TECHNICAL NOTE

A CLOSED SYSTEM AUDIO HELMET FOR MONKEYS¹

A closed auditory system such as earphones avoids the inherent problems involved in maintaining uniform in-the-field stimulus presentation. Earphones have been used to determine auditory sensitivity in non-human primates using positive reinforcement paradigms (Stebbins, 1966; Stebbins, Green, and Miller, 1966). In these studies, the subject's head was maximally restrained, which permitted placement and maintenance of earphone position but prohibited self-feeding. Stebbins (1966) delivered the food pellet directly into the subject's mouth, which avoided the self-feeding problem.

In some paradigms it is considered desirable to permit the subject a large degree of mobility. For example, the conditioned suppression technique allows a monkey the freedom of responding with either hand, moving its head freely in all planes, and to feed itself the reinforcement pellet. As a result, the subject is able to reach its face and head, making earphone placement difficult. The present paper describes a reliable and inexpensive closed system audio helmet which eliminates the need for head restraint and permits self-feeding.

Standard 26-gauge galvanized iron sheet metal was used to construct the helmet body. The speaker openings and screw holes were punched and drilled, and all components except the collar were attached to the sheet metal before forming the helmet.

The transducer was a Thoro-Test (PS-8) enclosed "pillow" speaker. The speaker cone cover was removed and replaced with a 6.3-mm masonite gasket, and the speaker was then mounted to the helmet body. A small section of 6.3-mm hardware cloth attached to the inside of the helmet protected the speaker cone. The body was then lined with 12.7-mm foam rubber and the shape of the helmet was formed. The outer surface and edges of the sheet metal was covered with canvas tape. At this point, calibration of the speakers was carried out. Calibration was accomplished by tooling a small masonite adapter to fit the Bruel and Kjaer (B&K) artificial ear (type 4152) coupler for the MX-41/AR earphone cushion. The helmet, with the speaker centered on the adapter, was then clamped to the artificial ear with wide rubber bands. With the helmet in this position, measures of frequency response and harmonic dis-

tortion were made using B&K equipment (microphone, 4132; beat frequency oscillator, 1022; level recorder, 2305; microphone amplifier, 2603; audio frequency spectrometer, 2112; cathode follower, 2613). All calibration data were considered well within acceptable tolerances for a transducer as compared to the telephonic TDH39 earphone.

Since it was considered a strong possibility that the helmet would move slightly on the subject's head, frequency response curves were made with the speaker slightly off center of the artificial ear. Overlays of the level recordings were made and revealed only slight intensity variation at the test frequencies of 0.5, 1, 2, 4, and 8 KHz.

A collar fabricated from the 26-gauge galvanized iron sheet metal was used to maintain placement of the helmet onto the subject's head. Three screws, the spacing of which permitted changing collar size, were mounted in the collar and held in position with canvas tape. The collar was attached to three tabs extending from the bottom of the helmet. The screws were inserted through the tabs and secured with nuts. A series of holes in the collar permitted further fitting of the helmet. Figure 1

Fig. 1. Exploded isometric view of the audio helmet. (A) "Pillow" Speaker. (B) Masonite Gasket. (C) Helmet Body. (D) Hardware Cloth Speaker Cone Protection. (E) Foam Rubber Lining. (F) Collar.

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Fig. 2. Photograph of helmet on monkey.

is an exploded isometric showing the assembly of the helmet.

It was found that two helmets with inside dimensions 7.5 by 7.5 by 7.5 cm and 10 by 10 by 10 cm could be adjusted to fit rhesus monkeys whose weights ranged between 2.8 and 6.0 kg. The completed helmet fitted on a rhesus monkey is shown in Fig. 2.

The helmet was inexpensive and easily constructed of readily available materials. No special tools were required. Sheet metal was selected as the helmet body material (acrylic plastic was tried and rejected as the helmet body medium because of its rigidity) since some adjustment after construction was possible, thus reducing the number of helmets for a large number of subjects. Total cost was \$11.50, including \$4.50 for the speakers.

No problems were experienced in the daily fitting of the helmet. The subject was seated in a standard primate chair and then the helmet was fitted. Fitting consisted of slightly reforming the shape of the helmet body for individual subject differences so that pressure exerted to the sides of the head would prevent slippage. The pre-test preparation period required approximately 5 min. Only one experimental session (1 hr) was required for subject adaptation based on the return of pre-fitting lever-pressing baseline. Some tugging at the helmet was initially encountered but this behavior was extinguished in all subjects after the third or fourth session.

Data collected from four subjects indicate auditory thresholds at least equal to those established with much more sophisticated transducers. Intersubject variability did not exceed 10 dB (SPL) and intrasubject variability did not exceed 2 dB (SPL).

REFERENCES

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