with De Wied's (1966) report that CAR prolongation could only be obtained with the zinc phosphate preparation.[1]

Another important fact apparent from these data is the high degree of variance in S behavior. This is a common finding in research on the pituitary-adrenal system. The human clinical literature (Cleghorn, 1952) reports opposite behavioral effects of ACTH in different patients, and the research literature refers to bimodal or J-shaped distributions (e.g., Murphy & Miller, 1955) often extreme enough to warrant the application of statistical methods developed for exponential distributions. Several strategies have been employed to circumvent some of these difficulties. These include discarding slow learners (or "nonlearners"), discarding fast learners (or "hyperreactive" Ss), discarding fast (or zero avoidance) extinguishers, discarding (or more often discontinuing) Ss slow to extinguish, and the use of highly inbred S populations. Information regarding the effects of some of these procedures is only gradually becoming available (Joffe, 1964; Brush, 1966).

REFERENCES

BERTOLINI, A., VERGONI, W., GESSA, G., & FERRARI, W. Induction of sexual excitement by the action of adrenocorticotrophic hormone in brain. Nature, 1969, 221, 667-669.

BOHUS, B., & De WIED, D. Inhibitory and facilitatory effect of two related peptides on extinction of avoidance behavior. Science, 1966, 153, 318-320.

BOHUS, B., & De WIED, D. Failure of α-MSH to delay extinction of conditioned avoidance behavior in rats with lesions in the parafascicular nuclei of the thalamus. Physiology & Behavior, 1967, 2, 221-223.

BRUSH, F. On the differences between animals that learn and do not learn to avoid electric shock. Psychonomic Science, 1966, 5, 123-124.

CLEGHORN, R. A. Psychological and behavioral reactions as side effects of steroid administration. In: *Ciba Foundation colloquia on endocrinology*. Vol. 3. New York: Blakiston, 1952. P. 187.

De WIED, D. Inhibitory effect of ACTH and related peptides on extinction of conditioned avoidance behavior in rats. Proceedings of the Society for Experimental Biology & Medicine, 1966, 122, 28-32.

De WIED, D., BOHUS, B., & GREVEN, M. Influence of pituitary and adrenocortical hormones on conditioned avoidance behavior in rats. In R. P. Michael (Ed.), *Endocrinology and human behavior*. London: Oxford University Press, 1968. Pp. 188-199.

ENDROCZI, E., & LISSÁK, K. Spontaneous goal-directed motor activity related to the alimentary conditioned reflex behavior and its regulation by neural and humoral factors. Acta Physiologica Hungaricae, 1962, 21, 265-283.

FERRARI, W., GESSA, G., & VARGIU, L. Behavioral effects induced by intracisternally injected ACTH and MSH. Annals of the New York Academy of Science, 1963, 104, 330-345.

FESTINGER, L. An exact test of significance for means of samples drawn from populations with an exponential frequency distribution. Psychometrika, 1943, 8, 153-160.

JOFFE, J. Avoidance learning and failure to learn in two strains of rats selectively bred for emotionality. Psychonomic Science, 1964, 1, 185-186.

KORÁNYI, E., ENDRÖCZI, K., LISSÁK, K., & SZEPES, E. The effect of ACTH on behavioral processes motivated by fear in mice. Physiology & Behavior, 1967, 2, 439-445.

LEVINE, S. Hormones and conditioning. In *Nebraska Symposium on Motivation*. Vol. XIV. Lincoln: University of Nebraska Press, 1968. Pp. 85-102.

LEVINE, S., & JONES, L. Adrenocorticotrophic hormone (ACTH) and passive avoidance learning. Journal of Comparative & Physiological Psychology, 1965, 59, 357-360.

MALMO, R. Activation: A neuropsychological dimension. Psychological Review, 1959, 66, 367-386.

MASON, J. W. Psychological influences on the pituitary-adrenal cortical system. In G. Pincus (Ed.), *Recent progress in hormone research, XV*. New York: Academic Press, 1959. Pp. 345-389.

MILLER, R. E., & OGAWA, N. The effect of adrenocorticotrophic hormone (ACTH) on avoidance conditioning in the adrenal-ectomized rat. Journal of Comparative & Physiological Psychology, 1962, 55, 211-213.

