A simple BASIC language laboratory control system for microcomputers patterned after SKED®

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Microcomputers such as the TRS-80, when equipped with a simple digital input-output interface, become capable of completely controlling laboratory experiments. BASIC language software has been developed that allows simplified programming of experiments using the "state" concepts of the SKED system.

Instrumentation used for programming experiments in psychology has gradually evolved from manual control through electromechanical and solid state devices and, finally, to computers. The SKED® system developed by Snapper, Knapp, and Kushner (1970) allows a computer to program virtually any experiment in the form of a series of "states." The SKED system was designed for use on relatively expensive minicomputers and has remained beyond the financial capabilities of many researchers.

Recently, inexpensive and reliable microcomputers have become available in the price range below \$1,000. These complete systems can be interfaced to accept eight or more external input lines and to control eight or more output lines for an additional expense of approximately \$200. The inputs and outputs can be programmed by anyone familiar with the BASIC computer language, but programming complex experiments in BASIC is difficult and time-consuming.

The present program allows an experimenter to specify the state parameters that define an experiment in an interactive dialogue with the computer. The experiment can then be run, and the data can be recorded in the computer's memory for future analysis. After a satisfactory set of state parameters has been selected, a permanent version of the program may be recorded on cassette tape or disk to avoid reentering the parameters each time the experiment is to be run. The program is written in BASIC and should run on most computers with little modification.

The SKED system divides an experiment into "states" that completely describe the contingencies that are present at any given moment in an experiment. Rather than being concerned with the complex syntax of BASIC language programming, a researcher can simply specify the states that are to exist during different phases of an experiment. The SKED system then translates these states into stimulus-controlling outputs or time delays and allows the experiment to be run.

Every instant during an experiment may be considered

to be a state during which a number of events or outputs are switched and held on or off. A state may continue for a long time or may be terminated with entry into a new state. Exiting from one state and entering another state defines a transition. Transitions may occur for two reasons: as a result of an input or after a time delay. Thus, an experiment may be represented as a temporal series of states that transition into other states when certain inputs or time delays occur.

Each state is described by the number of outputs that are activated and by the methods of transitioning out of the state and into a new one. The experimenter selects these parameters before beginning the experiment by responding to a series of prompts that request information on the number of outputs to be activated by the state, the number of inputs that can initiate a transition, and the time delay after which a transition will occur.

In regular reinforcement, for example, the first state activates no outputs and has no time delay. It waits until an input in the form of a response occurs before transitioning into the second state. State 2 outputs reinforcement and immediately transitions back to State 1.

Because it is written in BASIC and is designed to record experimental data in a matrix within the computer's 16K memory, the program has many limitations that are not present in the SKED system. However, since BASIC programs are easy to modify, the program can easily be modified to eliminate specific deficiencies by removing such features as time-of-event data logging or by making a cassette tape of the data. If additional memory is available, the elimination of features may not even be necessary. After a satisfactory modification of the program is completed, the use of a BASIC compiler that converts a BASIC program into machine language will increase the speed of the final program considerably.

The program uses one- and two-dimensional matrices of subscripted variables to specify the parameters of a state. It can support 10 states. Each state may have up to six inputs, eight outputs, and one time delay. Inputs

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and time delays may be fixed or randomized. The total number of entries into each state is recorded. The time of occurrence of each entry into three selected states is recorded, and the time of occurrence of one input in one state may also be recorded.

The SKED system provides for the programming of multiple simultaneous experiments. The present program can support only one experimental chamber, but the price of 5 or 10 complete microcomputer systems to run an entire laboratory will be only a small fraction of the cost of a minicomputer. In addition, the price of a 1-year service contract on a minicomputer will buy three or four spare complete microcomputers that can

be used for word processing or data analysis while awaiting a breakdown. If a minicomputer requires service, the entire laboratory must shut down until it is fixed. If a microcomputer fails, the user can just plug in a spare one and send the defective unit off for service.

The program is distributed by Life Science, 1 Fenimore Road, Bayport, New York 11705 [(516) 472-2111].

REFERENCE

- SNAPPER, A. G., KNAPP, J. Z., & KUSHNER, H. K. Mathematical description of schedules of reinforcement. In W. N. Schoenfeld (Ed.), *The theory of reinforcement schedules*. New York: Appleton-Century-Crofts, 1970.