/N 2

p, 9

Semiannual Status Report
September, 1991 - February, 1992

Behavior & Performance Project

I. **SUMMARY OF FINDINGS**: The results of several experiments were disseminated professionally during this semiannual period. Integration of these data into the professional literature--essential to the science goals of the Behavior & Performance project--reveals the regard the psychological scientific community has expressed for this NASA-supported work. These studies are critical for the interpretation and acceptance of flight-based science to be conducted by the Behavior & Performance project.

A. **Publications** (In print and in press)

1. Washburn, D. A. (1992). External audio for IBM/PC-compatible computers. Behavior Research Methods, Instruments, & Computers, 24, 80-81. (see Appendix)

2. Washburn, D. A., & Rumbaugh, D. M. (In press). A comparative assessment of psychomotor performance: Target prediction by humans and macaques. Journal of Experimental Psychology: General.

Abstract

Although nonhuman primates such as rhesus monkeys have been useful models of many aspects of cognition and performance, it has been argued that they, unlike humans, may lack the capacity to respond as predictor-operators. Consequently these animals may respond to psychomotor demands in ways that are qualitatively different than humans. Data from the present series of experiments undermine this claim, suggesting rather a continuity of predictive competency between humans and nonhuman primates. A prediction coefficient, based on a regression analysis of the observed path of responding, was devised to examine the degree to which each subject's response path approximated the optimal predictive strategy. These coefficients indicated that whereas human subjects (N = 30) generally predict more accurately, the rhesus (N = 10) anticipated the movements of the target in all conditions and performed comparably to humans under some conditions. It appears that humans and rhesus monkeys both possess and exhibit the capacity, at least to some degree, to respond to where a stimulus is going.

(NASA-CR-190112) HUMAN BEHAVIOR AND HUMAN PERFORMANCE: PSYCHOMOTOR DEMANDS Semiannual Status Report, Sep. 1991 - Feb. 1992 (Georgia State Univ.) 9 p CSCL 05A
N92-20422
Unclas
G3/51 0079074

3. Washburn, D. A. (In press). Response path: A dependent measure for computer-maze solving and other tasks. Behavior Research Methods, Instruments, & Computers.

Abstract

Response time and accuracy are sensitive measures of overall performance but may mask underlying response strategies. For example, analysis of latency and accuracy measures produced in a computerized-maze task does not reveal whether rhesus monkeys really "solve a maze" or simply move as much as is possible toward the target, negotiating barriers through trial-and-error as they are encountered. Regression procedures are described for analyzing response path against several hypothetical response curves, and analyses of response path for rhesus monkeys' performance on the computerized MAZE task are presented to illustrate. The data suggest that rhesus monkeys do invoke a "solve the maze" response strategy, as the observed response topography is significantly associated with the optimal path of responding. It is argued that many experimental paradigms would benefit from analysis of the response path that subjects exhibit.

4. Hopkins, W. D., Washburn, D. A., Berke, L., & Williams, M. (In press). Behavioral Asymmetries of Psychomotor Performance in Rhesus Monkey: A Dissociation between Hand Preference and Skill. Journal of Comparative Psychology.

Abstract

Hand preferences were recorded for 36 rhesus monkeys as they manipulated a joystick in response to two computerized tasks. These preferences were then used to contrast 8 left- and 10 right-handed subjects on performance measures of hand skill. Individual hand preferences were found but no significant population asymmetry was observed across the sample. However, the performance data reveal substantial benefits of right handedness for joystick manipulation, as this group of monkeys mastered the two psychomotor tasks significantly faster than did their left-handed counterparts. These data support earlier reports of a right-hand advantage for joystick manipulation, as well as of the importance of distinguishing between hand preference and manual performance in research on functional asymmetries.

5. Washburn, D. A., & Rumbaugh, D. M. (In press). Testing primates with joystick-based automated apparatus. Behavior Research Methods, Instruments, & Computers.

Abstract

Nonhuman primates provide useful models for studying a variety of medical, biological, and behavioral topics. In the present investigation, 4 years of joystick-based automated testing of monkeys using the Language Research Center's Computerized Test System (LRC-CTS) are examined to derive hints and principles for comparable testing with other species--including humans. The results of multiple parametric studies are reviewed and reliability data are presented to reveal the surprises and pitfalls associated with video-task testing of performance.

