

# A multiple option observation system for experimental studies: MOOSES

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The purpose of this article is to outline the development of the Multiple Option Observation System for Experimental Studies (MOOSES), a flexible data collection package for applied behavioral research. Several data collection options are available to users of MOOSES. Event-based recording, interaction-based recording, duration recording, and interval recording are available to the users and can be used individually or together, depending upon the research question. The collection program can incorporate any of the keys on the keyboard. Function keys on the top or side are used for toggle (duration states) type data collection. Types of analysis include frequency and duration of discrete events, frequency of general behavior states, frequency and duration of events within behavioral states, percent interval analysis, sequential analysis, and interobserver agreement. Data obtained from MOOSES is easily incorporated with other data for further statistical analysis with standard statistical packages or popular spreadsheet programs. Applications of MOOSES and its uses in social interaction research are presented. Comparisons with other similar systems are provided.

Over the past 30 years, the use of direct observation procedures has increasingly become integrated with the study of human behavior. In the past, relatively simple recording systems were used, but recent trends in the field of behavior analysis have established the need for more complex recording systems. Included among these trends has been the call for the continuous recording of target behaviors instead of less precise time-sampling procedures (Bakeman & Gottman, 1986; Sackett, 1978). The ongoing collection of streams of behavior enhances our ability to develop hypotheses about variables that control behavior.

The collection of continuous data sets has been facilitated by advances in laptop computer technology over the last 5 years. Concurrent decreases in size and cost and increases in power have made laptop computers ideal for the collection of data in applied research settings (Denny & Fox, 1989; Farrell, 1991; Reith, Haus, & Bahr, 1989;

Repp, Karsh, Van Acker, Felce, & Harman, 1989). These hardware advances have opened the door for the development of software packages that have been designed specifically for data collection.

Software development represents a significant cost in conducting behavioral research (Schneider, 1991). Unfortunately, software developed for specific studies often requires modifications for subsequent use. Flexibility has not been a strength in many software packages. For example, most do not allow for the use of time-sampling data collection procedures that may have a place as a component part of some coding schemes. Also, researchers have become increasingly interested in the interactions between behavioral and environmental or social variables, an interest that requires the development of increasingly more complex collection systems. Schneider called for the development of "common software" to reduce the costs of computer-based research in both time and programming costs. While the use of computers to collect behavioral data is widespread, much work remains before a "common software" is readily available. This article describes the Multiple Option Observation System for Experimental Studies (MOOSES), a flexible data collection and analysis package for applied behavioral research that addresses some of the weaknesses of previous software packages and may represent a step toward "common software." Included is a description of hardware requirements, an overview of the package, its development, and illustrations of its use in previous research projects.

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Note: The author has a direct financial interest in some of the software described in this paper.—*Editor*

### Hardware Requirements

MOOSES is designed to run on MS-DOS-based personal computers. The program was written and compiled with Microsoft's BASIC PDS 7.0. The computer should have MS-DOS 3.0 or later and at least 640K of RAM. A hard disk is not required but is highly recommended. The program requires approximately 800K of storage space on disk, but the data collection module is capable of running within about 80K of disk space to facilitate running the collection program on machines without a hard drive. The data files created by MOOSES are generally small (about 3–4K). The size of the files is totally dependent on the nature of the coding scheme and the duration and number of events recorded in the collection sessions. A Microsoft or compatible mouse is supported and recommended but not required.

### User Interface

The program runs by means of standard pull-down menus that can be operated with a mouse or with the keyboard by using the <Alt> key and directional arrow keys to make menu selections. The user interacts with the program through several standard dialogue boxes. These boxes can be controlled with the mouse, the directional arrow keys, or the tab key. Several shortcut or "hot" keys also permit quick access to frequently used functions.

## PROGRAM OPERATION

### Setup

The setup menu allows the user to tailor data collection and analysis procedures for a particular research project. Modifications to the program are made by highlighting the needed options on the setup menu.

### Data Collection

Several data collection options are available to users of MOOSES. Event-based recording, interaction-based recording, duration recording, and interval recording can be used individually or together, depending on the research question. The collection program can use any of the number or letter keys on the keyboard for event codes. The function keys on the top or side may be used

as toggle switches for duration states-type data collection (see the Data File Types section below).

### Data File Types

Several types of data files are created and used by the MOOSES system. These include event files, toggle files, and interval files. Each type of file has its own unique three-letter extension. The extension in MS-DOS is the part of the file name that follows the period; it can be up to three characters long. MOOSES uses the extension to identify and look up files on the disk when the user is asked to pick the desired files for analysis. Each type of file can also be stored in its own MS-DOS subdirectory, which can be identified in the MOOSES program's setup menu.

