A PSYCHIATRIC ASSESSMENT-TREATMENT-OUTCOME INFORMATION SYSTEM: EVALUATION WITH COMPUTER SIMULATION

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Abstract

The prediction of treatment outcome will require a clinically dedicated and comprehensive information system to gather a sizable data file on each individual covering patient assessment, treatment and treatment outcome. The computer interview represents an information system capable of routinely gathering a large portion of this information. However, current methods of data analysis cannot adequately handle the information complexity associated with psychiatric treatment. Computer simulation is a method ideally suited to the investigation of complex subject matter and is proposed as a means to forecast the treatment outcome of actual patients under various conditions of treatment.

Many clinical activities involving psychiatric and psychological information are performed with great reliability by computers. Automated data processing can relieve mental health workers of routine and time-consuming tasks. The computer is seen as a potential means to accomplish clinical ends nearly impossible for human solution. These benefits would seemingly promote enthusiastic acceptance and support among clinicians. Nothing could be further from reality.

To the bewilderment of the developers of computerized clinical systems, most practicing clinicians view the computer with either indifference or outright hostility.

The clinician's unfavorable reaction may be symptomatic of the lack of preplanning that has gone into the development of clinical computer systems. No one has undertaken a thorough analysis of what constitutes a useful clinical system, although a number of investigators have touched on key issues of this analysis. This article will examine three areas of clinical computer application: (1) recordkeeping, (2) interviewing, (3) decision making, in order to identify reasons why clinical computers have acquired few proponents among clinical practitioners. The difficulties associated with existing clinical systems may suggest ways to design a more useful system. To this end, the article outlines the development of a clinical computer system.

CURRENT CLINICAL SYSTEMS

Recordkeeping

An important clinical duty of the therapist is to maintain a record of patient characteristics, treatment activities and progress. An inadequately-kept patient record is a basis to suspect that the patient may have received clinical treatment comparable to the care taken with the record. Hopefully, many exceptions are found to this rule, inasmuch as psychiatric case records are notoriously inadequate. Block [9] created a system of chart review in a mental health program but found that half the charts lacked essential information to allow evaluation of treatment. The psychiatric record is typically characterized by missing information, lost records, inconsistent terminology, irrelevant facts, unreadable notes and poorly-organized information. Many of these deficiencies can be solved by standardizing the record information and by using standard data processing procedures, both of which are key features of the computer system. However, other problems associated with clinical record systems cannot be mechanically solved with standardization but have more to do with the nature of computer information.

The information processed by most recordkeeping computer systems is fairly similar in content. Computer recordkeeping systems have generally overlaid existing human recordkeeping procedures and thus have adopted traditional kinds of psychiatric information. For example, computer recordkeeping systems are usually involved in maintaining census data, recording admission, transfer, and patient discharge. Certain automated systems collect daily patient activity and nursing notes. It is fairly common for clinical systems to have some version of a mental status examination. Many recordkeeping systems are programmed to generate DSM diagnostic labels and some systems have recently expanded their operations to include Problem Oriented Record (POR) information.
In general, a computer recordkeeping system contains a mixture of clinical and nonclinical data. Regardless of the extent of nonclinical data, most computer recordkeeping systems are labeled as clinical computers. Developers of psychiatric information systems have emphasized the clinicians' need for clinical information. Since the computer is an efficient tool to standardize and manage psychiatric information, it is also seen as a way to improve patient care [29,46].

Any improvement in patient care is not reflected by the fact that clinicians find the information of automated clinical systems to be of great value. The early descriptions of computer systems underscored their potential, while recent discussion has focused on why this potential has not been achieved [11,21,31,33]. Hamilton [24] summarizes the current state of the art: "despite the happy prophecies for overwhelming mass of clinical workers in medicine, they (computers) might as well not exist for the differences they have made to clinical practices" (p. 1).

To reverse this trend, Morgan and Frenkel [42] list two essential properties that a psychiatric information system must have in order to benefit the clinician: (1) clinically useful information, and (2) immediate feedback of information. Many computer recordkeeping systems fail on both counts. The information that is fed back is seldom immediate and not always useful to the clinician.