MIRSKY, I. A., MILLER, R. E., & STEIN, M. Relation of adrenocortical activity and adaptive behavior. Psychosomatic Medicine, 1953, 15, 574-588.

MURPHY, J., & MILLER, R. The effect of adrenocorticotrophic hormone (ACTH) on avoidance conditioning in the rat. Journal of Comparative & Physiological Psychology, 1955, 48, 47-49.

WEIJNEN, J., & SLANGEN, J. Effects of ACTH analogues on extinction of conditioned behavior. In D. De Wied and J. A. W. M. Weijnen (Eds.), *Progress in brain research*. Amsterdam: Elsevier, 1970.

WEISS, J., McEWEN, B., SILVA, M. T., & KALKUT, M. Pituitary-adrenal influences on fear responding. Science, 1969, 163, 197-199.

WINER, B. *Statistical principles in experimental design*. New York: McGraw-Hill, 1962.

NOTE

1. However, preliminary results from our laboratory (using other strains of Ss in the shuttlebox, as well as Ss of the strain used here but tested in other behavioral situations) show that the effect of the vehicle must be determined separately for each new combination of S and task variables.

Gerbil's pinnae movement as related to stimulus frequency and intensity*

RICHARD A. GALOSY† and LOUIS G. LIPPMAN
Western Washington State College, Bellingham, Wash. 98225

Pinnae responses to onset of tones, which ranged in frequency from 0.5 to 10 KHz and in intensity from 51 to 101 dB, are reported. The quality and frequency of these responses varied directly with intensity, but were not systematically related to frequency. The extent to which these responses index auditory sensitivity or serve a protective function are considered.

In a recent study (Lippman & Galosy, 1969) gerbil's pinnae movement (RSO) in response to the onset of a pure tone stimulus was described and reported to vary with stimulus intensity. It was hypothesized that this response could serve a protective function, preventing damage to middle or inner ear structures from high-intensity auditory stimulation by attenuating the amplitude of auditory input. If the RSO does serve to modulate

*This study represents a collaborative effort of the authors and the following students who served as Os and Es: T. J. Allwardt, N. J. Darnell, D. A. Eldridge, B. A. Gosling, R. R. Herling, L. L. McFadden, J. F. Metcalf, J. W. Munnis, and D. W. Peter.

†Reprint requests should be sent to Richard A. Galosy, Division of Behavioral Sciences, Hostos Community College, 260 East 161st Street, Bronx, New York 10451.

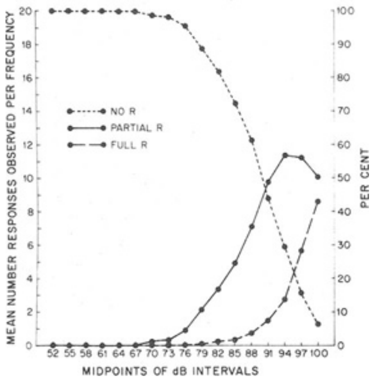

Fig. 1. Mean number of observations in each response class (full, partial, and no-response) averaged over a 0.5- to 10-Hz frequency range as a function of auditory intensity.

auditory input, the relative proportion of RSOs should covary with the frequency of a pure tone such that the greatest proportion of RSOs would occur in the 3 to 5 KHz frequency range, reported by Finck & Sofouglu (1966) to be the range of greatest sensitivity for the gerbil. On the other hand, the RSO, as described and measured, is specifically a response to stimulus onset rather than a differential positioning of the pinnae corresponding to ongoing auditory stimulation. The RSO may be specifically an attribute of a general startle response, elicited by the onset of auditory stimulation, which would serve as a poor indicator of gerbil's auditory sensitivity. Relatively uniform magnitudes of RSO across frequencies would indicate (1) different degrees of a startle response that may be expected at all frequencies that the gerbil can detect or (2) the possibility the the RSO is a response to a mechanical pressure on the pinnae that does not require association with auditory sensitivity. One purpose of the present study was to test RSOs at different frequencies in order to compare the topography of this response to published records of auditory sensitivity. The secondary purpose of this experiment was to test and extend the generality of our prior findings by relying upon inexperienced, rather than highly practiced, Os and Es.

SUBJECTS

The Ss were three male gerbils *(Meriones unguiculatus)*, approximately 200 days of age, obtained from DeCicco Farms, Germantown, N.Y. The Ss were housed individually and maintained on ad lib food and water throughout the experiment. All Ss had served previously as control Ss in experiments that involved handling and maze activity only.