Each type of file is stored in standard ASCII format so that it can be edited easily with any standard ASCII editor. Editing of the files is often necessary, since the MOOSES system does not allow access to codes that are entered during the collection process. Marker codes can be entered into the event stream to indicate the need for later edits. We have determined from experience that such editing is inevitable and much easier to do at a later time so that the observation session can continue unimpeded. A summary of the types of data files created by MOOSES and their function can be found in Table 1.

### Event Data Files

All event files either contain elapsed-time-based events or are interaction files in which an event sequence and time criterion are imposed (see Event Collection Options below). In other words, event files can be of two different types, depending on the mode in which data are collected. If the event mode is enabled on the setup menu, MOOSES treats events as mutually exclusive and exhaustive categories. Entering an event terminates the preceding event and begins the recording of the duration of the current event along a real-time continuum. During data collection, event codes are entered into the data stream as they occur. Once an event is observed, the data collector types the appropriate event code and hits the enter key. If codes are of a fixed length (i.e., three characters), MOOSES can be set up to automatically enter the code into the stream as the last digit of the

**Table 1**  
**MOOSES File Types**

File Type	Function	Options
Event Files *.EVE	Time-based behaviors along real-time continuum	Event mode or Interaction mode
Toggle files *.TOG	Frequency and duration of environmental and behavioral states	Mutually exclusive events within toggles
Interval files *.INT	Momentary time sampling	User-defined interval
List files No assigned extension	Specifies on which files to run analyses	Individual or pooled summaries
Output files No assigned extension	Outputs data in comma delimited format	Imports into spreadsheets or statistical packages

code is typed. When an event is scored, the code and its associated elapsed time (in seconds from the start of the session) are entered into the event data file.

Although mutually exclusive event codes are of interest to many researchers, sequences of reciprocal social behavior are often reported in the social interaction literature (Strain & Shores, 1977). In a number of studies (e.g., McEvoy et al., 1988; Strain & Timm, 1974), for example, the onset of bouts of social interaction has been defined as a particular child's initiating interaction to a peer and that peer's responding in some manner. Because of the prevalence of this type of measure in social interaction literature (Odom & Ogawa, 1993), an interaction option has been incorporated into the MOOSES data collection program.

If the interaction mode is enabled on the setup menu, the collection program will look for specific event-code sequences that signify initiations and responses to determine whether an interaction has begun. A user-defined latency criterion is established through the setup component so that the program can determine whether an initiation is responded to and, therefore, whether an interaction has begun. Once an interaction has started, the observer is prompted, at a user-determined interval, to continue or terminate the interaction. To make this more clear, consider the following example: Let "T" be the code for teacher and "S" be the code for student, and let the user-defined latency criterion be 3 sec. Assume that the teacher says something to the student; the observer then enters a "TS" into the event stream. If within 3 sec the student responds to the teacher, the user then enters an "ST" into the event stream. From the transposition of the characters on subsequent lines, the program records that an interaction has started between the teacher and student. After the interaction has started, the program presents the word "Continue?" with a beep every 3 sec. The user then enters a "Y" or hits the space bar to indicate that the interaction is continuing, or an "N" or any other key to indicate that the interaction has stopped. Other keys can be included after the "TS" or "ST" to code additional characteristics of the event (i.e., "TSN" could be entered to indicate that the teacher said something to the student in a negative way). The analysis options in MOOSES can then be used to determine the frequency and duration of interactions as well as to carry out the other analyses described below.

### Toggle Data Files

Toggle data collection allows for the user to measure the frequency and duration of environmental and behavioral states. Toggle files hold data collected with the F1-F9 function keys. Toggle data consist of start codes and stop codes for each toggle key.

Through the setup component, toggle data collection can be mutually exclusive or not. In nonmutually exclusive sets, any combination of the nine toggle keys can be in the "on" position simultaneously. For mutually exclusive data sets, when one toggle is turned on, all the other

toggles are turned off. The mutual exclusiveness feature can be set up for two to eight toggles.

### Interval Data Files

MOOSES can also be used to collect interval data. If "collect intervals" is enabled in setup, the collection program will prompt the user for an interval code at a user-defined interval (e.g., every 30 sec). The interval code can be of variable length; it is recorded by striking the enter key. Interval data are analyzed character by character so that the code entered into each character position can be analyzed independently of the other codes in the interval.

## ANALYSIS OPTIONS

### List Files and Output

The MOOSES system is designed so that the user can run analyses either on one file at a time or on several files by creating a "list." Such lists allow the user to run several analysis options on the same list of files. Summary information across files is included in a pooled report following the report for individual files.