Psychiatric recordkeeping systems require a number of human data processing steps, such as, collecting data, coding- keypunching- verifying information, submitting the "job" to the computer and distributing computer reports to the user. These steps consume much time and effort, and it is not uncommon for a clinician to receive a patient report weeks after the patient has left the treatment facility.

Faster turn-around of information would help, but if the reports are not clinically useful, then it hardly matters whether they are immediate or delayed. Casual inspection of the computer report will not always reveal its value. This report can be deceptive to the outside reader, for it suggest firsthand information about an unknown patient. Yet, the computer report often contains much information already familiar to the clinician. The reason for this situation is that psychiatric information systems typically process "second-hand" information and have little capacity to elicit information from an original source (e.g., patient, family members). Clinicians have direct contact with patients and relatives and are required to gather information for the computer. This mediating role creates an information redundancy problem. For the clinician, knowing what is already in the computer report diminishes the clinical worth of computer information.

The clinician's failure to accept and support computer recordkeeping may have, however, little to do with the fact that the computer is handling the recordkeeping chore. The computer appears to be the culprit because the clinician's use of recordkeeping information is evaluated only after the computer system is in-place. Had baseline or pre-computer utilization of clinical information been examined for its clinical value, then it would likely indicate that clinical recordkeeping and not the computer, per se, is at fault. Feinstein [19] points out that the maintenance of a careful medical record is not always necessary for the immediate care of patients. Clinicians can function without good records, and their ratings of computer information probably reflect this independence.

Furthermore, Bennett and Gruenberg [6] argue that the advantages of automated data processing are attributes of any good recordkeeping system. An efficiently run medical record department with cooperating clinical personnel can match the performance of computer recordkeeping systems. Thus, computer processing of psychiatric information would not appear to be essential for quality recordkeeping. Bennett and Gruenberg do not, however, describe the major effort to develop an effective recordkeeping department and the daily work to maintain human efficiency. The steady growth of computer recordkeeping systems may be partly due to the fact that the automated system is easier to control and manage than its human counterpart.

Two parties may benefit more from the computer than the clinician. The clinician generally loses out to the administrator who controls the system through undertaking its financing and, second, to the researcher who usually has a major role in designing the clinical subsystems. The administrators can tabulate computer data to reflect the efficient running of their facilities and researchers can use the data to answer research hypotheses. Unfortunately, the involvement of the administrator and researcher in a clinical system has certain drawbacks. Glueck [21] argues that it is impossible to share the psychiatric information system with nonclinical users and at the same time to avoid a compromise of clinical goals. The patient is seen differently by each computer user. Generally, the clinician views the patient as an individual and derives information unique to the patient from a human interview. The researcher/administrator sees the patient as a member of a group or program and derives results common to groups of patients. The different viewpoints of the same patient have many features of the idiographic and nomothetic controversy that has traditionally separated clinician and researcher.

Computer Interviewing

The interactive or interviewing computer gathers data directly from the patient and thus reduces the clinician's role in collecting patient information. The direct data collection also eliminates the problem of information redundancy for the clinician. Another advantage of computer interviewing is that patients serve to enter their own data, eliminating many data processing steps.
associated with non-interactive psychiatric information systems. Thus, for the clinician, the feedback of patient information is almost immediate. A computer report is generated as soon as the patient completes the interview.

While the computer interview speeds the flow of information to the clinician and minimizes the problems of information redundancy, does the clinician find the information useful? Our experience with computer interviewing indicates that many clinicians do not perceive automated interview data to be highly valuable. Other investigators report similar findings [23,27]. It would seem that the advantages of immediate information feedback and non-redundant information are logically necessary but do not constitute sufficient conditions to make the computer clinically useful.

Immediate feedback of non-redundant information stems from the mechanical features of the computer and from whether or not the patient is initially interviewed by the computer rather than by the clinician. The advantages of computer interviewing cannot appreciably alter the quality of psychiatric information nor overcome the limitations of irrelevant clinical information. The clinicians' negative attitude towards clinical computers may simply indicate that they do not find the data informative or suited to their therapeutic purpose.

