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BRIEF COMMUNICATION

An Avian Vocalization Detector

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SEVERNS, M., L. GRAY AND E. W RUBEL. *An avian vocalization detector*. PHYSIOL BEHAV 34(5) 843–845, 1985.—A simple circuit to detect avian vocalizations is described. Adjustments of five different controls (frequency, bandwidth, amplitude, duration and spacing) allow the circuit to accurately detect the vocalizations of different ages and species of birds. Analyses of over 4000 peeps and 500 inter-peep intervals from 40 chicks and 16 ducklings showed that the circuit and an experienced observer agreed closely in the timing and counting of vocalizations.

Birds Vocalizations Computers Apparatus Chicks Ducklings

COUNTING and timing the vocalizations of young precocial birds has been important in many behavioral studies, including investigations of normal development, perception, imprinting, motivation, social behavior and emotion [4, 6, 8, 11, 17, 19]. These measurements have been used to analyze the behavioral effects of early experiences, drugs, central nervous system lesions and neural stimulation [2, 13, 14]. Chickens have been the most common subjects in these studies, but ducklings [15], jungle fowl [18], quail [16], pheasants [10] and turkeys [3] have also been studied.

An objective, consistent and automated method for identifying vocalizations would thus be of value in a wide variety of studies that use birds. An electronic circuit was developed (by M. S.) to be easily adjustable so as to trigger on the vocalizations of different ages and species of birds, to minimize "false alarms," and to be easily connected to a computer.

Five criteria are used to detect vocalizations: frequency, bandwidth, amplitude, duration, and spacing. The output of a microphone is first shaped by a narrow bandpass filter, whose center frequency can be varied from 3000 to 5500 Hz. Bandwidth, a measure of the filter's sharpness, is adjustable from 3.8% to 38% (defined as the range of frequencies divided by the center frequency). After filtering, the signal is compared to an adjustable amplitude limit. Only signals which exceed this threshold within the selected range of frequencies are tested for duration and spacing. In order to pass the duration test, the signal must be present for a period of time which can be adjusted between 0.5 msec and 60 msec. In addition, a specified minimum period of time, adjustable between 50 msec and 250 msec, must have elapsed since the last vocalization occurred. This spacing criterion is necessary to avoid counting a single vocalization with a subthreshold dip in amplitude as two vocalizations.

In operation, an oscilloscope is connected to the output of the filtering circuitry, and the center frequency of the filter is adjusted to give the maximum output. The threshold is then set to reliably trigger on loud vocalizations. The duration and spacing controls seldom need to be readjusted for a given species of animal.

In order to establish the reliability of the circuit in detecting vocalizations, the output of the circuit was compared with the decisions of an experienced human observer (L. G.). Most of the testing involved young chickens, but a smaller number of ducklings were also studied to verify that the detector could be reset for a different species.

Two measurements of vocalization detection were judged of primary importance: the timing of inter-peep intervals, and the counting of vocalizations in a 5-second period [13]. Briefly, a human observer timed and counted the vocalizations of a young bird while a computer automatically recorded the output of the electronic detector.

Subjects were 43 chicks and 16 ducklings hatched in the laboratory. Chicks were tested between 6 and 24 hours after hatching (termed "0-day-old") or between 96 and 120 hours after hatching (termed "4-day-old"). Ducks were tested between 24 and 48 hours after hatching.

The birds were placed individually inside a vertical Plexiglas cylinder located inside a sound-attenuating room. The temperature [12] and lights were normal, inducing regular loud peeps [1] or "distress calls" [7] from these isolated hatchlings [5].

The animals' vocalizations were picked up by a nondirectional microphone suspended just above the cylinder.

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TABLE 1

DIFFERENCES BETWEEN ELECTRONIC AND MANUAL MEASUREMENT OF AVIAN VOCALIZATIONS

	Chicks 0-day	Chicks 4-day	Ducks 2-day	All Birds
Counting of Peeps				
Percent Agreement	99%	99%	99%	99%
Counted by Human Only	5	12	9	26
Counted by Circuit Only	12	3	1	16
Total Number	1432	1580	1078	4090
Timing of Peeps				
Mean Difference (sec)*	−0.011	+0.018	+0.015	+0.0063
Standard Deviation	0.010	0.050	0.069	0.0795
Total Number	200	200	132	532

*Mean of automatic minus manual measurement of the time to the first peep in each trial. Positive differences occur when the circuit's timing was longer than the human's; negative differences occur when the circuit detected peeps before the human did.

