DISCLAIMER NOTICE

This document is best quality available. The copy furnished to DTIC contained a significant number of pages which do not reproduce legibly.
NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.
AIR FORCE MISSILE DEVELOPMENT CENTER

TECHNICAL REPORT

PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM

Frederick H. Rohles, Jr.

HOLLOMAN AIR FORCE BASE
NEW MEXICO

October 1961
PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM

by

Frederick H. Rohles, Jr.

Aeromedical Field Laboratory
Deputy for Development and Test

AIR FORCE MISSILE DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Holloman Air Force Base, New Mexico

October 1961
CARE AND HANDLING OF THE SUBJECT

The animal experimentation performed in this study was conducted in accordance with the "Rules Regarding Animals" established by The American Psychological Association and The American Medical Association.
ABSTRACT

This report describes the performance of a rhesus monkey on four stimulus oddity problems with fixed interval reinforcement.

PUBLICATION REVIEW

This Technical Report has been reviewed and is approved.

HAMILTON H. BLACKSHEAR
Lt Colonel, USAF, MC
Dir of Aeromedical Field Laboratory

FELIX H. JONES, JR
Colonel, USAF
Deputy for Development and Test
TABLE OF CONTENTS

I. INTRODUCTION ................................................. 1

II. METHODS .................................................. 1
   A. Subject .................................................. 1
   B. Apparatus ............................................... 1
   C. Procedure ............................................... 3

III. RESULTS AND DISCUSSION ............................... 3

REFERENCES .................................................. 7

LIST OF ILLUSTRATIONS

Figure

1 Stimulus-Response Device ................................... 2

2 Cumulative Response Curves Showing Performance for Four Consecutive One-Hour Periods on a Four Choice Oddity Problem with an FI 1 Reinforcement Schedule .................................. 4
PERFORMANCE BY A RHESUS MONKEY ON A
TEMPORALLY REINFORCED ODDITY PROBLEM

I. INTRODUCTION

The placing of so-called cognitive problems on scheduled reinforcement programs (Ref. 1) has been studied only to a limited degree. Ferster (Ref. 2) investigated counting behavior in the chimpanzee in which the subject had to press one key three times and then press a second key for reward. Since the delivery of the reward was accompanied by the sound of a buzzer serving as a secondary reinforcer, it was possible to increase the number of repetitions of the response sequence on a FR reinforcement schedule. Ratios as high as 33 were achieved with this procedure. In another investigation, Kelleher (Ref. 3) employed different stimulus patterns as cues for a chimpanzee to perform either on a VR 100 schedule or under extinction conditions. In a similar investigation with pigeons Ferster (Ref. 4) placed a two choice matching problem under a variety of reinforcement schedules. And Rohles (Ref. 5) has studied the performance of a chimpanzee on a three stimulus oddity problem using a FR 19 reinforcement schedule.

The success attained by studying higher intellectual functioning with automatic equipment (Ref. 6) led this investigator to hypothesize that any number of cognitive problems could be placed on operant reinforcement schedules. Thus, the purpose of this investigation was to test a portion of this hypothesis by placing an oddity problem on a fixed interval reinforcement schedule.

II. METHODS

A. Subject

The subject (S) was an experimentally naive male rhesus monkey (macaca Mulatta).

B. Apparatus

All testing was conducted in a Foringer Primate Test Chamber, Model 1103. One wall of the chamber was modified in order that four contiguous stimulus-response devices might be mounted there (Ref. 2). These devices are shown in Figure 1. They were mounted in a horizontal row and centered 12.5 inches above the chamber floor; the distance between them was 2 inches.

Released by author September 1961.
Figure 1. Stimulus-Response Device
C. Procedure

Following a food deprivation period of 48 hours, magazine training was begun. This training consisted of delivering food pellets to S aperiodically four hours per day for two days. On the third day a symbol was presented on one of the displays until the subject responded; a food pellet was delivered when this response was made. A symbol was then presented on a different display and the correct response was again rewarded. This procedure continued through the fourth day.

On the fifth day all four displays were used. On three of these, like symbols were presented; the symbol on the fourth display differed from the others. Responses to the odd symbol were rewarded; incorrect discriminations caused all displays to be turned off for 20 seconds. After this period the same four symbols were presented on the display. Four symbols were used: a circle, a triangle, a plus, and an "X". Each stimulus symbol was controlled for position and distractor stimuli. Performance on this program continued for 36 days with 250 reinforcements per day. The accuracy of discrimination at the end of the 36 days was approximately 90 percent. At this time a one-minute fixed interval schedule was introduced. Under this program only the first correct discrimination was rewarded, provided that it occurred one minute or longer after the previous reinforcement. All correct or incorrect discriminations during this one minute period were unrewarded. When this schedule was introduced, the testing session was limited to one 4-hour period per day.