6. Washburn, D. A., & Rumbaugh, D. M. (1991). Environmental enrichment and performance assessment for ground- or flight-based research with primates (abstract only). ASGSB Bulletin, 5, 91.

Abstract

An automated training and testing paradigm was developed to provide (a) environmental enrichment for rhesus monkeys used in biopsychological space research; (b) continuous assessment of the psychological wellbeing of these animals; and (c) a battery of behavioral/ performance measures indicative of or correlative with biological indices of adaptation. Subjects respond to computer-generated stimuli by the skillful manipulation of a joystick in accordance with the demands of a variety of tasks. Measures of psychomotor competence, learning, attention, and memory are obtained with no significant compromise to potential biomedical analyses.

From a series of ground-based studies, data from 36 animals are presented to represent the characteristics of training and to provide empirical support that these three research goals can be satisfied. The data support the utility of the paradigm for ground-based research and its viability for future studies in microgravity. In particular, the potential is discussed for immediate integrated biopsychological studies of wellbeing and adaptation.

B. Submitted for publication

Smith, J. D., Schull, J, & Washburn, D. A. Cognition and Metacognition in Rhesus Monkeys.

Washburn, D. A. Comparative Perspectives on Cognitive Science: A Commentary. Submitted for publication.

Washburn, D. A., & Rumbaugh, D. M. Investigations of Rhesus

Monkey Video-Task Performance: Evidence for Enrichment. Submitted for publication.

C. Presentations

Washburn, D. A., & Rumbaugh, D. M. (1991, October). Environmental Enrichment and Performance Assessment for Ground- or Flight-Based Research with Primates. Poster presented to the annual meeting of the American Society for Gravitational and Space Biology, Washington, DC.

Washburn, D. A., & Rumbaugh, D. M. (1991, October). Investigations of Rhesus Monkey (Macaca mulatta) Video-Task Performance: Evidence for Enrichment. Paper presented to the Annual meeting of the American Association for Laboratory Animal Science, Buffalo, NY.

Washburn, D. A., & Rumbaugh, D. M. (1991, November). Joystick and Graphics Utilities for Studying Behavior. Paper presented to the annual meeting of the Society for Computers in Psychology, San Francisco, CA.

Washburn, D. A. (1991, November). A Tool for Analyzing Response Sequences. Paper presented to the annual meeting of the Society for Computers in Psychology, San Francisco, CA.

D. Other

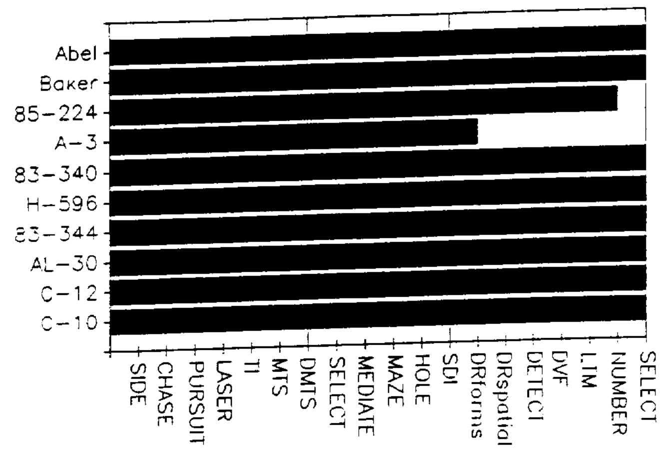
Kent, D. (1992). "Spotlight on research: What can monkey factors tell us about human factors?" (A report on the research by Washburn & Rumbaugh reported at the 1991 convention of the American Psychological Society). APS Observer, 4, 5. (see Appendix).

