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A Programmed Environment for the Experimental Analysis of Individual and Small Group Behaviour

G. E. Bigelow[1], H. H. Emurian and J. V. Brady

This paper describes a unique methodology for the study of small groups: that of establishing a self-contained, continuously programmed, experimental social environment. The term programmed environment refers to a setting in which conditions exist for manipulating or influencing a substantial portion of the behaviour of participants. Thus, its principal distinction is the high degree of experimental control which is brought to bear upon variables influencing individual and social behaviour. Development of this methodology is the result of the need for empirical research in the area of social functioning, the limitations of present methodologies, and the demonstrated utility of this experimental approach within other contexts.

In a recent review of research on small groups, Helmreich, Bakeman, and Scherwitz (1973) refer to their disenchantment with the significance of the current literature as well as their depression with the general absence of excitement in the area. They indicate that the vast majority of studies in social psychological effects have dealt only with acute reactions assessed over a brief period of time. These authors seem to feel that new life might be brought to the area if research shifted away from acute experimental studies to more long-term observation of the functioning of natural groups. These authors seem to feel that for the study of human behaviour the experimental method is applicable primarily to acute situations, and that non-experimental observational techniques are most appropriate for the study of longer term processes. However, this separation of methods appears to be based upon considerations of convenience and practicality rather than upon scientific utility, and need not occur.

[1]Johns Hopkins University School of Medicine, 720 Rutland Ave., Baltimore, Md. 21205.

Application of a rigorous experimental methodology involving the systematic manipulation of relevant controlling variables would certainly appear to offer the greater opportunity for determination of valid functional relationships. Clearly, the application of such rigorous methodology to the study of the complex individual and social performance repertoires involved in the continuous daily functioning of a society should broaden the applicability and generalizability of behavioural science principles. However, the opportunities for exercising the necessary degree of experimental control within a functioning society are indeed rare.

The necessary research mechanism would seem to be provided by the establishment of an experimental microsociety environment which incorporates the broad range of naturalistic behaviours typically involved in individual and social functioning, and which is under direct experimental control. The present paper describes such a laboratory, in which small groups (up to six individuals) can be continuously maintained and studied for substantial periods within an experimentally controlled and programmed environment which is isolated from external social contacts.

This laboratory development and research programme is a direct outgrowth and extension of earlier work by Findley, Migler and Brady (Findley, 1966) in the development and evaluation of a continuously programmed environment for an isolated human subject. Their work demonstrated the feasibility of maintaining continued subject participation and productivity within such an environment, and also established that such environments can provide stable behavioural baselines upon which to conduct systematic experimental manipulations. Extension of the programmed environment methodology to a social setting represents a significant addition to social psychological research methodology.

The present programmed social environment makes possible both objective measurement and experimental control, two prerequisites to an experimental analysis. Objective measurement has been achieved by subdividing the total behaviour repertoire into a series of behavioural units for which the frequency and duration of each can be measured via direct observation or interfacing with environmental control mechanisms. The term "experimental control" has two meanings. On the one hand, it represents the ideal of establishing a relatively constant environment in which to conduct experiments – control of extraneous variables. On the other hand, experimental control refers to the capability to manipulate experimentally relevant variables within the experimental setting. The programmed environment described here provides for experimental control in both senses. Extraneous variables are minimized by dealing with a closed social system within an isolated experimental setting. The ability to manipulate relevant environmental variables is made possible by the programmed nature of the environment as exemplified by the development of behavioural programming procedures, as described subsequently.

The continuously programmed environment research approach described here represents, on four counts, a significant extension of experimental methodology for the study of small groups: (1) it brings within the laboratory a broad range of complex and naturalistic units of behaviour seldom submitted to experimental analysis; (2) it permits the study of conditions and processes of considerably greater duration than does the typical acute social psychological experiment; (3) it permits direct objective observation and measurement of the behavioural units under study;

(4) most importantly, it permits the direct programming and manipulation of units and patterns of individual and social behaviour.