III. RESULTS AND DISCUSSION

A representative cumulative record of performance is shown in Figure 2. The performance is typical of the fixed interval schedule in that, following reinforcement, the subject does not respond but resumes lever pressing as the time for reinforcement approaches. The record shows this behavior in the form of "scallops"; however, they are not so pronounced as with other species. The level of accuracy was also high as evidenced by the number of errors. Timing accuracy is shown by the fact that during this session the subject received 229 reinforcements; perfect performance would have resulted in 240 reinforcements or one per minute.

The results of this investigation tend to support the hypothesis that problems involving higher intellectual functioning can be investigated by operant methods with automatic equipment. The results further suggest the importance of the reinforcement schedule in the learning of the instrumental skill sequence. As pointed out
Figure 2. Cumulative response curves showing performance for 4 consecutive one-hour periods on a 4 choice oddity problem with an FI 1 reinforcement schedule.
by Rohles (Ref. 7), when an oddity discrimination was changed from continuous reinforcement to fixed ratio reinforcement the subject responded to the serial order of the presentations instead of on the basis of concept. The explanation offered was that the delay in reinforcement would be longer if the subject was responding on the basis of concept than if it was responding in the basis of order. This explanation applied to the present study in that it is apparent that the learning of the order would in no way reduce the delay of reinforcement, and through observations it is believed that he was not responding in a serial order.

The procedure in this investigation of combining the cognitive problem and operant schedule presents a more difficult problem for the subject than does either technique used separately. It suggests a new and unique approach to the investigation of animal behavior for toxicity studies, research in space environments, and psychopharmacology.
REFERENCES


| DISTRIBUTION |
|---------------|----------|
| HQ USAF (AFRDRLS) | Commanding Officer |
| Wash 25, DC | Diamond Ordnance Fuze Laboratories |
| | ATTN: (ORDTL 012) |
| | Wash 25, DC |
| AFMTC (Tech Library MU-135) | 1 |
| Patrick AFB, Fla | USAFA (DLIB) |
| | 2 |
| APGC (PAGAPI) | Boeing Airplane Company |
| Eglin AFB, Fla | 1 |
| | Aero-Space Division |
| | Library 13-84 |
| | Seattle 24, Wash |
| ESD (ESSXT) | Commander |
| L.G. Hanscom Field | 1 |
| Bedford, Mass | Army Rocket and Guided Msl Agcy |
| | ATTN: Tech Library |
| | Redstone Arsenal, Ala |
| AFPTC (FTOOT) | Commanding General |
| Edwards AFB, Calif | 1 |
| | White Sands Missile Range |
| | New Mexico |
| | ATTN: ORDBS-OM-TL |
| AFOSR (SRRI) | British Liaison Office |
| Wash 25, DC | 1 |
| | Ordnance Mission |
| | White Sands Missile Range |
| | NMex |
| AFSWC (SWOI) | National Library of Medicine |
| Kirtland AFB, NMex | 3 |
| | ATTN: Library Acquisition |
| | Wash 25, DC |
| AFSWC (SWRB) | Defense Research Member |
| Kirtland AFB, NMex | 1 |
| | Canadian Joint Staff |
| AU (AUL-6008) | ATTN: Dr. M.G. Willans |
| Maxwell AFB, Ala | Director of Biosciences Research |
| | Wash 8, DC |
| ASTIA (TIPDR) | Cornell Aeronautical Labs, Inc., 1 |
| Arlington Hall Station | 1 |
| Arlington 12, Va | 4455 Genesee Street |
| | Buffalo 25, NY |
| AEDC (AEOIM) | Director |
| Arnold AF Stn, Tenn | 2 |
| RADC (RAALD) | Armed Forces Institute of Pathology |
| Griffiss AFB, NY | ATTN: Deputy Director for the Air Force |
| ASD (ASBMA) | Wash 25, DC |
| Wright-Patterson AFB, Ohio | |
| CIA (OCR Mail Room) | |
| Wash 25, DC | |
| Institute of Aeronautical Sciences | |
| ATTN: Library Acquisition | |
| 2 East 64th Street | |
| New York 25, NY | |
NASA
ATTN:  Biology and Life Support System Program
1520 H Street NW
Wash 25, DC

NASA
ATTN:  Chief, Division of Research Information
1520 H Street NW
Wash 25, DC

School of Aviation Medicine
USAF
Brooks AFB, Tex

Commander
U.S. Naval Missile Center
Point Mugu, Calif

Commander
Naval Air Development Center
ATTN:  Director, AMAL
Johnsville, Pa

Headquarters
U.S. Army R&D Command
Main Navy Building
ATTN:  NP and PP Research Branch
Wash 25, DC