Klein, Greist and VanCura [31] claim that our inability to demonstrate that the computer system is processing the highest form of quality psychiatric data has been a major obstacle to extensive clinical utilization of computer systems. The identification of clinical information would seem self-evident as a prerequisite to designing a useful clinical computer, but it is not always clear how to distinguish information on the basis of its psychiatric quality. This discrimination has, however, little to do with the computer. The development of a clinical computer instrument is independent of the computer and is based on the current state-of-the-art of behavioral science theory [41].

This would indicate that we face a more urgent and general problem than the issue of whether clinicians like computer information. Psychiatric information, whether computerized or not, is mostly unvalidated. Until the problem of validation is resolved, we might consider a halt to existing clinical computer systems. First, the problem of validation is only tangential to the clinical computer system. Second, since we cannot vouch for the information of the computer, there is always the chance that a computer system may be perpetrating more harm than good. If the information quality of an existing system is substandard, then we run the risk of conditioning clinicians to subsequently reject better information systems. Finally, if we continue to design systems, program computers, and focus on issues of technology, then we may divert scarce resources from the more important task of validating psychiatric information.

On the other hand, the computer interview provides an opportunity to address the issue of what constitutes useful psychiatric information. A choice must be made concerning the content of questions to be programmed for the interviewing computer. While recordkeeping systems have been somewhat forced to mimic human recordkeeping practices, the developers of computer interviewing have had a wider choice in selecting psychiatric content. Indeed, a number of investigators have suggested that certain kinds of computer interview information are more appropriate than others [31,32] . However, most descriptions of computer interviewing systems have not explained the selection of psychiatric information, nor explained the applied purpose of computerized information with respect to patient care. An assumption is usually made that the information has face validity. One is expected to accept the value of the information on the basis of its use elsewhere.

Computer recordkeeping and interviewing systems are not directly involved in the determination of what use is made of computer information. Instead, they are designed to turn over the information to clinicians with the implicit assumption that every clinician is infallible in the use of information. This assumption, however, can only be held while completely ignoring a substantial body of contrary evidence.

What happens to the computer information is important knowledge for those charged with evaluating the clinical system. Little is known of the clinician's actions stemming from the use of computer information. Failure to directly observe such actions forces the evaluator to infer their consequences. The evaluator can only ask clinicians if they find the information useful. Even when the clinician's response is positive, there is no absolute basis to indicate what the testimonial means. A more direct evaluation will require either that the computer system assess the clinician's use of information by gathering data on clinical judgments, or by having the computer system use its data to make decisions regarding patient care.

**Decision Making**

Wiggins [52] argues that if it can be shown that a clinician cannot combine data and make predictions more accurately than a computer, then the practical contribution of clinical judgments will be seriously questioned. The issue of clinical versus statistical (mechanical) predictions was initiated by Meehl's [40] review of twenty studies comparing human judgment to statistical prediction. The possible outcomes of these studies are that clinicians can judge better than, equal to, or worse than statistical prediction. Meehl's tally of statistical and clinical comparisons showed that over half of the statistical predictions were more accurate than those of clinicians and almost never less
Accurate.

It should not be implied that there are computer systems dedicated to making extensive decisions for clinicians. Routine clinical decisions by computers are limited to a few outcome areas, such as the length of hospital stay [3]. The research in the area of clinical versus statistical prediction has received little applied development because most investigators have focused on process questions, such as how clinicians combine data to make predictions.

The failure to consider practical clinical matters has precipitated an emotional controversy among clinical workers. Holt [26] claims that McArthur may have "sold the clinical approach up the river" (p.1). He argues that the prediction tasks, such as predicting grade-point averages, are inappropriate and alien to what the clinician does in practice. McArthur [36] emphasizes the triviality of such predictions and questions why we should experimentally study tasks clinicians do not perform. He raises the challenge to study what clinicians can do on their own terms, with criteria of their choice and with their own clinical methods.

One major task that clinicians do perform is to make treatment decisions, to predict, for example, that a specific treatment for a particular patient will be more successful than another treatment. In theory, a decision-making computer system would not be difficult to construct. This system would consist of a comprehensive set of decision rules of the form \( d(x) = p(y) \), where given information \( x \) about a particular patient, then the following treatment decision \( d \) will have a probable outcome \( p \). Seemingly, a statistical system of comprehensive treatment decisions and outcome predictions would be potentially useful to clinicians, especially if clinicians were unable to match the accuracy of the statistical predictions. We may ask why little of the computer's computational power is devoted to making decisions?

