TERMINAL REPORT ON

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Title: Brain Mechanisms of Arousal, Attention and Perception

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Acknowledgement

The Principal Investigator, on behalf of the University of California, Los Angeles, and representing his graduate students, postdoctoral investigators and himself, wishes to express to the National Aeronautics and Space Administration grateful appreciation for the financial support of this research project not only for the period of support covered in this report but for an earlier period of support extending from 1964-1968 under Contract NsG-623.

INTRODUCTION

The purpose of this research program was to gain a better understanding of the neural mechanisms underlying visual perception, arousal, attention, vigilance and decision processes in man, cat and monkey.

We have continued our investigations of perceptual and attentional processes in man but have progressively moved in the direction of animals, both cats and monkeys, as it has been necessary in some instances to deal with subcortical structures by means of recording and stimulating electrodes manuevered by stereotaxic technique directly to these deeper regions of the brain. A new technique developed in this laboratory, namely localized cooling by means of a cryogenic probe has proved very useful in blocking the function of a pathway or nucleus by cooling to a level which blocks function but does not kill or injure the tissue and which allows reversible recovery. Thus a structure or pathway may be cooled and blocked, then re-warmed to normal temperature with recovery of normal function. In this way inferences may be drawn about the nature of the functions mediated by the different structures concerned.

In man we have continued to study the three major electrical phenomena of the brain that may be recorded from the outside of the skull, by means of electrodes on the scalp, namely, the spontaneous electroencephalogram (EEG) with its alpha waves and other activity, the average evoked potentials which normally cannot be seen in the EEG proper, but which by means of computer averaging can be separated from the background electrical activity and studied, and finally the contingent negative variation (CNV), or slow potential shift associated with anticipation or expectancy.

No detailed report of the results of these studies will be given here since many have been published in scientific journals or are in press or in process of being prepared for publication. A list of these publications during this report period is given and reprints are submitted as required in the case where reprints are available.

As in any university research program of this kind, it is not only the publications of the research work which is important, for graduate students involved in the work obtain training leading to the Ph.D. degree, and post-doctoral investigators also obtain additional training in the course of being exposed to new types of experimental investigations. Accordingly, in addition to the published reports, tables are supplied listing the number of graduate students and postdoctoral workers who have benefitted by being supported from the grant or by being able to use the laboratory facilities available. Thus the training of young scientists is an important part of research activities such as this in a university setting and is reported here as one of the most important by-products of the research grant.

Finally, it should be noted that equipment supplied by the grant continues to be used for the same or similar purposes even following termination of the grant. Thus the NASA support and its benefits are by no means limited to the period of the grant. The research program goes on presently under the support of a U. S. Public Health Service grant, and work which it was possible to get started under NASA support does not stop. Hopefully, in the future many more publications will be produced, and also gradaute students and post-doctoral scientists will be trained, and in part this will be due to the NASA support of earlier years.

PUBLICATIONS UNDER NASA GRANT (SUPPORTED IN WHOLE OR PART) DURING PERIOD FROM July 1, 1968 to June 30, 1971

Skinner, J. E. and Lindsley, D. B. Reversible cryogenic blockade of neural function in the brain of unrestrained animals. Science, 1968, 161, 595-597.

Lindsley, D. B. and Riesen, A. (Eds.) Biological substrates of development and behavior. Chap. IV. In: Perspectives on Human Deprivation: Biological, Psychological and Sociological. Nat'l Inst. of Child Health and Human Development, U. S. Dept. of Health, Education and Welfare, 1968. Pp. 229-269. (no reprints available)

Velasco, M., Weinberger, N. W. and Lindsley, D. B. Effect of thalamocortical activation on recruiting responses: I. Reticular stimulation. Acta Neurologica Latinoamerica, 1968, 14, 99-115.

Velasco, M. and Lindsley, D. B. Effect of thalamocortical activation on recruiting responses. II. Peripheral and central neural stimulation. Acta Neurologica Latinoamerica, 1968, 14, 188-199.

Velasco, M. and Lindsley, D. B. Effect of thalamocortical activation on recruiting responses. III. Reticular lesions. Acta Neurological Latinoamerica, 1968, 14, 271-282.

Adkins, J. W., Fehmi, L. G. and Lindsley, D. B. Perceptual discrimination in monkeys: Retroactive visual masking. Physiol. Behav., 1969, 4, 255-260.

Fehmi, L. G., Adkins, J. W. and Lindsley, D. B. Electrophysiological correlates of visual perceptual masking in monkeys. Exp. Brain Research, 1969, 7, 299-316.

Skinner, J. E. and Lindsley, D. B. Effect of cryogenic blockade of nonspecific thalamo-orbito-cortical synchronizing system upon sensory evoked potentials. Electroenceph. clin. Neurophysiol., 1969, 26, 333-334. (Abstract)

Lindsley, D. B. Average evoked potentials - achievements, failures and prospects. In: Donchin, E. and Lindsley, D. B. (Eds) Average evoked potentials: Methods, results and evaluations. Washington, D. C. NASA, 1969, pp. 1-43.

Donchin, E. and Lindsley, D. B. (Eds.) Average evoked potentials: Methods, and evaluations. Washington, D. C.: NASA, 1969. Pp. 400. (no copies available)

Lindsley, D. B. Neurophysiological mechanisms of attention and perception: Their role in information processing in the visual system. In: D. P. Kimble (Ed.) Readiness to Remember. (Proceedings of Third Conference on Learning, Remembering and Forgetting.) New York: Gordon and Breach, 1969. pp. 437-507. (No reprints available)

Wicke, J. D. and Lindsley, D. B. Apparatus for randomly determining visual stimulus positions using a 'forced choice' psychophysical procedure. Amer. J. Psychol., 1969, 82, 410-413.