Commanding Officer
U.S. Army Medical Research Lab
ATTN:  Psychology Division
Fort Knox, Ky

Commanding General
Research and Development Div
Dept of the Army
Wash 25, DC

Director
Naval Research Laboratory
Wash 25, DC

Director
Office of Naval Research
Wash 25, DC

University of California Medical Center
ATTN:  Biomedical Library
Los Angeles 24, Calif

Director
Walter Reed Army Institute of Research
ATTN:  Neuropsychiatry Division
Wash 25, DC

Commanding General
Engineer Research and Development Laboratories
ATTN:  Technical Documents Center
Fort Belvoir, Va

Commanding Officer
U.S. Naval School of Aviation Medicine
Pensacola, Fla

STL Technical Library
Document Procurement
Space Technology Laboratories, Inc.
P.O. Box 95001
Los Angeles 45, Calif

Medical Records Section
Room 325
Division of Medical Sciences
National Academy of Sciences
National Research Council
2101 Constitution Avenue NW
Wash 25, DC

Lockheed Missile and Space Biomedical System Development Division
Sunnyvale, Calif

Librarian
U.S. Naval Research Center
Bethesda, Md

Aviation Crash Injury Research 1
A Division of Flight Safety Foundation
2871 Sky Harbor Blvd.,
Sky Harbor Airport
Phoenix 34, Arizona
Director
Langley Research Center
NASA
ATTN: Librarian
Langley Field, Va

Librarian
National Institute of Health
Bethesda, Md

Librarian
Quarterly Cumulative Index Medicus
American Medical Association
535 North Dearborn Street
Chicago, Ill

The Rockefeller Institute
Medical Electronics Center
66th Street and New York
New York 21, NY

MORAIR Division of Northrop
Corporation
ATTN: Bioastronautics Branch
1001 West Broadway
Hawthorne, Calif

New Mexico State University
University Library
University Park, New Mexico
ATTN: Library

Princeton University
The James Forrestal Research Center Library
Princeton, NJ

Government Publications Div
University of New Mexico Library
Albuquerque, NM

Life Sciences Group
Northrop Corporation
1001 Broadway
Hawthorne, Calif

School of Aviation Medicine
USAF Aerospace Medical Center (ATC)
ATTN: SANDYNA
Brooks AFB, Texas

3 ASD (WB)
Wright-Patterson AFB
Ohio

Life Sciences Dept., Code 5700
U.S. Naval Missile Center
Point Mugu, Calif

1 ASD (ASBAT Library)
Wright-Patterson AFB
Ohio

Aerospace Medicine
The Editor
394 So. Kenilworth Ave
Elmhurst, Ill

1 Chief, Pathology Dept
Presbyterian - St. Lukes Hospital
ATTN: Dr. George M. Hass
1753 W. Congress St
Chicago 12, Ill

1 Chief, Dept of Pediatrics
University of Oregon Medical School
ATTN: Dr. Donald Pickering
3171 S.W. Sam Jackson Park Road
Portland 1, Oregon

1 Chief, Pathology Dept
Evanston Hospital
ATTN: Dr. C. Bruce Taylor
Evanston, Ill

1 AFSC Liaison Office
ATTN: Captain James A. Street
1327A Wellington Street
Ottawa 3, Ontario, Canada

1 Dr. C.T. Morgan, Editor
Psychological Abstracts
University of Wisconsin
Madison, Wisconsin

1 Dr. Donald R. Meyer
Dept of Psychology
Ohio State University
Columbus 2, Ohio
Dr. Joseph V. Brady  
Chief, Dept of Psychology  
Walter Reed Army Institute of Research  
Walter Reed Army Medical Center  
Wash 12, DC

Dr. Thom Verhave  
The Lilly Research Laboratories  
Eli Lilly and Company  
Indianapolis 6, Ind

Professor Willard F. Day  
Dept of Psychology  
University of Nevada  
Reno, Nevada

Dr. Merrill Thompson  
Dept of Psychology  
New Mexico State University  
Las Cruces, NMex

Mr. R. T. Kado  
University of California Medical Center  
Los Angeles 24, Calif

Dr. W. Winters  
University of California Medical Center  
Los Angeles 24, Calif

Dr. Richard Lawton  
Missile and Space Vehicle Department  
General Electric Company  
3198 Chestnut Street  
Philadelphia 4, Penn

Dr. Floyd Homme  
Teaching Machines, Inc.  
235 San Pedro, NE  
Albuquerque, NMex

Dr. James T. Freeman  
Operations Analysis  
HQ Strategic Air Command  
Offutt AFB, Nebraska

Dr. George H. Foster  
Director, Bionics Laboratory  
G.E. Adv Electronics Center  
Ithaca, NY

Dr. Harley M. Hanson  
Merck Institute for Therapeutic Research  
West Point, Penn

Dr. Arthur J. Riopelle  
Director, Yerkes Laboratories of Primate Biology, Inc  
Emory University  
Orange Park, Fla

Dr. Fred W. Oberst  
Chief, Gassing Branch  
U.S. Army Chemical Corps  
Research and Development Command  
U.S. Army Chemical Research and Development Laboratories  
Army Chemical Center, Md.