Klein, Greist, and VanCura [31] state that the reason clinicians do not find computer assessment data of psychiatric patients of great value is that no one has established a relationship between these data and treatment outcome results. These investigators are correct in their observations but have not specifically isolated the main problem. The source of difficulty is that there are large sets of patient assessment and treatment outcome data, and that no one can decipher the correspondence between the two; rather, the problem is that we currently lack an extensive body of treatment outcome data. The lack of outcome data makes it impossible to even contemplate the issue of relationships. In the above decision formulation, one side of the equation--that is, probable treatment outcome--is effectively an unknown quantity.

Without sufficient outcome results, no psychiatric information can be found clinically useful. Information has little intrinsic value unless some action is attached to it. The basis to judge whether one kind of information is more useful than another is to observe the action (including no action) taken with it and to note the consequences (outcome) of this action. The systematic relationships between certain information and particular actions can be described in the form of decision rules. In turn, the outcome of these decisions will impart a measure of usefulness to the decision-making information.

While the value of outcome data is highly prized by the clinical field, less than adequate progress has been made to gather outcome data. The collection of treatment outcome data would receive our highest priority in the development of a clinically useful information system. Indeed, we would first design an outcome information subsystem and then develop other system components around this subsystem. The present priority of information systems tends to emphasize the gathering of intake or pretreatment data. This approach seems logical in terms of starting at the beginning, but it has been relatively unproductive with respect to validating clinical information.

**ASSESSMENT-TREATMENT-OUTCOME SYSTEM**

From the survey of existing clinical computer systems, the following steps seem essential in designing a more useful clinical system. First, to be termed a clinical system, the computer must be specifically dedicated to the task of the clinician. The clinician is primarily concerned with the treatment of a single patient. If treatment is individualized, then the clinician will require full and detailed information about the individual patient. Comprehensive information means that the data gathered by the clinical information system must equally extend to all stages of treatment, covering patient assessment (pre-treatment), treatment planning, treatment execution, patient progress, and treatment outcome.

Second, the computer must do more than collect and distribute computer information to clinicians. It must offer the clinician a comprehensive set of treatment decisions. While we may eventually find that these decisions are the same as those clinicians have been using all along, we will not discover this similarity unless we create a parallel decision system. It may turn out, as has happened in other areas, that the statistical decision system will be superior to clinical decisions.

In the design of a useful clinical computer system, the division of labor is twofold: 1) the collection of data that fully describes the patient's characteristics, treatment progress and outcome; and 2) the method of analyzing these data in order to formulate treatment decision rules.
Outcome Variables

The collection of clinical data involve, first, the question of what type of data to collect and, second, how to gather these data. Deciding on what data to collect is determined by the choice of criteria which best describes treatment outcome. In psychiatry, there is no clear consensus of what ideally depicts patient outcome, and at least two different types of interpretation complicate outcome measures of great generality and applicability to all patients.

Recently, a strong case has been made for measuring outcome in terms of the alleviation of patient problems. Battle, et al [5] argue that problem reduction can serve as the basis for followup evaluation and seems to be more promising than other outcome measures. The problem oriented approach requires outcome measures of exquisite specificity, amounting to an almost atomistic focus on distinct behaviors and multiple outcomes.

Measuring general patient functioning with a single index or assessing problem reduction with as many measures as it takes to describe the patient's set of problems, will result in a quite different clinical system. In the design of the present system, we have selected problem oriented data to describe treatment outcome. For those who choose a different type of outcome, the following discussion may have little relevance.

Variables Influencing Treatment Outcome

An extensive range of diverse variables affect treatment outcome. McLean and Miles [38] and Paul [45] have outlined the major categories of variables influencing treatment outcome (Table 1). At present, there is little to say about the actual usefulness of this information. Certain variables will be found unrelated to a particular outcome but whether such variables have no predictability, whatsoever, can only be determined by comparing them to the full set of multiple outcomes. In effect, our current knowledge of treatment outcome does not facilitate a one-stage transition to a clinical system which initially employs only valid information. At present, the quality of psychiatric information cannot be prejudged and we must collect a wide variety of treatment outcome variables until some discrimination is possible. To insure against continued indiscriminate use of irrelevant variables, the system needs a self-contained mechanism to evaluate the quality of information.