PHYSICAL DESIGN

The goal in the design of the physical environment has been to permit a considerable range and flexibility of research usage within the constraint of maintaining a high level of experimental control. Certain of the specific physical design characteristics result, of course, from the multiple constraints imposed by attempting, within the fixed and limited total floor space available, to satisfy a variety of specific research-related goals. These research-related design goals are reflective of our own dispositions with respect to (1) the areas of investigation for which this laboratory is appropriate, (2) the technical style of research practice believed most likely to reveal meaningful relationships, and (3) the classes of variables which are likely to exert potent controlling influences.

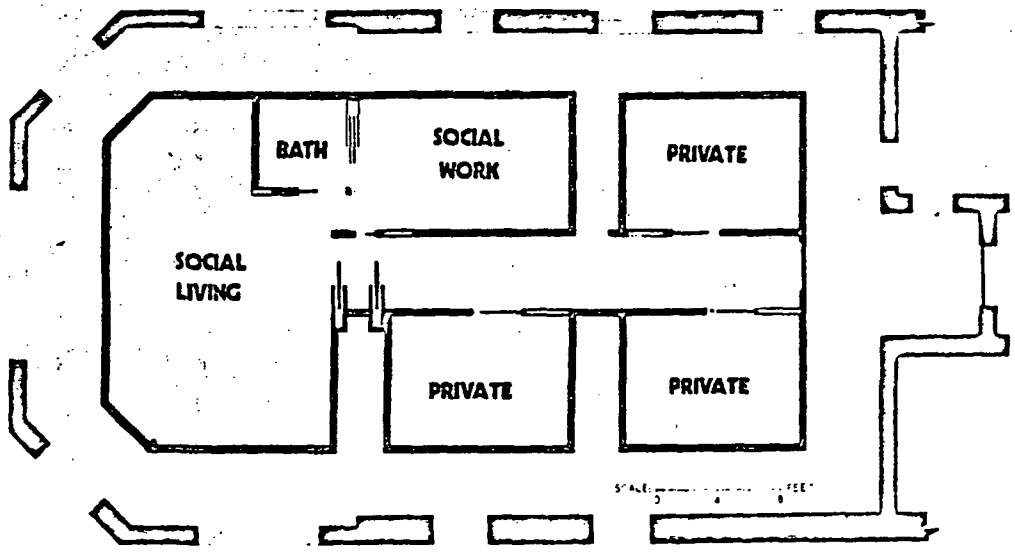

Figure 1 *Floor plan of the programmed environment laboratory.*

Examples of specific research-related design considerations are as follows: the environment should contain an array of facilities sufficient to permit the continuous residence of participants. Facilities should be sufficient for a minimum of three residents. The arrangement of facilities should permit but not demand social interaction or social living by the participants. Isolation of participants from external social contacts should be possible. Requirements of experimenters' intrusion into the environment for maintenance and materials exchange should be minimal. Provisions should exist for experimentally controlling access to physical facilities. Objective recording of participants' behaviour should be provided for.

The resulting experimental environment consists of a complex of five specially-designed rooms constructed within a wing of the Phipps Clinic of the Johns Hopkins University School of Medicine. The overall floor plan of the laboratory and its arrangement within the external building shell is depicted in Figure 1. There are

three identical one-room private apartments (each 8-1/2 x 11 feet), plus a large social living area (14 x 22 feet) and a social work area (8-1/2 x 13-1/2 feet), all interconnected by a common corridor. These are arranged such that the experimenters have external access to most walls of each area.

Each living area (private and social) is a complete, self-contained living unit, containing the fixtures and furnishings necessary to permit continuous residence by participants – kitchen, bath, bed, table, chair and storage facilities. Each private area can support a single individual; the social area can support three individuals. The social work area provides a work bench and storage facilities for work tasks and supplies, and contains a washer-drier unit for laundry. Selected storage facilities in all areas are accessible both to participants inside the environment and to the experimenters outside so that transfer of supplies may be made without external intrusions. Each room contains a programme console for display and selection of behavioural schedules. Figure 2 depicts the specific arrangement of facilities within the private living areas.