Dr. T.C. Ruch  
Dept of Physiology and Biophysics  
University of Washington  
Seattle, Wash

Dr. C.B. Ferster  
Institute of Psychiatric Research  
Indiana University Medical Center  
Indianapolis 7, Indiana

Dr. Richard E. Belleville  
Ames Research Center  
National Aeronautics and Space Administration  
Palo Alto, California

Dr. Sylvan J. Kaplan  
Dept of Psychology  
Texas Technological College  
Lubbock, Texas

Dr. William D. Thompson  
Dept of Psychology  
Baylor University  
Waco, Texas

Dr. W. Lynn Brown  
Dept of Psychology  
University of Texas  
Austin, Texas
Professor Harry Harlow
Dept of Psychology
University of Wisconsin
Madison, Wis

Dr. Frank A. Beach
Dept of Psychology
University of California
Berkely, Calif

Dr. Dominic Finocchio
Ciba Pharmaceutical Products, Inc.
Medical Services Division
556 Morres Avenue
Summit, NJ

Mr. Stanley A. Hall
Project Engineer
Biomedical Systems
Missiles and Space Division
Lockheed Aircraft Corporation
Sunnyvale, Calif

Dr. Milton H. Joffe
Contract Administrative Officer
Toxicology Division
U.S. Army Chemical Research and Development Laboratories
Army Chemical Center, Md

Dr. Kenneth C. Back
Toxic Hazards Section
Biomedical Laboratory
Aerospace Medical Laboratory
Wright-Patterson AFB, Ohio

Professor B.F. Skinner
Dept of Psychology
Memorial Hall
Harvard University
Cambridge, Mass

Dr. Werner Honig
Dept of Psychology
Dennison University
Granville, Ohio

Arctic Aeromedical Laboratory
Fort Wainridge, Alaska

Air Force Missile Development Center
ATTN: MDR
NLO
MDNH
MDRB
SRLTR
MDRAR
<table>
<thead>
<tr>
<th>Air Force Missile Development Center Holloman AFB, New Mexico</th>
<th>UNCLASSIFIED</th>
<th>Air Force Missile Development Center Holloman AFB, New Mexico</th>
<th>UNCLASSIFIED</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM, By Frederick H. Rohles, Jr., October 1961. 8 pp incl illus, Project 6893 (AFMDC-TR-61-31) unclassified report</td>
<td>UNCLASSIFIED</td>
<td>PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM, By Frederick H. Rohles, Jr., October 1961. 8 pp incl illus, Project 6893 (AFMDC-TR-61-31) unclassified report</td>
<td>UNCLASSIFIED</td>
</tr>
<tr>
<td>This report describes the performance of a rhesus monkey on four stimulus oddity problems with fixed interval reinforcement.</td>
<td>UNCLASSIFIED</td>
<td>This report describes the performance of a rhesus monkey on four stimulus oddity problems with fixed interval reinforcement.</td>
<td>UNCLASSIFIED</td>
</tr>
<tr>
<td>Air Force Missile Development Center Holloman AFB, New Mexico</td>
<td>UNCLASSIFIED</td>
<td>Air Force Missile Development Center Holloman AFB, New Mexico</td>
<td>UNCLASSIFIED</td>
</tr>
<tr>
<td>PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM, By Frederick H. Rohles, Jr., October 1961. 8 pp incl illus, Project 6893 (AFMDC-TR-61-31) unclassified report</td>
<td>UNCLASSIFIED</td>
<td>PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM, By Frederick H. Rohles, Jr., October 1961. 8 pp incl illus, Project 6893 (AFMDC-TR-61-31) unclassified report</td>
<td>UNCLASSIFIED</td>
</tr>
<tr>
<td>This report describes the performance of a rhesus monkey on four stimulus oddity problems with fixed interval reinforcement.</td>
<td>UNCLASSIFIED</td>
<td>This report describes the performance of a rhesus monkey on four stimulus oddity problems with fixed interval reinforcement.</td>
<td>UNCLASSIFIED</td>
</tr>
</tbody>
</table>
PERFORMANCE BY A RHESUS MONKEY ON A TEMPORALLY REINFORCED ODDITY PROBLEM, by Frederick H. Rohles, Jr., October 1961.
8 pp incl illus, Project 6893 (AFMDC-TR-61-31) unclassified report

This report describes the performance of a rhesus monkey on four stimulus oddity problems with fixed interval reinforcement.