II. TRAINING

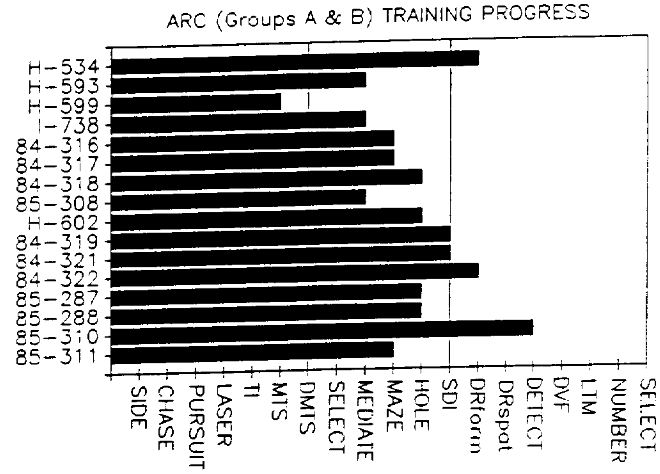
The animals continued to progress satisfactorily through the tasks at both labs. Changes, based on the growing corpus of training data, were made in the training criteria during this semiannual period; already it is clear that these changes are enhancing progress through the training curriculum. Figure 1 displays the training status of each animal in the current training pool.

Testing of the new NASA-produced software (see below) has enabled GSU animals to begin additional training, for instance on those SELECT icons that correspond to tasks not currently available in the GSU-written SELECT task.

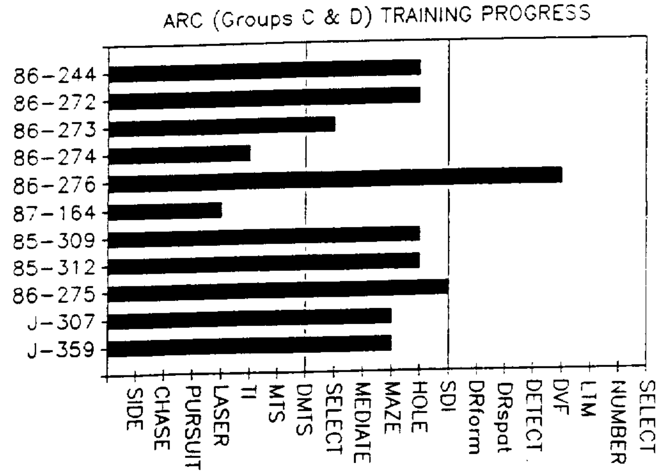
GSU TRAINING PROGRESS



ARC (Groups A & B) TRAINING PROGRESS



ARC (Groups C & D) TRAINING PROGRESS



III. RESEARCH ACTIVITIES: The following support studies and research-related activities were undertaken within this semiannual period.

A. **Continuation of ongoing studies.** We continue to test Abel and Baker regularly, as well now as the 6 other animals that have completed the entire training protocol. These sessions contribute to the corpus of normative and support data required for our science. In particular, Abel and Baker are key subjects for hardware/software verification and for continuing investigations of enrichment and psychological well-being--as evidenced by the publications of this period. Extended testing effects on SELECT task performance, were the SELECT options may be changed, is an important part of this continued testing, as ARC animals will be maintained on SELECT after completing training. Additionally, follow-up studies to the previously published NUMBER, isolation, memory, and DVF papers are underway.

B. **DESK support study.** During the last semiannual period, it was observed that ESOP performance is significantly worse than performance by the same animals in the PPR. A series of experiments was conducted to determine whether the location of the ESOP desk is the cause of this performance disruption. The results of these studies have been reported, and are summarized below.

DESK Support Study #1 Abstract
(31-Dec-91)

To determine the effects of the ESOP desk upon PTS performance, one unrestrained monkey (Abel) was tested under conditions that differed only in the position of the desk relative to the tip of the joystick. Using a mock-up of an ESOP desk, attached to Abel's home cage for testing that was otherwise normal, desk position relative to constant joystick position/ angle was varied. Desk position was found significantly to affect the speed and accuracy of psychomotor responding ($p < .05$). Performance was compromised with the desk in the standard ESOP position (11 mm below the tip of the joystick), but was improved approximately 5% when the desk was lowered slightly (to 36 mm below the tip of the joystick).