APPARATUS

The apparatus was identical to that used previously (Lippman & Galosy, 1969) with two exceptions: A Hewlett-Packard oscillator (Model 200 AB) was substituted for the Jackson oscillator and noise from the Hunter timer was further attenuated by packing the timer in foam rubber inside a sound-insulated chamber. In general the apparatus consisted of a small wooden box resting on foam rubber and acoustic tile with one wall of brass rods that faced a vertically mounted Electrovoice speaker. A sound-level meter permitted direct readings of auditory intensity inside the box. Onset of a 1-sec tone was instigated by a press on a silent pushbutton that was operated by O.

PROCEDURE

Three levels of RSO were defined: no observable response, partial response (twitch), and full closure of the auditory passage. Data for each of the three Ss was collected by different E-O groups. These Es and Os were undergraduate students in an advanced experimental psychology/statistics course at Western Washington State College who were given vocal and written descriptions of the RSO levels plus a demonstration of the data-collection process (using an extra gerbil). These Es and Os were informed of the relationship between the RSO intensity, but no hypotheses were discussed regarding frequency.

The O observed responses, indicated the RSO level silently by hand signals, and initiated tone presentation when S was in an appropriate position for observation. The E manipulated intensity and frequency into a haphazard presentation sequence, noted the intensity of tone according the sound-level meter, and recorded the associated level or RSO that O indicated. The interval between successive tone presentations ranged randomly from 5 to 20 sec.

Twenty frequencies, ranging from 0.5 to 10 KHz in 500-Hz steps, were presented. Each frequency was presented at 17 levels of intensity ranging from 51 to 101 dB in intervals of 3 dB. Twenty observations within each of the 340 frequency-intensity combinations were made for each S. In addition, 400 blank trials, in which the timer was activated but no tone was presented, were interspersed among the test trials. The 7,200 observations of each S were conducted over a 2-month period in irregularly scheduled sessions that lasted no more than 45 min each. Before each session S was placed in the box for 5 min with no tone present. The background intensity was approximately 47 dB throughout all testing.

RESULTS AND DISCUSSION

Other than extension to a range of frequencies, major differences between the prior (Lippman & Galosy, 1969) and present studies were observations by Es and Os who had minimum familarity with RSOs, somewhat older Ss from a different supplier, better silencing for the timer, and an increased base sound level. Despite these differences, the topography of RSOs at 1,500 Hz closely matched and replicated Lippman & Galosy with the overall exception that fewer RSOs were observed or reported. No response was observed on any of the blank trials.

Intensity

Data of all Ss were combined over the 20 frequencies and averaged to represent the overall relationship between RSOs and stimulus intensity, as shown in Fig. 1. Despite the fact that comparatively few responses were observed or reported, this function indicates that, in general, likelihood of an RSO varies directly with intensity.

Frequency

If the RSO serves an auditory protective function, then this response should occur most frequently in the 3- to 5-KHz frequency range. The only apparent covariation with frequency was the essential absence of RSOs at 500 Hz; there was also a weak curvilinear trend in which RSOs were most frequent at 1, 9, and 10 KHz and least frequent in the 3- to 7-KHz range. This trend fails to match a sensitivity function based upon cochlear potentials (Finck & Sofouglu, 1966). If the RSO does serve a protective function, then the present data would suggest that head and bone conduction is predominant at those frequencies at which the gerbil is reported to have maximum sensitivity. On the other hand, the RSO, as defined and observed, may be a portion of a startle response or a response to pressure on the pinnae. A better test of the relation between gerbils' pinnae movement and frequency would be to examine the posture of the pinnae (perhaps via EMG) during ongoing auditory stimulation. Irrespective of the possibility that RSOs vary with frequency, the response to stimulus onset may be attributed to a number of different processes. The RSO can provide, at best, only a rough index of auditory sensitivity.

REFERENCES

FINCK, A., & SOFOUGLU, M. Auditory sensitivity of the Mongolian gerbil *(Meriones unguiculatus)*. Journal of Auditory Research, 1966, 6, 313-319.

LIPPMAN, L. G., & GALOSY, R. A. Pinnae movement as related to auditory intensity in gerbils. Psychonomic Science, 1969, 16, 276.