Behavior Research Methods & Instrumentation
1976, Vol. 8 (2), 179-181

SESSION IX CONTRIBUTED PAPERS: SYSTEMS AND TECHNIQUES

JAMES CHUMBLEY, *University of Massachusetts, Presider*

Use of a campus-wide time-sharing computer to run reaction time experiments

GEORGE R. POTTS
Dartmouth College, Hanover, New Hampshire 03755

The present paper describes a relatively inexpensive and easy to use system for running on-line reaction time experiments under the control of a campus-wide time-sharing computer. This system puts the computerized control of such experiments within the range of a majority of psychologists and has value both as a research tool and as an inexpensive way to introduce undergraduates to computerized experimentation.

The present paper describes a relatively inexpensive and easy to use system for running on-line reaction time experiments under the control of a campus-wide time-sharing computer. Such a system places the computerized control of these experiments within the resources of a vast majority of psychologists.

SYSTEM DESCRIPTION

It is usually assumed that a campus-wide time-sharing computer cannot be used to accurately control timing. This assumption is correct; the solution is to place the timing mechanism external to the computer system itself. The heart of our reaction time collection system is a "little black box" designed and built by James Hansen of Polytronics, Inc. This box is inserted between a CRT terminal (any brand) and an acoustic coupler linked to a time-sharing computer.

Inside the little black box is a timer that runs continually and is reset as each character passes from the acoustic coupler to the terminal. After the last character of a test stimulus (e.g., a letter, a symbol, a word, or a sentence) is transmitted to the screen (and thus presented to the subject), the timer continues to run until a response is made. To avoid problems due to the time spent printing a multiple-character test stimulus, a mask is placed on the screen and the stimulus is printed below the mask. Once the stimulus is printed, it is scrolled into view using a line feed. The line feed serves to present the stimulus and start the timing interval, i.e., resets the timer a final time. Whenever the subject responds by pressing a key on the terminal, logic inside the box stops the timer and transmits both the response and reaction time (in ASCII) to the time-sharing computer. Thus, for each buttonpress, the logic inside the box generates and transmits two ASCII characters separated by a comma.

A more detailed description of the logic inside the box is shown in Figure 1. As the last character of a stimulus is transmitted from the modem to the CRT, the control and timing logic resets the accumulator to zero one last time, thereby beginning the response interval. When the subject presses a key on the terminal keyboard, the control and timing logic stops the timer, deactivates the keyboard (so no further response can be made), and transmits the subject's response (in ASCII) to the time-sharing computer via the modem. The data selectors then format and serialize the contents of the accumulator for ASCII transmission. The reaction time is preceded by a comma and followed by a carriage return. When transmission of this reaction time is complete, the timer and keyboard are reactivated and the little black box is ready to process another response. Other components of the system are the data clock which controls the baud rate, and a monitor jack that enables the experimenter to monitor the progress of the experiment on a second CRT screen.

Requests for reprints or for further information should be directed to George Potts, Department of Psychology, Dartmouth College, Hanover, New Hampshire 03755 Several people have been involved in the development and refinement of the system described in this paper. Most notable of these are George Wolford, and our graduate students, John Polich, Paul Flagg, Sam Hollingsworth, and George Porter

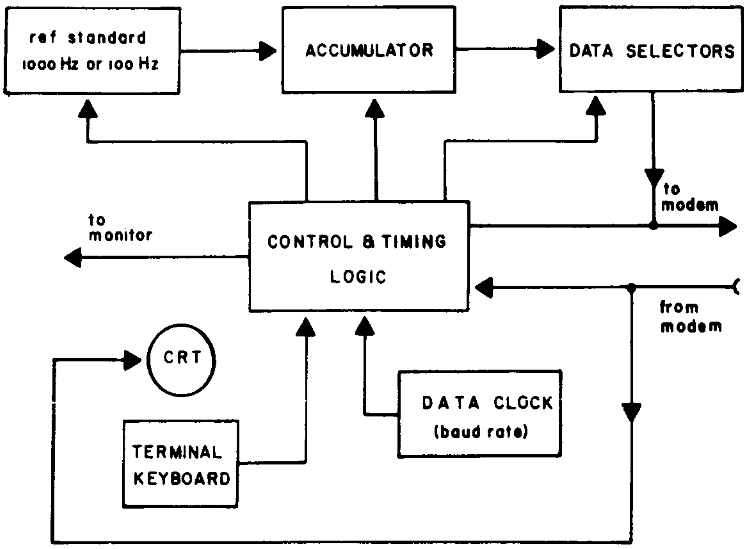

Figure 1. Diagram of the logic inside the reaction time collection box.