A primary consideration in the programme design has been the association of behavioural units with specific elements of the physical facility. A series of remotely controlled solenoid locks throughout the environment place access to the various

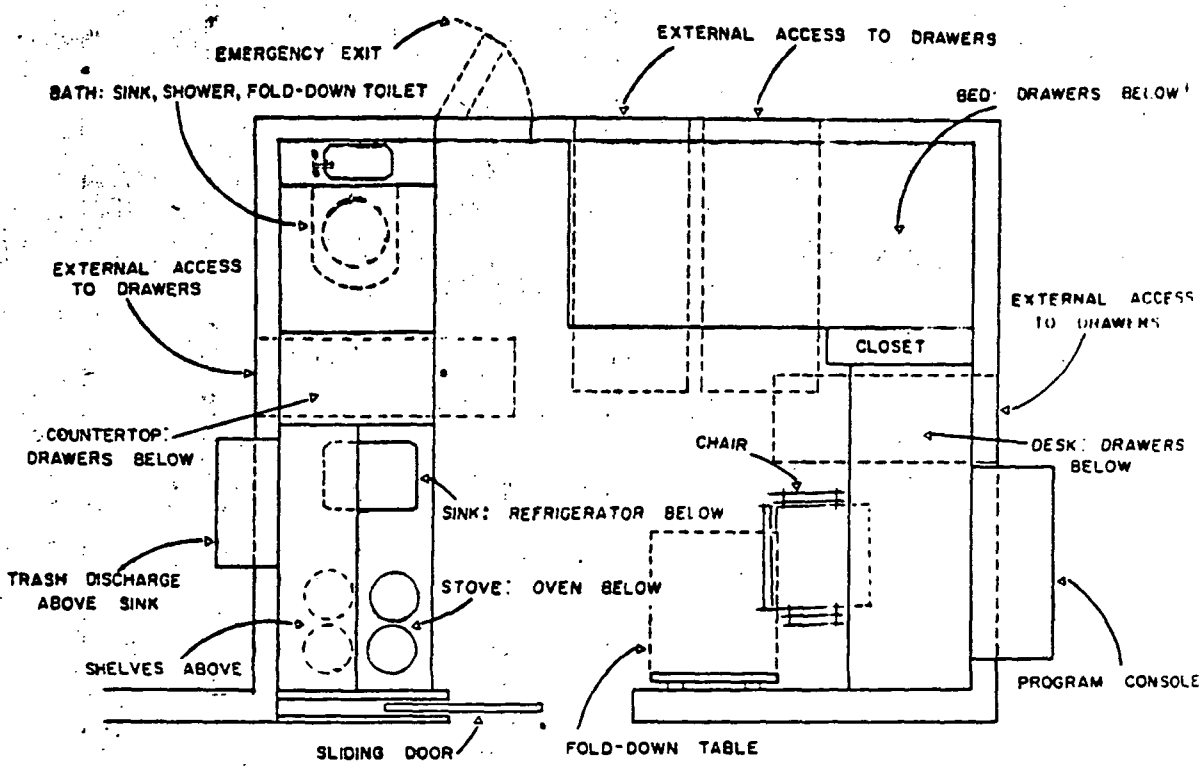

Figure 2 *Detailed floor plan of a private living area, showing the locations of facilities.*

facilities and areas of the laboratory under experimental control. Thus, since particular behavioural units require access to particular sets of environmental facilities, control over the physical facilities of the environment is translated into control over behavioural units. For example, access to the storage area containing materials for a specific activity (e.g., work supplies or reading materials) is permitted only when that particular work or reading behavioural unit is scheduled. Correlation of

behavioural units with physical facilities seems desirable from the point of view of establishing stimulus control over activities, as well as from the more general vantage of ease of establishing experimental control.

Social interactions within the environment can be regulated in the same manner as other behavioural units, that is, by controlling operation of or access to the relevant physical facilities. These include a telephone intercom for communications within the environment and potentially with the experimenters; an audio monitor system permitting subjects to listen in on other locations within the environment; and a video monitor system which permits subjects to view other areas within the environment or to view programme material selected by the experimenters. Subject movement within the environment can be similarly regulated. Remotely controlled controllable solenoid locks on all doors prevent unscheduled entries. Upon entrance to, or departure from the social areas, subjects must pass through a "transition" cubicle for identification and routing to the appropriate room (see Figure 1). This transition cubicle constitutes an "air lock" chamber to verify that each subject who passes through is identified and routed only to scheduled areas.