The problem of data collection is that each category in Table 1 represents hundreds of specific variables. In the past, a single investigator has studied only a small aspect of each category and a few specific variables within a category. The cost, effort and logistics of doing outcome studies have been enormous. These difficulties have greatly restricted the researcher's ability to explore many kinds of variables and types of patients. Also, outcome studies are short-lived due to the above restrictions. It is rare to find a treatment program engaged in ongoing outcome investigation. Zusman and Ross [53] argue that outcome studies will never become a routine part of quality evaluations of individual treatment facilities. They perceive that outcome investigation will remain arduous, expensive techniques of special research projects. Furthermore, they predict that many years will pass before outcome studies are accepted in mental health programs, even on a limited basis.

<table>
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<th>TABLE 1. Variables Influencing Treatment Outcome</th>
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<td>Paul [45]</td>
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<td>4. Treatment</td>
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We do not perceive the routine collection of outcome information to be an impossible task. The thousands of specific variables subsuming the categories of Table 1 can be feasibly gathered. Our present experience with computer interviewing indicates that a large data base on each patient can be easily attained [4]. The interviewing computer can reduce the cost and effort of performing outcome studies. It can also provide routine and ongoing outcome evaluations in a variety of treatment programs. The decreasing cost of computers is approaching the recordkeeping budgets of most large- and moderate-size treatment programs.

Our present computer interview system has succeeded in routinely gathering extensive patient pretreatment or baseline problem data in a number of varied treatment programs. The system has also been designed to gather patient treatment progress information and treatment outcome results. The system is not presently designed to interview the clinician, but the need for such information is evident from the many categories in Table 1 related to the behavior of clinicians. However,
using the same computer interview strategy we have applied to patient assessment, it would be a simple matter to design a therapist interview system.

Certain mixed feelings are associated with asking the therapist to input data to the system. One advantage of patient interviewing with the computer is that it has reduced the data collection role of clinicians, freeing them to do other more important jobs. Now, we are asking for one of these jobs to be the reporting of their treatment activities. Hopefully, the computer will minimize the clinician's chore associated with this reporting. The factors that have made computer interviewing a positive experience for patients may operate to make it a similar experience for clinicians.

We are confident that the computer interview will solve the problems of performing routine evaluation, and we turn to the next step of how to analyze the data. Perhaps we are naively assuming too much, but in most articles of treatment evaluation, considerable time is spent discussing the problems and logistics of gathering data and little mention is devoted to how these data will be analyzed or interpreted. Most investigators assume that once the actual data are gathered, then powerful multivariate procedures are available to handle them.

**RELATIONSHIP OF INFORMATION**

The size of the overall patient file of the assessment-treatment-outcome system raises the question of how to evaluate the mass of information. Our initial efforts in analyzing the data of a comprehensive computer interview, representing 3450 data points per patient, have suffered from not having a systematic plan of analysis, an integrating theory or a way to assimilate the complexity of information. Our approach corresponds to what Edwards, Guttentag and Snapper [17] describe as "baseball statistics." Results are reported as an exhaustive compendium of facts; and although the facts are laid out in a somewhat logical fashion, they lack any degree of integration. Because the decision makers cannot understand or assimilate thousands of measures, they must select out a few pieces of information, which makes many decisions less than accurate. This raises the question of whether too much information is as useless as too little.

**Traditional Methodology**

The traditional methodology of outcome investigation has usually involved two similar groups of patients, an experimental and control set of treatment operations, and identical measures of outcome for each group. This comparison is suited to the evaluation of treatment programs and types of therapies. It also serves the purpose of program administrators and researchers but may have little to offer the clinician.

