GROUPCOM: A computer program for investigating social processes in small groups

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A flexible computer program for conducting on-line social psychological research is described. Using cathode-ray tube terminals, two to six subjects can communicate with one another, or one to six subjects can "communicate" with one to nine simulated others. In the latter case, the simulated information received by each subject can be independently manipulated. The experimenter has control over several features of the experimental trials, including response order, response type, method of response collection, and display format. The program can be used to investigate phenomena such as conformity, reaction to deviance, social comparison of abilities, group decision making, impression management, and leadership.

Within recent years, investigators have developed a number of computer-based techniques for investigating social psychological processes. Thus, computers have been utilized to study interpersonal referential communication (van Rooijen & Goode, 1973), bargaining and coalition formation (Flaherty, 1976; Rapoport & Kahan, 1974; Shure, Meeker, & Hansford, 1965), consequences of stimulus familiarity (Stang & O'Connell, 1974), interpersonal attraction (Evans & Dabbs, 1975), conformity (Kris, Kinchla, & Darley, 1977; Seligman & Stang, 1975), and susceptibility to persuasive communication (Ronis, Baumgardner, Leippe, Cacioppo, & Greenwald, 1977).

Several advantages derive from the use of computers in social psychological research. First, because computer methodology allows a high degree of control over the experimental situation, variables of theoretical interest can be precisely manipulated. In addition, the impact of theoretically irrelevant but potentially powerful variables (e.g., experimenter cues) can be reduced. These advantages stem from the sophisticated timing and display capabilities of computers, reduced experimenter contact with subjects (and experimenter error) due to preprogrammed and automated stimulus presentation, and the capability to present different stimulus sets to different subjects simultaneously. Because a large number of stimuli can be presented to any given subject, powerful within-subjects designs can be used. On the dependent variable side, computer methodology allows accurate measurement of subjects' responses (e.g.,

response latency) and greatly reduces experimenter effort by allowing automatic data recording. Finally, because interacting with a computer (or with others via a computer) is an interesting activity, subjects' involvement in the experimental situation may be increased.

Several potential disadvantages also exist. Low external validity of results may occur because computer methodologies often employ highly artificial experimental settings which lack important features of the "real world." Other potential problems are relevant to internal as well as external validity. For example, subjects may have difficulty using computer hardware (e.g., terminal keyboards) and may be intimidated by the knowledge that they are interacting with a computer. If these problems persist for the duration of the experimental session, the negative consequences are obvious. Moreover, if these problems diminish over time, they may produce changes in behavior which are erroneously attributed to the independent variables under investigation. Finally, computer methodologies do not reduce the ethical problems inherent in deception and do not necessarily eliminate several artifactual sources of variance in the experimental situation (e.g., demand characteristics, subject suspiciousness).

In spite of the potential weaknesses mentioned above, computer methodologies have sufficient strengths to warrant their continued development and testing as alternatives to more traditional techniques. In this paper, we describe a flexible multipurpose program to study social processes in small groups. The Group Communication (GROUPCOM) program allows subjects to interact with either real group members or simulated group members. Subjects use cathode-ray tube terminals located in the same room or in different rooms; it is also possible for subjects in different buildings to participate together, if appropriate telephone connections are arranged. The program has several advantages which make it attractive for social psychological research. First, subjects can interact with real or simulated others. Second, data can be collected from several subjects at

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once. Third, perceived group size can be manipulated easily. Fourth, different subjects can be run simultaneously in different conditions. Fifth, because lengthy written messages, as well as brief responses, can be collected, realistic discussions and self-presentational strategies can be presented. Sixth, on each trial the experimenter has control over a number of important parameters, such as response order, response type (short or long answer), method of response collection, display format for responses, etc. Finally, very little experimenter effort is required at run time to present experimental trials or to record subjects' responses.

