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SESSION XIII
COMPUTERS IN BEHAVIORAL RESEARCH: MICROCOMPUTERS AND BEHAVIORAL OBSERVATION

Personal computers and behavioral observation: An introduction

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Some fundamental aspects of observational data are outlined, and some basic issues in implementation of small computers in observational research are discussed.

In this symposium, we will illustrate several Apple II applications to observational research issues ranging from undergraduate instruction in methodology via highly general and simple programs to much more sophisticated and specialized programs developed for specific long-term research projects. These applications share common issues and problems, although the solutions to them differ considerably.

CATEGORIZING THE BEHAVIORAL "STREAM"

A burdensome task in conducting observational research is transforming the raw behavioral record into meaningful measures having both internal and external validity. By use of a computer, either these operations may be performed on-line as the observation is performed or they may be calculated almost instantly by separate programs following the observation session through rapid reentry of the data from a high-speed storage medium (typically a floppy disk).

Let us consider four types of measures commonly used in naturalistic research. Reviews describing the utility of these measures can be found in Altmann (1974).

Time Allocation

Here, several (sometimes many) mutually exclusive behavioral categories are defined and the researcher is interested in determining how time is apportioned among these behaviors. Instantaneous sampling, the recording of the behavior category in progress at the end of each observation interval (e.g., every 15 sec), yields results very close to the real-time data base, particularly when the number of samples is large (Leger, 1977). Instantaneous sampling has become a very useful procedure for nonautomated field observation and is one programming approach that should seriously be considered when a research application requires long observation sessions and a large number of behavioral categories, because observer fatigue is minimized and interobserver reliability is generally quite good. On the other hand, the speed and memory capacity of even the least expensive small personal computers are sufficient in that recording the time of onset and offset of each discrete behavioral event can generally be accomplished provided the observer is not overburdened with too many categories.

Time-allocation measures are useful when the entire repertoire of behavior is of interest or when a description of the profiles of activity of the subject is required. For example, Bernstein's research (Bernstein & Livingston, 1982) makes extensive use of time allocation without employing instantaneous sampling. Other applications include the behavior of animals before and after alarm call playbacks (Leger & Owings, 1978; Leger, Owings, & Boal, 1979) and could be employed in studies of play behavior in preschool children or in behavioral profiles of psychiatric patients.

Behavioral Frequency

In many cases, a researcher may study behaviors of short duration for which the frequency or rate of occurrence (as opposed to total time allocated) is of primary interest. The acquisition of rate data by human observers, particularly when several behaviors are being concurrently monitored, is subject to the sampling biases and observer fatigue discussed earlier. Although computer assistance cannot eliminate these problems, the vast reduction in the information processing load of the human observer, brought about by efficient data acquisition, should provide indirect benefit by allowing the observer to denote a greater portion of his or her attentional resources to the observation task. Moreover, appropriate software should all but eliminate data analysis errors so common in this work.

Temporal Features of Behavior

In certain research applications, the temporal pattern of a small number of behaviors is of interest. Included would be the distribution of bout durations for certain behaviors such as eating and drinking in an operant situation (Rachlin, in press), the temporal (sequential) relationships among behavior categories (McCleery, 1978), and interresponse intervals such as in suckling behavior by young rhesus monkeys (Hinde, Rowell, & Spencer-Booth, 1964).

The performance of the human observer is crucial in determining the quality of the data obtained; subjects must be continuously observed, and the onset and offset times of behavior episodes must be consistently recorded. Thus, observer fatigue is of major concern. In addition to increasing the efficiency of the observation process, the major contribution of small computers in research involving temporal behavior patterns is that of data analysis. Because a complete behavioral record is essential, the observer cannot divert his/her eyes from the subject even for a moment. Thus, checklist data recording is out of the question, leaving only time-event recorders, videotape analysis, and related methods, all of which require prolonged, tedious postobservation analysis. However, by using a microcomputer, the researcher may acquire immediate access to temporal pattern data, updated during the observation process, if necessary. With computer assistance, research decisions can be made within an observation session that otherwise would require several days of postobservation analysis to complete.

Contingency Analysis

Perhaps the most complex (but often the richest) type of data yielded by observational studies is the pattern of dependencies between behaviors. Two main types of contingency analysis have typically been used. The first concerns transitional relationships among behaviors such as the probability of behavior X occurring next given that behavior Y is in progress. The second type of contingency concerns the probability of occurrence of some behavior within a specified time frame, given the occurrence of some other behavior. For example, how likely is cigarette smoking within 15 min following the completion of a meal? The major contribution of a small computer to answering these questions efficiently rests in the data analysis phase. If observational data are recorded directly upon a high-speed storage medium such as a floppy disk, it is a very simple and labor-free process to read the data back into the computer for a printout of whatever type of contingency analysis is required by a particular research application.