The electromechanical environmental control devices are interfaced with a minicomputer for remote scheduling and determination of environmental functioning capabilities. In addition to control of environmental facilities functioning, the computer can concurrently accumulate data and provide schedule information or instructions to the participants via cathode-ray tube (CRT) displays within each room. The alpha-numeric keyboard on the displays provides participants with the capability of direct communication with the system control to indicate initiation of behavioural units and to indicate individual activity selections when options are presented in the behavioural programme. These subject responses on the CRT keyboard can automatically activate the relevant facilities and begin automatic data recording. In addition to these data, audio and video monitoring equipment in each area of the environment provides experimenters with continuous information concerning all subjects' activities.

BEHAVIOURAL PROGRAMMING

Although control of access to the physical facilities associated with behavioural units contributes to the development of a behavioural programme, the term "behavioural programming" refers to more than just the automation or remote control of physical facilities. Behavioural programming refers to the experimental scheduling of behavioural events.

The aim of behavioural programming is experimental control desired for two purposes: (1) to establish stable performance baselines upon which the effects of manipulated variables may be revealed; and (2) to permit the direct manipulation of performance as an independent variable.

A behavioural programme can be conceptualized as consisting of two components: the array of activities or behavioural units included, and the rules which govern the inter-relationships between these activities or units. These elements provide the ingredients and structure by which the controllable characteristics of the laboratory are translated into experimental control of behavioural units.

The nature of the particular behavioural programme selected for use is determined by the nature of the particular problem under experimental study. A multitude of behavioural programmes can, of course, be developed which lie along a continuum ranging from the relatively impoverished minimum ecology necessary to sustain an individual, to as rich, varied, and complex a programme as environmental resources will permit. Clearly, an interplay will exist between the complexity of the inventory of activities and the potential complexity of the rules which may govern their inter-relationship. As the inventory becomes more extensive, the rule structure may become more intricate. Thus, it should be emphasized that behavioural programming does not necessarily imply the rigid, lockstep scheduling of a repetitive sequence of activities. Behavioural programming is a very flexible procedure which can be utilized to attain a variety of different performance baselines – ranging from a rigid and repetitive sequence to complex branching programmes including a multitude of personal options.

One prerequisite for behavioural programming is that the available behavioural repertoire be subdivided into manageable units. An effort has been made to specify behavioural units which possess some operational or functional unity. Thus, broad performance categories have been selected for analysis rather than more detailed moment-to-moment qualities of performance. Table I presents a summary of the behavioural units incorporated into a typical programme.

The intent has been to establish an environment in which behaviour will occur as a function of conditions and contingencies prevailing within the microsociety, rather than as a consequence of subjects' unique individual histories outside the experimental setting. This statement is not intended to denigrate the significance of individual differences, but rather to indicate that control was sought over variables sufficiently potent to reveal their effects despite individual differences. Thus, the major class of variables with which the rule structure deals is that of the temporal, sequential and contingent relationships among behavioural units, in other words, the specification of the times and durations of activities, of the order in which activities occur, and of which activities are required to gain access to other activities. These are a class of relationships which have been demonstrated to exert powerful control over behaviour, but which have not been generally accessible to detailed experimental control and manipulation within a continuous residential setting.

The rule structure that has been adopted in our preliminary efforts to develop a satisfactory baseline behavioural programme is modelled after a chained schedule of reinforcement such as was successfully employed with a single participant in a previous study by Findley, Migler, and Brady (Findley, 1966). In that study, chains or sequences of activities were presented, and all of the requirements associated with one activity had to be completed by the participant before the next activity in the sequence became available. Both fixed and optional activities were available, and the activities were generally arranged sequentially in such a way that more desirable activities followed less desirable activities, and a greater number of options were available later in the sequence than early in the sequence. These contingent relationships between activities, the sequential arrangement of activities, the distribution of scarce reinforcers within the total repertoire, and the precise stimulus control and measurement associated with each activity illustrated the application of fundamental behaviour principles to the maintenance of a complex human repertoire.