A number of research applications for GROUPCOM are apparent. In addition to its obvious utility in studying conformity and reaction to deviance in small groups, GROUPCOM is also potentially useful for investigating other social psychological processes. For example, the program's flexibility in allowing transmission and receipt of lengthy written messages (in addition to short votes) opens up intriguing possibilities for investigating such phenomena as ingratiation, impression management, and leadership style in real and simulated groups of varying sizes. In addition, risk taking, bargaining, and coalition formation tasks might be adapted for use with GROUPCOM. Finally, the program seems well-suited to investigating social comparison of abilities, because it can provide authentic-looking performance feedback for the subject and simulated others. These suggestions are representative, rather than exhaustive, of GROUPCOM's potential utility in social psychological research. Undoubtedly, other uses for GROUPCOM will become evident as we and others gain experience in using the program.

GENERAL DESCRIPTION

To use GROUPCOM, the experimenter must specify several parameter values for each condition in the experiment. A given experimental condition can contain 1 to 200 trials. Each trial can be one of two types: real or fake. Real and fake trials can be interspersed in any order. On real trials, two to six subjects can communicate with one another. Subjects enter responses on their terminal keyboards, and these responses appear on the screen of each terminal. On fake trials, one to six subjects can "communicate" with one to nine simulated others. Subjects enter responses on their terminal keyboards and see predetermined responses allegedly entered by other (simulated) subjects. On fake trials, the information presented to each subject is independently controlled. Therefore, on any given fake trial all subjects can receive different simulated responses. This feature of the program allows subjects to be run simultaneously in different conditions. On both real and fake trials, the experimenter specifies whether subjects enter short answers (votes), long answers (notes), or both votes and notes.

On trials on which votes are collected, a number of options are available for the form of the votes, the manner in which votes are collected, and the manner in which votes are displayed. Thus, votes can be any character or integer within an experimenter-defined range, or a free-formatted input of up to 25 alphanumeric characters. Votes can be collected in a sequential response order, with each subject receiving a cue when it is his or her turn to respond, or by batch method, with each subject responding at will. Votes can be either displayed or not displayed to subjects. When displayed, votes collected in sequential order are displayed one at a time as they are obtained; votes collected by batch method are held and then displayed together after the last vote is obtained. On real trials, subjects see their own and other group members' votes. On fake trials, subjects see predetermined votes allegedly entered by other simulated subjects. In addition, on fake trials the subject can see either his or her own vote or a predetermined vote (e.g., the subject might receive the word "incorrect" after entering the answer to a math problem). The amount of time the votes are displayed is under experimenter control, as is the visual configuration of displayed votes (e.g., a display of Xs above a response continuum, which resembles the lights on a Crutchfield-type electrical signaling apparatus; a list of numbers, letters, words, or short statements identified by subject response number). In addition, on fake trials the experimenter controls the latency preceding the appearance of simulated votes. Options for votes can be changed from trial to trial.

On trials on which notes are collected, subjects are allowed to type free-formatted messages containing up to 600 characters. Notes can be either displayed or not displayed to subjects. On real trials, subjects see other group members' notes, identified by sender. On these trials, the experimenter controls the number and "identity" of notes each subject sees. On fake trials, subjects see predetermined notes, identified by simulated sender. On these trials, the experimenter controls the number of notes each subject sees, as well as the alleged sender and content of each note. On both real and fake trials, the experimenter controls the amount of time each note is shown. Options for notes can be changed from trial to trial.

On each trial, each subject is assigned to one of n response positions (on real trials, n equals the number of actual subjects; on fake trials, n equals the number of alleged subjects in the group). On real trials, each subject is assigned to a different response position (i.e., one subject is assigned to Position 1, another subject is assigned to Position 2, and so on). On fake trials, each subject can be assigned to any of the n response positions (e.g., all subjects could be assigned to the fifth position). Response positions can be shifted from trial to trial.

Sequencing of trials and timing of events within trials can be controlled either by the experimenter (from

a master terminal) or the program. Real or simulated information about other subjects can be presented before and during the experimental trials, and a post-experimental questionnaire can be administered afterward. Subjects' responses and response latencies, as well as extensive information about trial type, responses seen by subjects, etc., are recorded on an output data file.¹

TECHNICAL INFORMATION

Program Design

The GROUPCOM program package allows one to six subjects and the experimenter to run simultaneously as separate, though interrelated, jobs in a timesharing system. The GROUPCOM package consists of three separate program modules: COMPIL (compiler program), SUBJEC (subject program), and MASTER (master, or experimenter, program). Associated with each module are one or more data sets (disk files). There are several different data-set types in the GROUPCOM package, each serving a special function. These data-set types, together with the program modules, comprise a program which allows a great deal of experimenter control and flexibility.