MOOSES can output results from all analyses to the screen, a printer, or a disk file in comma-delimited format. The disk option aids data management in that it allows the data from the analyses to be easily translated to popular spreadsheet programs (e.g., Lotus 1-2-3), incorporated with other data, and submitted for further analysis run with standard statistical packages (e.g., SPSSPC, SAS).

### Event Frequency and Duration

This analysis computes the frequency and duration of each code in one or more event files. For interaction data, the data are first recoded into initiations and responses. Each initiation that is matched with a response within the user-set time interval is recoded as an interaction start. The analysis program provides frequencies for both interactions and unmatched initiations. Durations are provided for matched interactions and for the total time during which there is an absence of interaction. A sample output for event frequency and duration analysis can be found in Table 2.

### Event Interobserver Agreement

This analysis produces a report that details the degree to which two observers (e.g., files) agree with one another with regard to the frequency of the event codes and duration of each event or bout. The methods for calculating agreement coefficients are outlined by Maclean, Tapp, and Johnson (1985). For interaction data, the files are automatically recoded as described above and the interobserver-agreement analysis is performed on the resulting data.

The frequency agreement analysis is computed with a user-defined time interval or window around each event code found in the primary file. If a match is found, one agreement is scored. All unmatched codes are consid-

**Table 2**  
**Sample Frequency and Duration Report**

\*\*\*\*\* Frequency and Duration Report \*\*\*\*\*

Header Information: File name: JOE1.EVE

John Smith Classroom 1 Monday May 21 1991

Frequency and Duration Report:

CODE	Frequency	Duration
111	9	9
123	1	3
222	9	10
333	9	38

ered to be disagreements. If any code is found within the interval window in the corresponding secondary file, only one disagreement is scored. The agreement ratio—that is, agreements divided by agreements plus disagreements, or  $A/(A+D)$ —for each code is output in the resulting report.

Durations of events are compared on a second-by-second basis to identify agreements and disagreements. The duration agreement program calculates occurrence and nonoccurrence agreement coefficients and uses the mutual exclusiveness of the data to calculate an overall kappa coefficient (Cohen, 1960).

### Toggle Frequency and Duration

This analysis program computes the frequency and duration of each of the nine toggle keys. The results are identical to the event-frequency and duration results, with one notable exception. When toggles are not mutually exclusive, the possibility of overlap of toggles exists. This analysis counts frequencies and durations of the overlap during which two or more toggles are on concurrently. This “nested” toggle option, if desired, can be turned off in the setup menu.

### Toggle Interobserver Agreement

This analysis uses the same method for calculating frequency as that used to calculate the event frequency and duration. The results of toggle interobserver agreement include the agreements, disagreements, and  $A/(A+D)$  for the onset/offset analysis. Agreement on the duration of toggles is calculated for both occurrence agreement and nonoccurrence agreement. In addition, a kappa coefficient is computed for each individual toggle agreement (see MacLean et al., 1985, for a discussion concerning the use of kappa in this manner).

### Interval Analysis and Interobserver Agreement

Interval analysis computes the percentage of total intervals in which a specific code has been entered. Codes are analyzed by character. Results include the code, the number of intervals in which it occurred, and the percentage of the intervals that the frequency represents.

This interval-agreement analysis also computes the number of intervals of agreement, the number of inter-

vals of disagreement, and  $A/(A+D)$  for each code found in the each column of the data.

### Lag Frequency Contingency Tables

MOOSES provides analysis of the sequential relationships between specific events, criterion or given events, and target events. The lag-frequency contingency table option computes probabilities for codes following or preceding one another for a maximum of 10 events (lags) before or after a given event. Within this analysis routine, the user may view data in several ways. Different settings allow the user to vary the number of lags, search for both given and target codes, search backward or forward from the given event(s), and choose whether given events are to be viewed individually or as a class of behaviors. The program outputs frequencies and probabilities for each lag for each given code or class of given codes for each target code. This analysis is provided for exploratory purposes only. Because of the various assumptions associated with sequential analysis (Bakeman & Gottman, 1986), there are no significance measures given or implied.

### Multilevel

This analysis provides the duration of events relative to toggle and interval time windows. The event file and the toggle and interval files are used together, and the program computes the duration of events that occur while each toggle is turned on. For instance, one may be interested in comparing the frequency or duration of inappropriate behavior (event code) when the teacher/caregiver is present with when he/she is absent (environmental states).

## OTHER FEATURES

### File Printing

MOOSES can print files from any of the data directories to the standard DOS printer device (PRN). The DOS MODE command can be used to redirect printer output for users who have serial printers. No changes to DOS are needed for the use of a parallel printer. The file name is included at the beginning, and a form feed is sent after any file printed.