TABLE I

INVENTORY OF BEHAVIOURAL UNITS WITHIN REPRESENTATIVE PROGRAMME

Abbreviation of Unit	Full Name of Unit	Brief Description of Behavioural Unit
HC	Health Check	Temperature, pulse, subjective report
PE	Physical Exercise	Light calisthenics, 10 minutes
TO	Toilet Operations	Use of bathroom and contents of TO drawer - toiletries, clean clothing
AB	Autogenic Behaviour	Relaxation and concentration exercises on tape
FD1	Food One	Two selections from a list of light foods
WK1	Work One	Social, cooperative paced contour tracking task
SLP	Sleep	Unlimited use of bed surface
WK2	Work Two	Varied problems, experiments, and construction projects
PI	Programmed Instruction	Access to book or programmed material
PA	Puzzle Assembly	Social, cooperative assembly of a puzzle
MB	Manual Behaviour	Access to art materials
MU	Music	Earn one cassette tape
SR	Social Recreation	Social, access to games in social area
FD2	Food Two	Private major meal
FD3	Food Three	Social, major meal in social area
REQ	Requisition	Earn delayed delivery of treats or replenishment of consumables
COM	Communication	Access to intercom
LTO	Limited Toilet Operations	Access to commode

An alternative rule structure which might be implemented and evaluated involves programming by economic rather than sequential contingencies (e.g., Ayllon and Azrin, 1968). Economic and sequential contingencies can be viewed as related techniques existing on a continuum. In fact, most economic or sequential rule structures will involve elements of the other. In the present case, a predominantly sequential contingency arrangement has been seen as providing the more precise degree of experimental control over behaviour.

A REPRESENTATIVE BEHAVIOURAL PROGRAMME

In the present research project behavioural programmes have been selected whose activity inventories provide for a broad range of individual work, educational, personal hygiene, and sustenance activities, a variety of direct (*i.e.*, face-to-face) social work and recreational activities as well as more indirect social interaction via intercom communication. Thus, these activity inventories are intended to provide a rich ecological setting which incorporates a variety of naturalistic behavioural units such as may typically be involved in complex individual and social functioning.

Table I describes the inventory of behavioural units included in a representative behavioural programme which has been in recent use. Figure 3 presents a diagramatic representation of the rule structure which has governed the temporal and contingent relationships among these units. Each box within the diagram denotes a specific behavioural unit. Subjects progress through the programme temporally from left to right. This is a branching programme containing a fixed activity sequence and an optional activity sequence. Regardless of the sequence selected, the diagram represents that all behavioural units are scheduled on a contingent basis one to another, such that access to a succeeding activity in the programme demands satisfaction of the requirements associated with the preceding behavioural unit.

