

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

A Study of Attention and Psychological Time

Final Report

Grant No. NGR-52-059-001

Submitted to:

National Aeronautics and Space Administration
Washington, D.C.

by:

Alfred B. Kristofferson
McMaster University
Hamilton, Ontario, Canada

May, 1971

N71-28283

FACILITY FORM 602

ACCESSION NUMBER: 8

(THRU) A3

(PAGES) CR-119023

(CODE) 04

(NASA CR OR TMX OR AD NUMBER)

(CATEGORY)

A Study of Attention and Psychological Time

The research funded by Grant No. NGR-52-059-001, with three supplements, covered the period from September, 1965 to September, 1969. Permission was obtained to continue the work, without additional funds, for one additional year.

The program of which this research is a segment began in 1961 and it continues at the present time. It is now wholly supported by the National Research Council of Canada.

Prior to the period which is the subject of this report, the program was supported by NASA Contracts 2-1790 and 2-2486 with Bolt Beranek and Newman, Inc., of Cambridge, Massachusetts.

This report consists of nine items, four published papers and five Technical Reports. Copies of the items are enclosed as References 1 through 9 of this report. These items will be summarized briefly below.

In addition, a number of other items were produced under this grant. They are as follows:

1. Attention. Annual Review of Psychology, 21, 1970, pp. 339-366 (with John A. Swets).
2. Aufmerksamkeit. Lexikon der Psychologie. Ed. by W. Arnold, H.-J. Eysenck and R. Meili. Verlag Herder K. G. Freiburg (in press).
3. Review of: Attention. Selective Processes in Vision and Audition. By N. Moray. Contemporary Psychology, 16, No. 1, Jan. 1971, pp. 20-22.
4. Sensory Attention. In symposium on attention (chairman A. B. Kristofferson) XIX International Congress of Psychology, London, England, Aug. 1969.

5. Mechanisms for temporal numerosity in audition. Sharon Abel. Ph.D. thesis, McMaster University, 1970.
6. Recovery of masked visual targets by inhibition of the masking stimulus. Robert Hansen. B.Sc. thesis, McMaster University, 1968.
7. Duration discrimination of short visual stimuli. E. W. Wiens. B.A. thesis, McMaster University, 1969.
8. The recovery effect in visual backward masking as a function of the intermask interval. John Galloway. B.A. thesis, McMaster University, 1969.
9. Effects of temporal summation on the discrimination of successive sensory impulses. David Giles. B.A. thesis, McMaster University, 1969.
10. Duration discrimination of brief visual off-flashes. Marnie McKee. B.A. thesis, McMaster University, 1970.
11. Some evidence for a unit of psychological time. Invited paper. Symposium on Temporal Factors in Vision. Center for Visual Sciences, University of Rochester, June, 1966.
12. Detailed presentation at Conference on Temporal Factors in Behavior. University of California, LaJolla, June, 1966.
13. Some temporal aspects of attention. Symposium at meetings of American Psychological Association. New York, September, 1966.
14. Attention and Psychophysical Time. Symposium No. 5 "Orienting reflex, alertness and attention", XVIII International Congress of Psychology. Moscow, USSR, Aug. 1966.
15. Some attempts to manipulate the human alpha frequency and the application of a Fourier analysis to the E.E.G. frequency spectrum. John Santa Barbara. M.A. thesis, McMaster University, October, 1967.

A total of 30 papers, technical reports, theses and invited addresses resulted from this program during the six years of NASA support. In addition, two of the papers have been reprinted in books of readings.

Summary of the Program

- Reference 1. Attention and Psychophysical Time. A.B. Kristofferson. Acta Psychologica, 27, (1967), 93-100. This volume published separately as "Attention and Performance". Ed. A. F. Sanders. This article reprinted in "Information-Processing Approaches to Visual Perception." Ed. R. N. Haber, Holt, Rinehart and Winston, 1969.

This reference presents a concise account of the basic theory and of the initial experiments which led to its formulation.

The theory states that there is a fixed-frequency "clock" within the human central nervous system which controls and integrates the flow of information into and through the brain. The clock emits a succession of equally-spaced time points and the psychophysical "time quantum" is defined as the time between two adjacent time points. Two functions are attributed to the time points. They control the admission of information into the central processor by controlling the switching of attention between input channels. Specifically, a time point represents an opportunity for attention to switch; it cannot switch at other times. Secondly, information which is within one stage within the central processor can proceed into a subsequent stage only when a time point occurs.