Bergin [7] has questioned the classical methodology of doing outcome research. Procedures that entail similar groups of patients, contrasting treatment and equal outcome measures are currently viewed as an unrealistic research endeavor. Bergin has strongly urged a moratorium be placed on this type of research. The research does not begin to answer the question of what treatment, by whom, for that particular problem, under which circumstances, is most effective. These qualifications represent a very abstract patient and treatment setting, that is, an individual and a treatment setting defined by a large set of variables. The alternative is the notion of a fairly uniformed patient and treatment approach; however, Kiesler [30] has attributed a large portion of meaningless results and confusion in psychotherapy research to these myths of uniformity.

No one believes these myths, but neither are they being effectively dispelled. The methodology of psychology and psychiatry is not able to handle the complex data analysis of treatment outcome represented by greater patient abstraction. Factorial designs are generally recommended for the study of outcome [30,45]. A factorial design is one in which two or more variables, each varied in two or more ways, are studied in all possible combinations. It permits a researcher to evaluate the overall effectiveness of two or more therapies and whether there are differential responses of therapy patients. However, the number of treatments, combined with a variety of patients, must stay within finite limits. The factorial design cannot accommodate more than a few factors. The analysis of ten factors, for example, would produce results difficult to interpret and conceptualize.

In the complex area of treatment outcome, the size of the factorial design may be held within manageable limits. Kiesler [30] has proposed that experimental and control patients be matched on relevant measures. In this approach, it is uncertain how many relevant variables must be controlled. If this number is very large, then matching procedures would require screening large populations of patients before finding an adequate sample of experimental and control patients to study. Lee Cronbach has raised similar doubts about factorial designs in the study of treatment outcome. He envisioned the number of relevant treatment variables to be so large that enough cases to account for them will never be available [16p. 54].

The problem of complexity might be solved by the discovery of a few well-chosen variables which are predictive of various outcomes. Factor analytic studies, supported by the availability of computational computers, have frequently been proposed as techniques to simplify the complexity of outcome data. Factor analysis can reduce this complexity to a few dimensions and thus provide a manageable set of variables for the factorial analysis-of-variance design. In practice, however, the dimensions of combined variables, when related to a heterogeneous group of patients,
have negligible power to forecast what a person is likely to do in any one situation [12].

We could possibly segment the investigation of treatment outcome by dividing the research among different investigators, and thereby increase research precision with a more focused analysis. In effect, this approach seems to be what is happening in the study of outcome. Paul [45] indicates that no single study or any degree of complexity will be capable of investigating the full range of treatment variables; instead, knowledge of treatment and outcome variables will be accumulated across many studies. This strategy is not without difficulty.

In synthesizing the results of studies involving many researchers, we generally piece together what variables have main effects. Missing from the synthesis are the many higher-order interactional effects, which do not, so to speak, extend across different studies. How important are these interactions? Cronbach [12] describes his concern over inconsistent findings coming from roughly similar inquiries of different researchers. He suspects that a large part of the inconsistency arises from unidentified interactions among variables. Such interactions must be analyzed if we seriously consider questions about the what, when, that and which of treatment outcome rather than the main effects of two contrasting treatments.

So far, we have described the potential problems with conventional methods when the number of independent variables becomes sizable and complex. Some would assert that these problems are not insurmountable. Perhaps not, provided that the treatment outcome of diverse patients and treatments is the same dependent variable. The analysis of problem oriented data appears to contradict this approach. Instead, knowledge of treatment and outcome variables will be accumulated across many studies. This strategy is not without difficulty.

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Computer Simulation

The proposal that outcome studies adopt the methodology of computer simulation is not based on any successful application. Indeed, the application of computer simulation to treatment outcome investigation is a virgin research territory. It is our belief, however, that computer simulation is a unique methodology which will allow us to maintain the size of our patient data base and to make some sense out of it.

The basis for the above optimism is that computer simulation is not subject to the many limitations associated with conventional design procedures. The important advantage of computer simulation is that it is a research methodology equipped to investigate complex subject matter. Schultz and Sullivan [47] point out that a greater degree of complexity can be accommodated in a simulation model; the high-speed computer makes computer simulation a powerful tool for modeling complex processes. Dutton and Briggs [14] find that computer simulation is especially useful as a means for understanding complicated processes. It allows the researcher to combine a great variety of otherwise disparate elements into a single entity. Psychological and psychiatric treatment certainly has the involved properties to qualify it as a complex process, one that is urgently in need of theoretical integration.