CONFIGURING A "PERSONAL" COMPUTER FOR OBSERVATIONAL RESEARCH

Aside from their low price and widespread availability, the major advantage of the "personal" microcomputers, such as the Apple II, in assisting observational research is their complete portability, a sharp contrast with the previous generation of laboratory minicomputers. While turning a personal computer into an observational research data acquisition and analysis instrument is quite simple and inexpensive, there are some basic prerequisites and options that must be considered. It should be noted that few, if any, of the modifications to hardware that one might wish to make need interfere in any way with other applications of the same computer. In fact, hardware modifications need not be made at all; the purchase of suitable over-the-counter peripherals or modules, together with appropriate software creation or acquisition, is all that is necessary for most applications.

Timers

One prerequisite for observational research is a time-base generator. At present, there are essentially two types of devices one might acquire to perform the timing function. The most flexible and least expensive (as far as the Apple II is concerned) is a programmable timer such as the CCS 7440, which operates by generating computer interrupts at prespecified intervals. However, one must generate the software (generally at assembly language level) to adapt the interrupt-based timer to a behavioral observation program. Despite the less than adequate documentation provided with some of these peripherals, the programming involved is not very complex, once the researcher determines how to provide the timer card with the appropriate commands.

One advantage provided by the use of programmable timers is flexibility in time-base selection; one can select time units in a virtual continuum from less than 1 msec to several hours. The same timer in a basic undergraduate teaching laboratory, for instance, can serve such diverse functions as the measurement of reaction times and the timing of events in an operant conditioning experiment.

Another type of module that can serve the timing function is a real-time clock. The Mountain Computer Apple Clock has the ability to produce interrupts (generally at a single rate, such as 1 sec), but these devices are more typically used to read out clock times in hours, minutes, seconds, and, occasionally (with some additional programming effort), fractions of a second. For timing very short intervals, accessing some real-time clocks from a language such as BASIC can take time and precision may be compromised. However, for most applications, this is not a problem. Depending on the model selected, the price of a real-time clock may be somewhat greater than that of a programmable timer, although software implementation of a clock might initially be easier for a novice. Applications currently in use in our department include both the CCS 7440 programmable timer and the Mountain Hardware Apple Clock.

Data Input

During the observation period, the researcher must have some input device, typically a set of buttons, switches, or keys. Using a personal computer, the simplest solution to data input is the use of the computer's keyboard. This solution can be quite satisfactory if the behaviors being observed are mutually exclusive (i.e., they do not overlap in time) and if the observer is able to monitor the session while seated at the keyboard. Given that these conditions are met, the occurrence of a change in behavior may be signaled either by a single keypress or by the entry of one or more characters generally forming a mnemonic term, followed by a carriage return. The use of single keypresses without the carriage return may be more suitable when observing rapidly changing behaviors, while the use of longer character strings provides greater opportunities for error trapping in less time-critical situations.

In some applications, the investigator may wish to investigate temporally overlapping behaviors or to employ simultaneous judges monitoring the same behaviors. In such cases, the use of custom-designed input devices, possibly employing a parallel port, is indicated. With the Apple II, however, three single-bit "game-button" inputs are provided, and these may be used if the number of behaviors to be monitored is small. Clever use of the Apple II's analog game-paddle inputs can allow up to four observers to simultaneously monitor several exclusive behaviors.

Data Storage and Analysis

A high-speed storage mechanism such as a floppy disk is essential. A software decision must be made as to how much data analysis should be made during the observation process and how much should be relegated to subsequent analysis programs. If data are written to disk in a convenient format, the simplest of which is perhaps a mnemonic label for the behavior followed by an onset or offset time, then any number of straightforward programs can be called in later to perform temporal pattern or contingency analyses. However, it is probably always useful to present some data on the video monitor that is updated continuously during the session. The design of the video format should be carefully planned so as not to overload the operator with unnecessary information during the observation period. One advantage of a small computer over hand-held coding devices, however, is the availability of updated information and visual feedback that can serve to alert the observer to special conditions or problems.

Summary and Implications

There are several research implications arising from the use of small computers. One has already been mentioned. The reduction in the expense (both time and labor) of data analysis by several orders of magnitude permits investigations that are impractical to pursue with traditional methods of mechanical recording. This greater ease in conducting high-quality observational research may well facilitate the use of behavioral observation procedures within subdisciplines of psychology as a supplement to experimental laboratory investigations.

Furthermore, the widespread availability of small computers in undergraduate teaching laboratories should permit laboratory courses in research design to include greater emphasis on observational methodology. With adequate software, it is quite easy to provide a number of experiments and demonstrations that give the undergraduates experience with naturalistic observation methods without the enormously tedious and time-consuming coding problems previously associated with such exercises. Issues of internal and external validity, interjudge reliability, and so on, can be presented in terms of examples obtained by the students, instead of as abstract entities presented in a textbook or lecture.

Finally, new methodological issues and problems should be raised as widespread use of computer-assisted behavioral observations develops. One potential area of interest concerns the information processing limitations of the human observer. Computer-assisted observational methodology simplifies the evaluation of such variables as the number of behavior categories, amount of training, and data input structure on the observer's performance, and the quality of data obtained.

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