The COMPIL module, which is run prior to the experimental session, is used to prepare several of the data sets required for input to the SUBJEC and MASTER modules (see Figure 1). For each subject and for the experimenter a separate compiled data set is created. For each subject, the COMPIL module accesses and merges information from several different data sets (experiment, questions, votes, notes). The COMPIL module also checks the data sets for errors and incompatibilities; if errors are detected, the COMPIL module provides diagnostic statements. Experiment data sets specify all essential parameters for all trials seen by a given subject (e.g., real vs. fake trial, sequential vs. batch method of vote collection, subject's response position, which notes are displayed to the subject, whether the trial is sequenced by the experimenter or program, and the questions, votes, and notes data sets used). Questions data sets contain all questions presented to a given subject on both real and fake trials. Votes data sets contain all simulated votes seen by a given subject on fake trials. Notes data sets contain all simulated notes seen by a given subject on fake trials. The merged information contained in each subject's compiled data set completely describes every trial in the experiment for that subject. The compiled master data set contains only information common to all subjects' compiled data sets. In addition, a display data set and a delay data set are created prior to the experimental session. The display data set specifies possible formats for displaying votes on subjects' terminals. The particular format for each trial is specified in the compiled subject data sets. The delay data set specifies delays within and between trials. Delays specified in the delay

data set remain constant across all trials in a given experimental session. All subjects in a given experimental session access the same display and delay data sets.

Because some trial specifications (e.g., trial type, response type, method of response collection) are identical for all subjects in a given experimental session, the compiled data sets of all subjects contain many of the same specifications. In cases in which only real trials are used, the compiled data sets of all subjects typically are quite similar (except for response position), because the same questions data set is used by all subjects and neither a votes nor notes data set is employed. However, when fake trials are used, marked divergences can occur among the compiled data sets of different subjects. Although all subjects typically use the same questions data set on fake trials, each subject can use a different votes and notes data set.

The SUBJEC and MASTER modules are utilized during the experimental session (see Figure 2). The SUBJEC module is run independently by each subject at his or her assigned terminal. It accesses the compiled subject data set, the display data set, and the delay data

Figure 1. Creation and compilation of trial specifications prior to the experimental session.

Figure 2. Example of program configuration and communication between two subjects and experimenter during the experimental session.

set. Moreover, the SUBJEC module sequentially paces the subject within and between trials of the experiment, receives responses from the subject, provides visual output to the subject's terminal, and writes information on the output data set. The MASTER module, using the compiled master data set (which contains trial parameters common to all subjects), synchronizes the signaling required for intersubject communication, allows the experimenter to give instructions for trial sequencing, and provides visual output to the experimenter's terminal regarding subjects' responses.

Computer and Programming Languages

The GROUPCOM package is operated on a general-purpose timesharing system designed to support a wide range of computing applications. The system, called Experimental Time-Sharing System (ETSS), is based on a Digital Equipment Corporation (DEC) PDP-15 computer (see Fitzhugh & Glaser, 1975, for a detailed description of ETSS). A major feature of ETSS is its ability to support a mix of jobs, or "tasks," including terminal-oriented conversational timesharing tasks.

The hardware configuration of the PDP-15 based system includes: 48K words of memory, memory protection/relocation hardware, a 1,000,000-word high-speed drum storage unit (used as a program-swapping device), three IBM 2314-equivalent disk drives, two DECtape drives, paper-tape equipment, several internal clocks (used by the operating system for a variety of internal purposes, including timing of input/output events), a telecommunications controller, and a terminal controller currently controlling 32 terminals at varying data rates.