Current Computer Simulation

One way to proceed with the computer simulation of treatment outcome is to attach this development to current computer simulation work, or at least explore what prior work in this area may be helpful. In 1962 a conference was held to discuss the possibility of computer simulation of personality [50]. Over the years, a number of conference participants have reported the progress of their computer simulation. Colby [10] has designed a computer program to simulate the belief system of the neurotic person. Abelson and Carroll [27] have developed a somewhat similar system involving the manipulation of attitudes. Loehlin [34] has created a system to recognize a situation and to act emotionally (love, fear, anger), to react (approach, withdraw, attack) and to suffer various consequences (injury, frustration, satisfaction). Gullahorn and Gullahorn [22] have designed a system to simulate the decision-making of persons who seek to derive
reward from social interactions. Recently, Malone [35] has investigated two-person interactions with computer simulation, and Seltzer [48] has described a computer simulation of J.W. Atkinson and D. Birch's theory of motivation. Attempts have been made to adapt psychoanalytic theory to computer simulation [43,51].

Simulation of process. The computer simulation studies of personality and social interaction all have a number of common features. These studies are intent on the investigation of psychological and social processes. In describing the benefits of computer simulation to a psychiatric audience, Naylor and Gianturco [44] view the potential of this methodology as a tool of psychiatric research to do process studies. These investigators have emphasized an important feature of computer simulation. While most behavioral scientists are concerned with process study, other scientists and engineers have used computer simulation for the purpose of obtaining output or results of the process being modeled [18]. Computer simulation is ideally suited to perform forecasting or outcome predictions. The emphasis on process study is perhaps due to the scientific attitude of social and behavioral scientists that process studies are more rewarding than applied matters of forecasting. Of course, in the study of psychological process, one must evaluate the computerized process by noting how well the process results correspond to results in the "real world."

In the field of computer simulation of behavioral processes, Blackmore [8] cites the growing concern of the lack of studies. He finds that the huge effort and time to construct computer simulations is an exercise in futility unless the computer model results are checked against subject data under known conditions to validate the model. To date, computer simulations of personality have generated very little empirical research. How the results of the computer simulation relate to human personality, social interactions, and decisions is still open to question.

A common feature of the computer studies of personality is that they involve the simulation of unspecific prototypic individuals. One reason for this is that the prototypic individual can cast the simulation in the abstract so that it can acquire greater generalization. This strategy fits a prevailing attitude that the study of an actual individual is not sufficiently general to be interesting and that the proper domain of research scientists is general theory [15, p. 146]. The general theory is best obtained by studying many individuals simultaneously or by employing an idealized individual that embodies common characteristics of many persons.

The problem with this approach in the computer simulation of behavior is that it is not always clear where to find the "prototypic" non-computer subjects in order to generate comparable results. In seeking such results, Hart and Sung [25] gathered decision data from a random sample of human subjects and compared them to the computer simulation results of the prototypic decision maker. The random sampling allowed non-essential variables to confound and cancel one another, thus reflecting the "abstract" individual (or group). The results of the computer simulation were compared to the decision making of human subjects and no significant differences were found. In this instance, significant differences bring into question the appropriateness of the computer model, but the study merits attention because it is one of the few computer simulations of behavioral processes that has attempted systematic validation. Such validation, when coupled with failure, can be a stimulus to build a better computer model. To this end, Hart and Sung [25] have proposed obtaining direct measures from individuals and incorporating this information into the computer simulation.

This proposal is the key to the development of a computer simulation of treatment planning and outcome prediction for specific patients.

Simulation of the individual. In the simulation of personality, the use of subject data to set the parameter values of the computer program has been suggested but seldom done. This approach conflicts with the rationale for using prototypic computer subjects, for the results of the computer run will be highly specific to the subject and situation modeled. The computer input of subject data places greater constraints on the relationship among variables and, thus, produces a less general model. Abelson [1] questions whether such simulations are of general relevance or merely the forced imitation of idiosyncratic persons. The point not considered is that the use of prototypic computer subjects may never have been realistic in the first place. While the modelling of a prototypic individual will make the results more general, these results may unfortunately not correspond to anything in the "real" world.