### Event Recoding

Event files can be recoded to meet a variety of needs. The “recode events” option can be used to recode any event in a file or list of files to any string given. The user may also recode several events to any string given in a single pass and do several recode passes through the same list of event files. The original event files are left intact, and the extensions of the recoded files are set to “EVR” instead of the original “EVE” extension.

### Sound Option

The collection program includes several beeps to prompt the user that input is needed or that a code is continuing. In some situations, beeps from a personal

computer can be distracting to the subjects being studied and can influence their behavior. A setup option is included so that the beeps can be turned off in the collection program.

### **Length to Consider Option**

MOOSES can be set to consider only the first set number of digits in the event files. This option is included to enable the user to analyze events at different levels of specificity. For example, if the first digit of a code was an indication of the room in which the subject was located and the second digit was an indication of the activity occurring, the length-to-consider option could be used to tell MOOSES to read only the first digit (or up to the  $n$ th digit) and therefore only look at the analysis of the room in which the subject was located and not consider the activity occurring.

## **DEVELOPMENT AND APPLICATION**

The beginnings of MOOSES were in the late 1970s at Peabody College in Nashville. The stereotyped behavior of persons with mental retardation were continuously recorded with a DATAMYTE (Electro General Corp.) and, later, OS-3 electronic data recorders. Both had internal clocks, and an observer entered a numeric code that marked the start and end of bouts of topographically defined categories of aberrant responding. The OS-3 had toggle switches from which the current use of the function keys evolved. Data were uploaded to an Apple IIe computer that ran the data management and analysis software developed by the first author. As these machines began to wear out and laptop technology began emerging, it became apparent that portable computers could provide the tools needed for collecting real-time data. In the late 1980s, data collection and analysis programs were developed and MOOSES assumed its current incarnation.

At this time, considerable effort was placed on ensuring the accuracy of the data analysis program. Numerous trials were conducted with contrived data files. These files were created and analyses conducted by hand. Hand analyses were then checked against the comparable MOOSES output. Disagreements between the two analyses were checked and errors in programming were fixed. Thus, the MOOSES program has evolved into a reliable observation package. Described below are some recent applications of the MOOSES program that illustrate its flexibility.

The FASTRACK project (Conduct Problems Prevention Research Group, 1992) is a multisite project designed to implement and evaluate a comprehensive intervention package to prevent conduct disorders and social maladaptation in adolescence and adulthood. During the 1991–1992 school year, the project observed 360 first-grade students across four 30-min sessions each, using Compaq 286 laptop computers. The event and toggle modes of MOOSES were used. Twelve discrete behavioral events, which included teacher behavior toward

the target child, peer behavior toward the target child, and the target child's behavior toward teachers and peers, were recorded. The function keys (toggles) were used to record mutually exclusive levels of social or instructional engagement. The F9 key was used to note whether the setting was structured or unstructured and could be used in combination with the other function keys.

In a study recently completed by Shores et al. (1993), MOOSES was used to collect data on the classroom interactions of children identified as behavior disordered, using T1000 (Toshiba) laptop computers. Data were collected in classroom situations by using 28 operationally defined responses in the event mode and nine environmental/instructional conditions on the toggles. A four-digit response code was used to indicate the actor (column 1), the behavioral response (columns 2 and 3), and the recipient of the response (column 4). For example, if the teacher (1) gave an academic request (31) to the target student (2), a code of "1312" was entered. Variables such as student groupings, teacher presence, and activity transition conditions were scored on the toggle switches. Frequent event sequences were recoded to a single code (e.g., handraise/disruptive) by using the re-code option. Operationally defined responses and recoded events were subjected to lag-sequential and to event-within-condition analyses.

The Ecobehavioral Assessment of Social Interaction (EASI) code is used by the Social Interaction and Perinatal Addiction Project (SIPAP) at the University of Minnesota under the direction of Scott McConnell and Mary McEvoy. The EASI code uses the MOOSES program and Tandy 1100FD laptop computers. Data are collected with the use of the toggles, interaction mode, and interval recording options. Social interactions of the target child with his/her peers, siblings, and caregivers are recorded by using sequential criteria of component social responses. Initiations are coded by typing the initiator's code and that of the receiver of the initiation (e.g., 12). If a response (i.e., 21) follows within 5 sec of the initiation, the onset of an interaction is recorded. If there has been no exchange of verbal, vocal, or gestural behavior for 5 sec, the interaction is terminated. With the toggle keys, various behavior codes are also recorded: negative affect, inappropriate behavior, unavailable for interaction (e.g., sleeping), and participation in a group activity. The interval recording component of MOOSES is used to simultaneously measure, using a 1-min interval, the child's location, the child's play materials, and type of activity in which the child is engaged.