The three program modules composing the GROUPCOM package (COMPIL, MASTER, SUBJEC) were written primarily in ETSS FORTRAN IV. The compiler for this language is a modified version of the DEC F4X FORTRAN IV compiler. ETSS FORTRAN IV conforms to the USASI Standard FORTRAN (X3. 9-1966), but has several additional features, including ENCODE/DECODE, part-word notation for arithmetic statements, and several input/output options. Approximately 10% of GROUPCOM was written in MACRO-15 (the basic PDP-15 assembly language) to improve program performance or to achieve results not obtainable using FORTRAN.

Special Software Features

Two new software features were implemented in ETSS to facilitate the operation of GROUPCOM. These features, SEMAPHORE and COMMON DATA AREA, are designed to reduce system overhead and processing time. Both features are designed in ETSS, but in such a manner that they can be used easily in a higher level language (such as FORTRAN).

In order for the operating system to provide the SEMAPHORE service in a standard way, it is designed to

be treated as a pseudo-device so that programs can easily read from and write to SEMAPHORE. Tasks operating under ETSS attach to the SEMAPHORE device and use it as a signaling vehicle by WRITEing formatted ASCII records to it. In this manner, tasks can set their own flag in SEMAPHORE, test (and suspend program execution) until some condition is satisfied, or both set and test SEMAPHORE. Tasks can interrogate the status of SEMAPHORE at any time by READing a formatted ASCII record from it. In regard to GROUPCOM, these capabilities enable SEMAPHORE to control sequencing of trials and events within trials.

The COMMON DATA AREA allows user programs running under control of ETSS to create named "common blocks." These blocks, which consist of a user-specified number of words, can be viewed as existing in a memory space outside the user program space. All, or portions, of these blocks can be transferred to and from the user's program space on request. If so specified, more than one user program can access a single block. In the case of GROUPCOM, a single named common block is created by the experimenter program and specifies that the subject programs can access the block. This common block is used to pass information, such as subjects' responses, among the subject and experimenter programs. Each subject has a designated area in the block to which he or she may WRITE. In addition, the experimenter or subject can READ the entire block to obtain information placed there by other subjects.

INITIAL APPLICATIONS

We are presently conducting two lines of research using GROUPCOM. In studies of reaction to attitudinal deviance in small groups, several college students are seated at computer terminals in a large room and are asked to make judgments on an opinion issue. On each of several trials, subjects vote on the issue and type written statements (notes) explaining their position. Subjects are led to believe that all group members see one another's responses. In fact, all subjects see predetermined responses allegedly representing others' answers. Each subject observes several group members who consistently agree with his position and one member (target) who disagrees in one of several ways (e.g., gradually moves away from majority opinion). Dependent measures include subjects' degree of opinion shift, communication to the target in notes, and evaluation of the target.

In studies dealing with reaction to "forced" social comparison of ability, young children (6-7 years old) are brought individually to the laboratory and seated at a terminal. The subject is told that he and four other children (allegedly located in separate rooms) will work on a series of perceptual problems. After each problem, the subject receives predetermined feedback about his

own and others' performance. Over the course of the problems, the subject sees one of several patterns of group performance (e.g., he and three others perform poorly, while one individual performs well). Dependent measures include subjects' self-reported mood, attributions for their own and others' performance, and evaluations of other group members.

As the above brief descriptions indicate, the GROUPCOM program is proving useful for investigating phenomena of interest to social psychologists. Moreover, as mentioned earlier, a number of other applications for the program are also possible. Therefore, we hope that investigators with varying research interests will seek to adapt GROUPCOM to their own needs. Future applications of GROUPCOM, in addition to revealing the strengths and limitations of the program, should shed light on more general issues concerning the utility of computer methodology in social psychological research.

NOTE

1. Although the description of GROUPCOM highlights its utility for investigating real and simulated social interaction, the program can be used for other purposes as well. For example, each subject can be told that he or she is working independently and can be shown only his or her own answers. In this mode, GROUPCOM can be used to obtain responses from up to six subjects working simultaneously but independently on the same or different tasks. Several types of stimuli and responses can be used in this mode. For example, stimuli can include math problems, factual questions, opinion statements, prose passages,

etc. Responses can include numbers (with or without a response scale), short statements, paragraphs, etc.

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