eliminated by placing each mother in a holding box which had fine double screening on the end of the box facing the infant. Air was drawn out of the chamber past the two mothers. Twenty runs were completed using 13 mother-infant pairs. The last nine runs were recorded for later analysis of communication signals.

Infants chose their own mothers in 15 of the 20 runs. The authors conclude, therefore, that individual recognition did occur but are unable to determine whether recognition was based on auditory and/or olfactory stimuli. Analysis of the recorded runs shows differences between mother-infant pairs in both

the duration of the infant's isolation call and the interval from the end of this call to the beginning of the mother's antiphonal chirp. Implications of these differences are discussed.

## *ACKNOWLEDGMENT*

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## *DISCUSSION*

WATERMAN: The flying foxes in the Caroline Islands seem to have rather prominent social communication in our audio range. Do these kinds of bats have an echo-locating mechanism?

GOULD: No, but Nelson (ref. 13) has indicated that there is antiphonal calling. He observed the mothers calling to their specific infants; he suggested that they were, in fact, recognizing one another. He did not conduct experiments with individual recognition, although Kulzer (ref. 22) showed that the mother could identify her infant if the infant was in a bag next to a strange infant in a bag. Nelson has described quite a number of vocalizations and has shown how many of them promote spacing in the group since there seems to be in some places limited roosting sites; territorial males are also described.

GRIFFIN: Have you studied the communication calls of the adult bats?

GOULD: Yes. Turner and Shaughnessy put cages a few feet apart and separated them with thick cotton, placing microphones so that only the infant sounds from a single cage were detected. It was rigged with a signal operated relay and checked out on the event recorder to see whether the calling of infants and adults were related. After a long quiet period, the mother would call and then the infant would call, and this would go on throughout the night. They also found that this was true with two different infants. They tried it with adults that were in the colony for some time, and there was no such correlation. A better approach might be to take adults that have been separated for a period of time, where there might be a greater likelihood of communication, particularly those who are closely related or in colonies.

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