Schlag-Rey, M. and Lindsley, D. B. Effect of prefrontal lesions on trained anticipatory visual attending in cats. Physiol. Behav., 1970, 5, 1033-1041.

Lindsley, D. B. The role of nonspecific reticulo-thalamo-cortical systems in emotion. In: Perry Black (Ed.) Physiological Correlates of Emotion. New York: Academic Press, 1970. Pp. 147-188.

Lindsley, D. B. and Young, F. A. Introduction. In: Young, F. A. and Lindsley, D. B. (Eds.) Early Experience and Visual Information Processing in Perceptual and Reading Disorders. Washington, D. C.: National Academy of Sciences, 1970. Pp. 1-13.

Young, F. A. and Lindsley, D. B. (Eds. and Organizers) Early Experience and Visual Information Processing in Perceptual and Reading Disorders. Washington, D. C.: National Academy of Sciences, 1970. 533 p.

Skinner, J. E. and Lindsley, D. B. Enhancement of visual and auditory evoked potentials during blockade of the nonspecific thalamo-cortical system. Electroenceph. clin. Neurophysiol., 1971, 31, 1-6. (Just published, no reprints yet available)

Kietzman, M. L., Boyle, R. C. and Lindsley, D. B. Perceptual masking: Peripheral and central factors. Perception and Psychophysics, 1971, 9, 350-352.

Wilson, G. F. and Lindsley, D. B. Detachable lead holder for human subjects. Psychophysiology, 1971, 7, 281-282.

Peck, C. K. and Lindsley, D. B. Average evoked potential correlates of two-flash perceptual discrimination in cats. Vision Research, 1971 (in press)

Huang, C. and Lindsley, D. B. Mapping of evoked polysensory responses in pulvinar and related posterolateral thalamic nuclei in the cat. (submitted for publication)

Anchel, H. and Lindsley, D. B. Reticulo-hypothalamic systems differentiated by their effects upon the hippocampus. Electroenceph. clin. Neurophysiol., (submitted for publication)

Wilson, G. F., Wicke, J. D. and Lindsley, D. B. Generalized and specific pacemaker influences on the human electroencephalogram. Electroenceph. clin. Neurophysiol., (submitted for publication)

(Several other papers are in preparation dealing with visual mechanisms in cats, perceptual discrimination in monkeys, sources of visual evoked potentials in the pulvinar-lateralis posterior complex, etc. Reprints will be submitted when available.)

Postdoctoral Investigators Whose Work Was Supported in Part or Who Utilized Some of the Facilities Provided by the Nasa Contract - 7/1/68-6/30/71:

Name	From	Present Location
ANCHEL, HARVEY	Ph.D. McMaster Univ.	Brain Res. Inst. UCLA
CHALUPA, LEO	Ph.D. Queens College,CUNY	Brain Res. Inst. UCLA
HUANG, CHUONG	M.D. Univ. of Taiwan Ph.D. UCLA	U. of Missouri Medical School-St. Louis
PECK, CAROL	Ph.D. UCLA	Asst. Prof. Pomona College Claremont, Calif.
SALINGER, WALTER	Ph.D. UCLA	Brain Res. Inst. UCLA
SCHLAG-REY, MADELEINE	Ph.D. U. of Brussels	Dept. of Psychology, UCLA
SKINNER, JAMES E.	Ph.D. UCLA	Asst. Prof. of Physiology Baylor U. Medical School
WICKE, JERRY D.	Ph.D. UCLA	VA Hosp., West Haven, Conn.
WILSON, GLENN F.	Ph.D. U. of Arizona	Dept. of Psychology, UCLA

Predoctoral Investigators whose Work was Supported in Part or Who Utilized Some of the Facilities Provided by the Nasa Contract, and Who Were Awarded, or Are Completing, Ph.D. Degrees - 7/1/68-6/30/71:

Name	Degree Status	Present Location
BUCK, MARSHALL D.	Expected 1971 (Ph.D.)	Dept. of Psychology, UCLA
DAVIES, THOMAS	Ph.D. UCLA 1970	Postdoctoral Fellow with Dr. Scheibel, UCLA
COLEMAN, JAMES	Ph.D. in progress	Dept. of Psychology, UCLA
GOULD, JAY E.	Ph. D. expected in 1971	Dept. of Psychology, UCLA
HOISMAN, NANCY	Ph.D. UCLA 1970	Los Angeles
HUANG, CHUONG	Ph. D. UCLA (Physiology)	U. of Missouri Med. Sch. St. Louis (Research)
NAKAYAMA, KEN	Ph.D. UCLA 1968	Asst. Prof. Physiology, U. of Nova Scota Med. Sch.
NORTON, THOMAS	Ph.D. UCLA 1970	Postdoctoral Fellow with Dr. Sprague, U. of Pennsylvania (Research)
PECK, CAROL	Ph.D. UCLA 1969	Asst. Prof. Psychology Pomona College
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SALINGER, WALTER	Ph.D. UCLA 1969	Postdoctoral Fellow with D. B. Lindsley, UCLA
SATTERBERG, JOHN	Ph.D. UCLA 1968	Asst. Prof. Psychology Univ. of Toronto
SEALES, DAVID	Ph.D. in Progress	Dept. of Psychology, UCLA
SYNDULKO, KARL	Ph.D. expected in 1971	Dept. of Psychology, UCLA
WEISSBLUTH, STEPHEN	Ph.D. expected in 1971	Dept. of Psychology, UCLA
WILSON, CYNTHIA	Ph.D. in Progress	Dept. of Psychology, UCLA