In the experiments three kinds of measurements are made. Successiveness discrimination determines the ability to discriminate that two sensory signals in different channels are successive rather than simultaneous. This ability is limited by the switching of attention and this measurement yields one estimate of the time quantum. Uncertainty as to which channel will contain the next signal increases reaction time because attention must switch on some trials. This gives another estimate

of the quantum. Finally, frequency distributions of reaction times have quantal characteristics suggesting quantal control over the movement of information from stage to stage.

These three measurements yield identical magnitudes for the quantum, averaging 50 msec. over individuals. They are correlated over subjects and independent of input channel, confirming a central locus. Finally, they are equal in magnitude and correlated with the interval between zero-crossings of the alpha rhythm of the electroencephalogram, hence the latter may be a fourth measure of the quantum which is precise and easy to obtain.

Reference 2. Attention. A. B. Kristofferson. Ch. in "Applications of Research on Human Decision-making." Ed. by R. M. Patton, T. A. Tanner, J. Markowitz and J. A. Swets. NASA SP-209. 1970, pp. 49-65.

This chapter recapitulates the material in reference 1 in greater detail, relates it to the work of others, and integrates it with some of the more recent experimental results. Additional evidence for the time quantum is given and some of the problems associated with practical applications of the theory are discussed.

This reference is the most detailed, complete and up-to-date statement of the program which is available in any one place.

Reference 3. Successiveness discrimination as a two-state quantal process. A. B. Kristofferson. Technical Report No. 7, Department of Psychology, McMaster University, Hamilton, Ontario, July, 1967.

Following the completion of the research described above in ref. 1, I set out to try to achieve a more complete understanding of the three basic parameters and of the behaviors from which they are abstracted.

This goal has been reached as far as successiveness discrimination is concerned and the outcome is described in this report. A somewhat more elaborate theory of successiveness discrimination is presented along with much more extensive data and additional data which confirm the quantum hypothesis in another way. The relationship between the quantum and the alpha half-period is also confirmed.

Reference 4. Successiveness discrimination as a two-state quantal process. A. B. Kristofferson, SCIENCE, 8 December, 1967, Vol. 158, pp. 1337-39.

This brief paper is a concise account of the principle aspects of the work described in ref. 3 above.

Reference 5. Sensory Attention. A. B. Kristofferson. Technical Report No. 36, Department of Psychology, McMaster University, July, 1969. A paper presented in the symposium on attention at the XIX International Congress of Psychology, London, England, August, 1969.

When the research into successiveness discrimination was finished I returned to reaction time with the initial intention to develop more adequate quantal models of the form of reaction time frequency distributions. This effort has gone in many directions, none of which have led to a decisive result. One such direction is described in this reference as an interim report.

This work is continuing at the present time as one of the two major components of the program.

Reference 6. Duration discrimination of brief visual stimuli. L. G. Allan. A. B. Kristofferson, E. W. Wiens. Technical Report No. 38, Department of Psychology, McMaster University, January, 1970.

- Reference 7. Duration discrimination of brief visual off-flashes. M. E. McKee, L.G. Allan. A. B. Kristofferson. Technical Report No. 42, Department of Psychology, McMaster University, June, 1970.
- Reference 8. Duration discrimination of brief light flashes. L. G. Allan, A. B. Kristofferson, E. W. Wiens. Perception and Psychophysics, 1971, Vol. 9 (3B), pp. 327-334.
- Reference 9. Discrimination of brief empty time intervals. R. Carbotte and A. B. Kristofferson. Technical Report No. 21, Department of Psychology, McMaster University, March, 1971.

This group of references describes the second major, current component of the program.

In parallel with the work on reaction time I began an attempt to discover another function for the time points in addition to their role in attention-switching and information transfer. The new hypothesis in this connection is that the time quantum is involved in time discrimination and time perception. Does the central clock also provide a basis for the human time sense?

There are no adequate, and few inadequate, quantitative theories of time perception and we are taking a broad approach to this area. One theory which we have found useful is one proposed by D. Creelman a number of years ago which posits that the human observer takes a measure of a time interval by counting a random pulse source during the interval. This theory maps continuous physical time into continuous psychological time.

We have developed several other theories which are quite different from Creelman's. Some of these assume that continuous physical time is mapped into discrete psychological states and that these states are quantized by the central clock. The most complete report of this is

contained in reference 9 which also reports data which are encouraging with respect to this kind of theory. However, memory factors become important here and have to be contained in this theory.

The most promising theory at the present time is the quantal onset - offset theory which we set forth in reference 8. This theory differs from those alluded to above in that it portrays continuous physical time as mapped into continuous psychological time but through the mediation of quantal mechanisms. Excellent data supporting this theory are reported in reference 8 as well.

All of the various theories of duration are being compared with each other using data from many different kinds of experiments. We have made substantial progress on this problem but we do not yet have a final answer to propose. This work continues into the future.