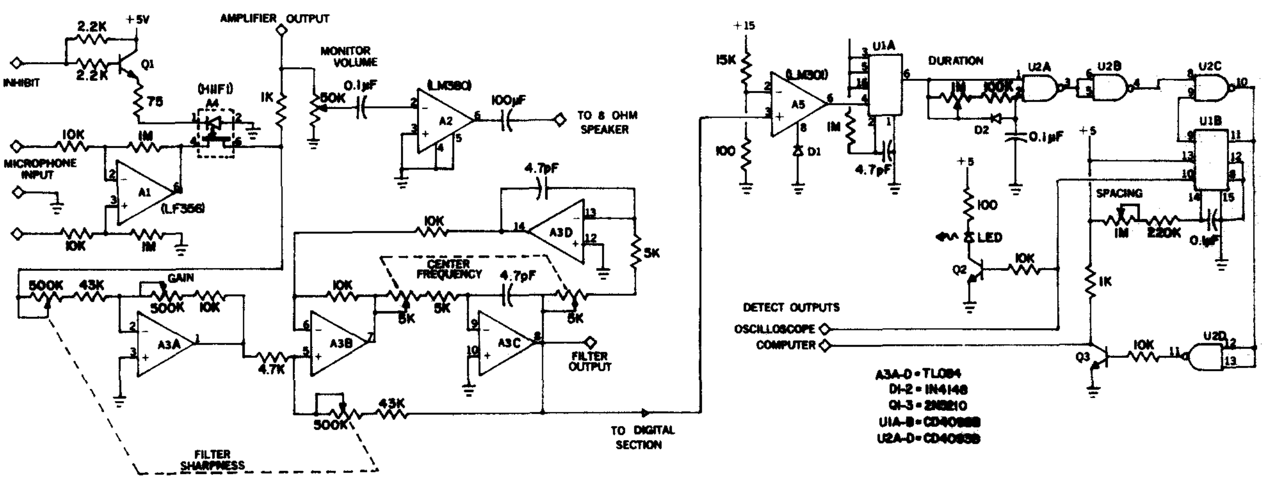

FIG. 1. Avian vocalization detector circuit. The microphone input is amplified ×100 by A1, disconnected from the detection circuit by A4, can be inhibited by grounding an input, and is sent to an external speaker through A2. A3 forms a two-pole state-variable band pass filter from 3500–7000 Hz; two potentiometers adjust the Q from 4 to 60 and maintain a constant gain. A variable gain and a fixed threshold of 0.1 volts, set by the resistors around A5, are used to adjust the circuit's sensitivity. Monostable multivibrator U1A converts a series of pulses at the input frequency into a single pulse slightly longer than the input burst. This charges the input of U2A with a variable time constant and the output goes low when the duration criterion is satisfied. The output of U1B is driven low for a variable period, cutting off the output of U2C, and producing the spacing criterion. An inverted and buffered pulse of several microseconds can be sent to a computer. Another pulse which is equal in width to the spacing criterion can be seen on an LED and oscilloscope.

The output of the microphone was led outside the room to a storage oscilloscope, an audio monitor, and the vocalization detector circuit.

Animals were acclimated to the chamber for approximately two minutes, by which time they had begun to vocalize regularly. During these two minutes, adjustments were set on the vocalization detector to optimize detection of "distress calls" and nothing else. The most frequent adjustment made between subjects was the center frequency (CF). (Newborn chicks triggered the detector best with the CF set around 4 kHz; ducks and 4-day-old chicks with the CF set at around 3.5 kHz). The filter was set at maximum bandwidth (38%). Duration was set at approximately 2.2 msec, but often had to be increased slightly to prevent multiple triggers on the longer peeps of newly hatched chicks, and decreased for the rapid vocalizations of ducklings. The spacing control was set at 190 msec for chicks and slightly less for ducklings. A few birds (5%) were discarded because they did not peep, or because the detector circuit could not be adjusted to trigger reliably.

Observation trials were started by a computer as soon as the bird peeped twice in 2 seconds [9]. This peeping criterion insured that trials were conducted only when the subjects were actively vocalizing. At the beginning of each trial the computer triggered the storage oscilloscope, which displayed the next 5 seconds of output from the microphone.

The computer recorded the time to the next detected vocalization and counted the number of peeps in the next 5 seconds. The human observer, looking only at the stored trace of the microphone on the oscilloscope and listening to an audio monitor, made these same two measurements.

There was a 15-second delay after each trial to allow time for the manual measurement and count, then the oscilloscope screen was erased and another trial begun (after 2 peeps in 2 seconds). No more than ten trials were made on any subject. Trials were terminated if a bird did not peep for 2 minutes at any time during the test.

Table 1 shows differences between automatic and manual measurements of avian vocalizations broken down by age and species. Results from all birds tested are shown in the right column. Data in the top half of the table show agreement within 1% on counts of vocalizations. Data in the bottom half show that the average discrepancy in the timing of inter-peep intervals was 6 msec and not significantly different from zero. These results indicate that the circuit will detect the same vocalizations as an experienced human observer 99% of the time, and that automatically measured inter-peep intervals will be within 211 msec of manually measured intervals 99% of the time.

In summary, this study shows that an experienced investigator and an electronic circuit agree closely on what constitutes a "distress call" from young chicks and ducklings. Additional instructions for assembly of this circuit are available from the authors and are on file with the editor.

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