LIMITATIONS AND CAPABILITIES

Using the above system, the user can collect accurate reaction times using a campus-wide time-sharing computer. One cannot, however, control timing between trials. This major limitation arises from the fact that one must communicate with the main time-sharing computer between trials. Because of the nature of large time-sharing systems, variable delays are encountered whenever such communication occurs.

As it turns out, this limitation is often unimportant. A large number of reaction time tasks, especially those in cognitive psychology, require subjects to pace themselves, i.e., trial N + 1 starts whenever trial N is completed by the subject. This is exactly how the above system operates. Though the delay between two trials is somewhat variable, on the Dartmouth time-sharing system this delay averages about 4 sec, with a range of about 3 to 5 sec, which is acceptable for most of our experiments. If possible, one should avoid complex computations and calls to subroutines or files during this interval. The average length of the intertrial interval can be increased by printing dummy characters below the mask.

Most of our work with the system has pertained to issues in cognitive psychology. Applications to other areas probably exist, but have not yet been explored in our laboratory. Within the area of cognitive psychology, the range of experimental tasks that can be handled by the system is extensive. It includes sentence recognition experiments (e.g., extensions of Bransford & Franks, 1971, which analyze reaction times), semantic memory experiments (e.g., Collins & Quillian, 1969; Rips, Shoben, & Smith, 1973), three-term series problems (e.g., Clark, 1969; Huttenlocher, 1968), and a variety of tasks dealing with the process of language comprehension (e.g., Clark & Chase, 1972; Gough, 1965; Potts, 1972; Trabasso, Rollins, & Shaughnessy, 1971). It also includes a variety of paradigms in classic verbal learning, discrimination learning, and problem solving. Because of the wide range of experimental paradigms that can be handled by this system, we have found it to be very useful not only as a tool for performing research, but also as an inexpensive way to introduce undergradate laboratory courses to computerized experimentation.

PROGRAMMING

One of the most desirable features of this system is the ease of writing "process" programs, for no special programming techniques are necessary. Since the time-sharing computer does not know that the little black box is on-line, all "process" programming is accomplished using the standard instructions of the computer system's time-sharing languages (in our case, BASIC). These languages are designed for ease of use and can be mastered very quickly by almost anyone. Our system eliminates the need to worry about things such as interrupt priorities, which make programming on a dedicated mini difficult.

An example of the ease of programming using our system is given below. To present the text, "Press a button as quickly as you can," and collect a response and reaction time, only three lines of BASIC coding are necessary:

```
100 Print "Press a button as quickly as you can"
110 Print
120 Input A, B
```

The print instruction on line 100 prints the text below the mask on the CRT. The print instruction on line 110 scrolls the text above the mask and resets the timer one final time. When the subject responds, the little black box stores his response (A) and reaction time (B). These values are transmitted, in ASCII, to the time-sharing computer in response to the "INPUT" statement. The programmer can then do as he wishes with these values (e.g., store them) using the standard coding of the BASIC language. When an experimental session is over, all responses and reaction times are available for any kind of analyses the researcher wishes to perform. Of course, one can also operate on the subject's responses while the experiment is in progress, so stimulus presentation can be made contingent on the subject's response.

COST

The materials in the black box cost about $150. The total cost of our initial black box, including design, materials, and labor, was $500. The only other items required are a CRT terminal and a modem.

IMPLICATIONS

The system described herein represents an attractive compromise between running experiments by hand and purchasing a dedicated mini. The costs and expertise required for this system are minimal and should be within the resources of most psychologists. The system has values both as a research tool and as an inexpensive way to introduce undergraduates to computerized experimentation.

REFERENCES

Bransford, J. D., & Franks, J. J. The abstraction of linguistic ideas. *Cognitive Psychology*, 1971, **2**, 331-350.

Clark, H. H. Linguistic processes in deductive reasoning. *Psychological Review*, 1969, **76**, 387-404.

Clark, H. H., & Chase, W. G. On the process of comparing sentences against pictures. *Cognitive Psychology*, 1972, **3**, 472-517.

Collins, A. M., & Quillian, M. R. Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, 1969, **8**, 240-247.

Gough, P. B. Grammatical transformations and speed of understanding. *Journal of Verbal Learning and Verbal Behavior*, 1965, **4**, 107-111.

Huttenlocher, J. Constructing spatial images: A strategy in reasoning. *Psychological Review*, 1968, **75**, 550-560.

Potts, G. R. Information processing strategies used in the encoding of linear orderings. *Journal of Verbal Learning and Verbal Behavior*, 1972, **11**, 727-740.

Rips, L. J., Shoben, E. J., & Smith, E. E. Semantic distance and verification of semantic relations. *Journal of Verbal Learning and Verbal Behavior*, 1973, **12**, 1-20.

Trabasso, T., Rollins, H., & Shaughnessy, E. Storage and verification stages in processing concepts. *Cognitive Psychology*, 1971, **2**, 239-289.