DESK Support Study #2 Abstract
24-Jan-92

A rhesus monkey (Abel) was tested with a range of potential desk and joystick positions to determine the effects on psychomotor task performance. The subject was tested with the joystick above the desk by 0, 11, 22, 33, or 44 mm, or with the desk removed altogether. These distances were achieved first by manipulating the position of the desk and then by manipulating the position of the joystick; for both sets of manipulations, the order of distances was randomized (e.g., 33, 0, 22, 11, 44 mm separation. CHASE response time and PURSUIT accuracy was found systematically to improve by lowering the desk as much as 44 mm, although performance was poor when the desk was removed altogether. In contrast, performance on the psychomotor tasks improved only when the joystick was elevated 22 mm above the desk; further elevations of the joystick resulted in poorer performance. In all cases, performance declined as the joystick was raised. These data confirm earlier suspicions that the position of the desk relative to the joystick influences performance and that raising the joystick relative to the animal is the less preferred solution to the problem.

Desk Support Study #3 Abstract
(2-Feb-92)

The second DESK experiment was refined and repeated, holding joystick position/angle constant, to determine the putative "optimal displacement" between joystick and ESOP desk. Three fully-trained monkeys (Abel, Baker, C10) were tested with joystick-to-desk distance varied between 11 and 66 mm, or with the desk removed altogether. Performance systematically improved toward nominal baseline as the desk was lowered relative to the joystick. However, lowering the desk beyond 44 mm below the joystick tip resulted in relatively compromised performance, culminating in poor performance when the desk was removed altogether. It is recommended that the desk be positioned so as to achieve a 33 mm vertical separation with the joystick (which cannot be elevated to achieve this separation), resulting in freedom of joystick movement in all directions.

SUMMARY

- Desk position relative to joystick position does adversely affect performance.

- Raising the joystick slightly while keeping desk position constant results in slight benefits to performance. However, this option is not recommended because (a) further elevation of the joystick results in performance disruption; (b) that performance is relatively worse than baseline is probably attributable to the current elevation of the joystick; and (c) hardware restricts the degree to which the joystick can be raised without interfering with the monitor.

- Lowering the desk to permit 33 mm vertical separation between the tip of the joystick and the edge of the desk permits (at least with the joystick used in these experiments) free range of unrestricted joystick movement and, in these experiments, most favorable performance.

- Removing the desk altogether while leaving the joystick at its current ESOP elevation results in poor performance. Positioning the desk 33 mm below the joystick tip provides support for the arm.

- Thus, it is requested that the desk be lowered (approx. 33 mm) or modified within the ESOP so as to permit unrestricted joystick movement in all directions.

C. **Task-specific experiments.** The MAZE task was used in an experiment currently in press. The LASER task was used in an experiment which has been submitted for publication. PURSUIT, DMTS, CHASE, LASER, SDI, NUMBER, and MTS were used in experiments that are being prepared for publication.

D. **Comparative models.** In conjunction with these task-specific experiments, emphasis has been placed within this semiannual period on exploring/demonstrating the utility of the rhesus monkey as a model of human behavior and performance. Experiments in which both monkeys and humans were tested, and the relations between these two species were mapped, are expected to continue. These experiments form an essential basis for justifying and interpreting the science of the Behavior & Performance project.

IV. Integration of ARC data

The ARC data primarily contribute to the corpus of available normative data, and in many cases are used to replicate prior findings from Abel and Baker. The data provided by the ARC animals is increasingly being integrated with GSU-produced data for presentation and publication. This semiannual period saw the first publication in which ARC-animal data were included (Hopkins, Washburn, Berke, & Williams, in press). A second set of GSU and ARC data, the learning curves for various training tasks, are currently submitted for presentation this fall.

We also stand ready to contribute to any support studies that are conducted with ARC animals, including those on water consumption and respitrace effects that have begun during this semiannual period.

V. Testing of NASA-produced task software

The re-writing of the PTS tasks is progressing rapidly. Although the battery of tasks is not yet finished, the software currently reflects all 18 tasks, scheduling capability, and has few major bugs. GSU animals are presently tested routinely on the new PTS software, with performance videotaped and/or data maintained for subsequent analysis. We have, within this semiannual period, spent over 500 hours testing and evaluating this new software against the GSU tasks, against the Software Requirements Document specifications, and against the goals and needs of the Behavior & Performance project.