## **MOOSES AND OTHER PROGRAMS**

Hetrick, Isenhardt, Taylor, and Sandman (1991) described the Observational Data Acquisition Program (ODAP), which, like MOOSES, is executed by MS-DOS machines. This software allows for recording the frequency and duration of 10 or fewer coded events by pressing a key during the occurrence of defined behavioral events. Data are compiled automatically and la-

beled in raw and summary formats, one cumulative file for each subject. A list of and labels for valid entries are referenced in a code file. This program is adequate for behavior codes of limited size and complexity, as in the measurement of six topographies of self-injurious behaviors reported by Taylor et al. (1991). The data management capabilities are good. The use of a code file allows for error recognition, automatic code labeling, and improved formatting of raw and summary data outputs. This feature represents an advantage over the current version of MOOSES, but future revisions of MOOSES will contain such a capability. ODAP seems limited by its simplicity. It permits the collection of only frequency and duration data on a limited number of codes and offers none of the more sophisticated data analyses that one must therefore perform by resorting to other programs.

The Observer (Noldus, 1991) is a software system that is comparable to MOOSES with regard to capabilities. The Observer allows the researcher to use a complex coding scheme of differing types of variables (discrete, duration, mutually exclusive, and non-mutually exclusive) within event classes and to modify events during collection. These capabilities would seem to guide the observer during collection of complex codes and facilitate data management and analysis. While MOOSES accomplishes many of these functions, it does so through recoding, toggles, and operationalizing of behavioral definition in the code. To judge which strategies are superior would demand field comparisons beyond the scope of this paper. As with ODAP, the Observer requires that many data analysis functions be accomplished by other programs.

### CONCLUSION

As noted by Repp et al. (1989), computers allow the collection of continuous real-time data, thus minimizing measurement error associated with less precise recording systems, such as time sampling. However, we feel that a time-sampling component can augment continuous data collection by identifying variables associated with changes in data trends. A second advantage of computers is the reduction of the time required for data collection, management, and analysis activities, again reducing the possibility of human error (Reith et al., 1989; Repp et al., 1989). The continued progress in the portability and power of laptop computers has opened the door for the use of this technology in observational research.

When appropriate software is available, laptop computers represent more cost- and time-efficient options for the collection of observational data than do devices such as bar-code readers or hand-held computers. For example, although data collected with bar-code readers have been analyzed with the use of MOOSES, bar-code readers suffer from several flaws that make them less than ideal for continuous recording. For example, the observer must locate and scan the bar code on a data code sheet, which requires the observer to look away from the

target subject(s). Laptop computers are much more adaptable than are hand-held devices and accompanying software that require a separate computer for analysis.

The studies briefly described above emphasize that diffuse categories of variables are evident in observational research today. Over the past several years, our experiences in developing observational systems have taught us that although specific, operationally defined behavior codes are derived from given research questions, there is often a great deal of similarity in the coding schemes among different studies in a related area (e.g., social interaction). In addition, much of the data coding, recording, and analysis has been accomplished through the use of strikingly different strategies across software packages. In the past, the extent to which collection and analysis software survived the initial grant cycle was dependent on how similar the coding scheme for the next project was. Researchers would often ask us to rewrite the data collection program from a previous study to include one or two additional variables for the next study. The constant demand to create "new" collection systems was a major impetus for the development of MOOSES. This flexible data collection package allows researchers, with minimal effort, to program behavioral categories for a specific research question.

The application of computer-based observational systems is entering its second generation. As stated by Farrell (1991), the current packages allow data collectors more time to observe and record behavior in a more precise, accurate manner. In response to this increased capability, researchers have employed increasingly complex observational systems, allowing closer examination of the multitude of variables that affect human and animal behavior. With the development and continual modification of versatile software packages such as MOOSES, data collection strategies and codes can be adapted to changing research questions. We can only look forward to the continued refinement of such packages.

### Availability

Persons who wish to acquire MOOSES should contact the first author. The package includes the software disk and manual only; the computer must be purchased separately. The program is available at a cost of \$450, which includes up to an hour of support from the first author during nonbusiness hours. The software and manual are not available through e-mail, although updates will be made available to registered users via ftp. The first author is licensed by an agreement with Vanderbilt University to distribute the program to the general public. Checks can be made payable to Jon Tapp and Associates and sent to Jon Tapp, 306 Liberty Lane, Lavergne, TN 37086.

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