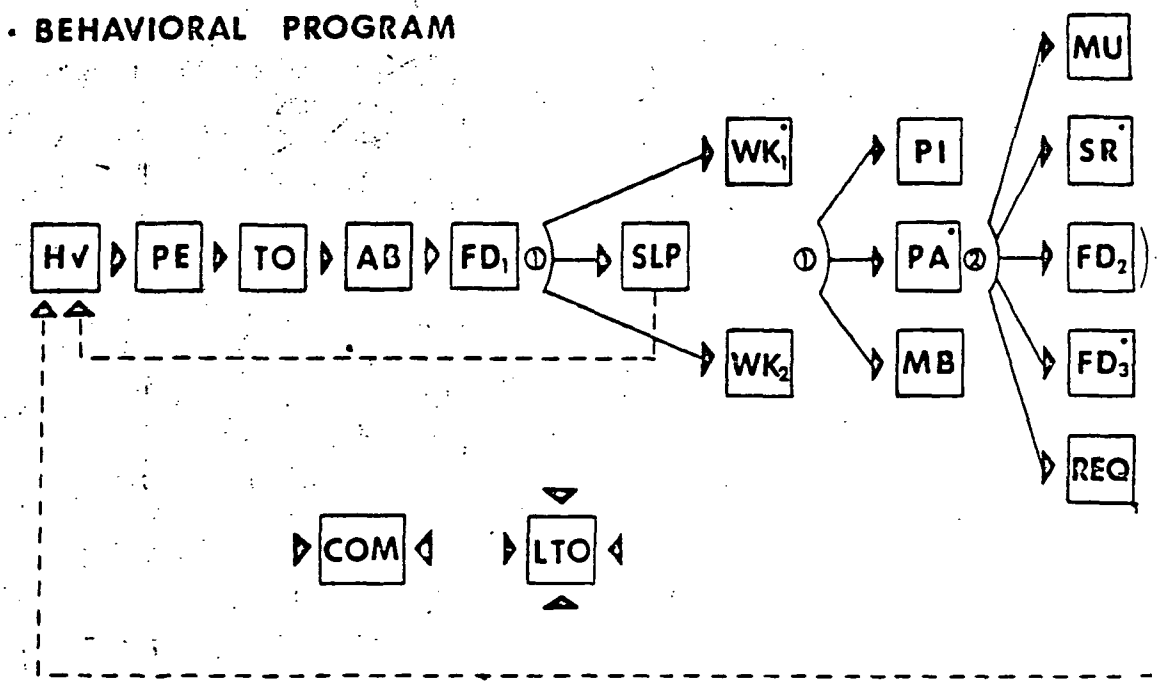

Figure 3 *Schematic diagram of a representative behavioural programme.*

For illustrative purposes, a detailed description of the functioning of this programme follows. This particular programme has been designed for, and utilized with, groups of two participants. In these early applications the corridor connecting the two private rooms has served as the social area for direct social engagements. In addition, this programme has been utilized in advance of achievement of the full level of automation of environmental facilities described earlier. Although this

behavioural programme has, thus, not utilized the full range of the laboratory's facilities and capabilities, a description of its functioning can serve to clarify the nature of this experimental approach.

Beginning at the left of the Behavioural Programme diagram (Figure 3), the fixed activity sequence is composed of all activities between and including H/, or Health Check, and FD 1, or Food One. The Health Check activity requires the subject to take his temperature and pulse, and to fill out a subjective status questionnaire. Once a subject has selected and completed Health Check, he then completes the following activities in the order displayed: PE, or Physical Exercise, in which 10 minutes of light calisthenics are required; TO, or Toilet Operations, allowing access to the bathroom and a drawer containing fresh clothing, towels, toiletries, and a vacuum cleaner; AB, or Autogenic Behaviour, in which the subject follows taped relaxation and concentration instructions; and FD 1, or Food One, in which the subject is permitted to select two items from a list of eight light foods such as coffee or tea, soup, cereal, etc.

When Food One is completed, the subject is eligible to select one of the following three activities: WK 1, or Work One, in which the subjects enter the social area simultaneously to operate the cooperative paced contour tracking task; SLP, or Sleep, which allows access to the bed for an unlimited time; and WK 2, or Work Two, which requires the subject to complete various problems, experiments or construction projects presented in the Work Two drawer. If the subject chooses Sleep, the dotted line on the diagram originating below the Sleep notation indicates that he is required to return to the Health Check activity and resume the fixed activity sequence at the completion of Sleep. Thus, this minimum recycling sequence is composed of activities designed to maintain and assess the subject's health if he is otherwise indisposed to engage in the broader selection of behavioural opportunities available within the full behavioural programme.

The optional activity sequence commences with the choice of either Work One or Work Two instead of Sleep. At the completion of either Work One or Work Two, the subject is eligible to select *one* of the following three activities: PI, or Programmed Instruction, involving a minimum of 30 minutes access to books and programmed educational material contained in the PI drawer; PA, or Puzzle Assembly, in which subjects are required to assemble a puzzle together within the social area; and MB, or Manual Behaviour, involving a minimum of 30 minutes access to art supplies contained in the MB drawer. At the completion of the selected activity, the subject is then eligible to select, one after another, *two* of the five activities presented in the last column of the behavioural programme: MU, or Music, allowing the subject to earn a cassette tape that can be played at any time during the programme; SR, or Social Recreation, allowing the subjects to enter the social area simultaneously to engage in games or visit together; FD 2, or Food Two, providing the subject with a major meal; FD 3, or Food Three, providing each subject a major meal to be consumed socially within the social area; and REQ, or Requisition, allowing the subject to earn points exchangeable for treats such as soft drinks, pastries, alcoholic beverages, or for staples such as soap and toothpaste. Once the subject has completed the second of his two choices among these five activities he returns to H/ and resumes the fixed activity sequence, as the dotted line originating after the last column of activities on the behavioural programme diagram indicates. Thus, the

optional activity sequence allows the subject a degree of flexibility with respect to the selection and arrangement of activities, both individual and social, that become available at the completion of the fixed activity sequence, and provides a broad selection of individual and social work and recreation activities.