Simulating "real" or actual patients under conditions of clinical treatment will shift the present emphasis from an almost exclusive study of process to an equal concern about outcome or forecasting the patient's behavior. The computer simulation of patients should not encounter the major validation criticism of social and personality simulations. Investigators would never be in doubt as to what their computer results reference. They would be aware of what is being simulated and to what ends.

Individualizing the computer simulation to model the treatment of an actual patient would require clinicians to collect patient information, not only to compare computer and human results, but to set the input values of the computer program. In the area of personality simulation, traditional personality tests are seen as a means to gather this information. How such instruments have generally failed to yield specific outcome predictions. Loeblin [34] claims
that any method based on five or twenty scores will not achieve prediction beyond modest success.

He suggest that good prediction of the individual by computer simulation will require thousands of facts about the person and the person's situation. However, Loehlin has questioned whether the collection of massive amounts of data is feasible.

**Computer Simulation of Treatment**

The application of computer interviewing, previously described, to the collection of extensive clinical data should counter the concern about insufficient data. The data are, or soon will be, available to support computer simulation of treatment, but development of this simulation work must avoid two trends which characterize most other behavioral simulation efforts: first, the exclusive focus on process study and, second, the investigation of the prototypic patient as a means to derive general results. However, since treatment is an applied area, the practical importance of the "real" patients will assert the necessity balance to emphasize outcome results. There is, however, no inherent force in the treatment endeavor to counter the study of the prototypic patient. In fact, the nomothetic inclinations of most administrators and researchers may divert computer simulation of treatment from the study of individual patients to that of group studies. If this happens, then the simulation will lose its clinical utility, and the clinician will not be served in the most needed way, i.e., treatment recommendations and outcome predictions for the individual patient.

Looking to the future, and bypassing the difficult issue of how to construct a treatment model, computer simulation offers therapists the capability of experimentally studying their patients. The patient's data file from the computer interview will provide the basis to set the parameter values of the simulation model. The specific goal of the simulation would be to predict future outcome behavior under various conditions of treatment. The computer simulation would operate to tell the clinician what the patient's followup status will be after a given interval of time. It should also be possible to have the computer results indicate the optimal treatment operations for a given patient, provided the desired outcome is specified beforehand. Each patient would receive followup evaluation and their "real world" results would be compared to the computer's prediction.

The computer's forecasting of treatment outcome for a specific patient may seem farfetched, but similar kinds of predictions are taking place today. Many large commercial firms are using computer simulation to make predictions. Gershefski [20] surveyed 323 companies and found that sixty-three firms were involved in the computer simulation of their corporation and an additional 39 corporations were planning to begin this development. The parallel to treatment simulation is that commercial firms are mainly concerned with the predictions of a single entity, i.e., the performance of their individual corporation. The individual corporation is not the same as an individual patient, but computer simulation is a general method that will work just as well for specific patients as it does for a particular corporation. The goals of both are similar. The corporation worker wants to know, given a set of current parameters for his company, what the consequences of his decision will be at some future time. In a parallel sense, the therapist wants to know, given a patient with a set of assessed pretreatment parameters, what will be the outcome of treatment.

As mentioned previously, the construction of a treatment model is no small task. It will require a number of assessment- treatment- outcome information systems located in a wide variety of treatment programs and a distributed network of data transmission to form an effectively large data base. Some will argue that the effort to build a treatment model is an enormous and hence an impossible endeavor. Others will contend that it would simply transfer our current lack of treatment understanding from the real world to the computer; that is, the computer model would be so cumbersome that its complexity would preclude any precise description of how it works. This possibility is real, but for the interim, we will settle for accurate predictions in lieu of understanding as opposed to presently having neither prediction nor understanding.

If we seriously desire a science of treatment, then the most promising feature of computer simulation is that it offers a systematic and organized method for building a model of treatment. McLeod [39] points out that computer simulation is a way of proceeding from vague ideas to problem solution in an orderly, logical fashion and a way of finding that our information is incomplete and that additional data must be gathered.

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**REFERENCES**