At the bottom of the Behavioural Programme diagram are presented two additional activities: LTO, or Limited Toilet Operations, allowing access to essential toilet facilities, and COM, or Communication, allowing access to the intercom.

The Limited Toilet Operations activity is the only activity that can be selected at any time within the behavioural programme and thus interrupt an uncompleted behaviour unit.

A subject is permitted to use the intercom to initiate or answer a communication only if he is between any two activities within the behavioural programme. That is, interruption of an uncompleted behaviour unit to engage in Communication is not permitted. Such restricted access to the intercom is thought to provide more sensitive measures of communication dispositions (as reflected in overall frequency of both calls and answers, delays tolerated prior to aborting Communication and entering the next scheduled activity, willingness or unwillingness to disrupt or terminate a particular on-going activity to gain access to the intercom), than if Communication opportunities had been freely available. Additionally, scheduling intercom opportunities between activities serves to sharpen the stimulus control of Communication and enhance its functional integrity with respect to the other activities within the behavioural programme. Finally, an actual conversation requires both subjects' simultaneous presence within the Communication activity, although the location of Communication within the behavioural programme could be different for each subject. Intercom communications can occur between activities although subjects may be located at different sequential positions within the total repertoire. For example, a Communication might occur when one subject is between Autogenic Behaviour and Food One, and the other subject is between Manual Behaviour and the last column of activities, and so on.

All social activities other than Communication require a more precise synchronization of schedules. To engage in Work One, Puzzle Assembly, Social Recreation, or Food Three, both subjects are required to be simultaneously present at the respective location in the programme before the activity is made available. Typically, subjects will arrange by intercom to meet for a social activity several items in advance, then pace their tempos appropriately to synchronize their schedules.

This particular programme is being utilized in the study of factors relevant to the successful sustaining of small groups under conditions of isolation and confinement. The programme has been designed to permit the direct measurement of, with minimal programme changes, the manipulation of two factors considered likely to be of importance: the temporal speed of progression between behavioural units, and the rate of selection of social activities.

CONCLUSION

The laboratory and experimental methodology described here represent a unique approach to the analysis and study of complex human behaviour. A broad range of

naturalistic individual and social performances can be brought into the laboratory and incorporated into the analysis of small group functioning.

Continuous residential settings have, of course, previously been utilized for both basic and clinical research purposes (Ayllon and Azrin, 1968; Alluisi, 1969; Altman, Taylor and Wheeler, 1971). Frequently, such studies have involved observation of individuals or groups within isolated environments with limited control over patterns of behaviour (Weybrew, 1963; Radloff and Helmreich, 1968; Helmreich *et al.*, 1972). The present laboratory appears to offer the unique combination of a pure experimental orientation plus experimental control over the full behavioural repertoire.

The high degree of experimental control made available by the present laboratory appears to represent its primary contribution. The approach described is obviously derived from the operant behaviour methodology utilized in basic animal research laboratories. Within such laboratories behaviour is brought under a high degree of experimental control. Consequent upon discrete environment stimulus changes, behavioural patterns may be abruptly and significantly altered in a predictable fashion. The intent has been to extend an approximation of this degree of experimental control over behaviour to the human social situation.

At present, four elements can be specified as important contributors to establishing such experimental control over behaviour: (1) isolation from the external environment; (2) remote control over functioning of environmental facilities; (3) the subdivision of the behavioural repertoire into functional behavioural units; and (4) the implementation of sequential behavioural scheduling programmes. The framework thus established provides the capability of applying a rigorous experimental methodology to the study of individual and small group behaviour. Application of such a methodology can be expected to offer a valuable extension of our understanding of human social functioning.

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