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ABSTRACT

Simulation, defined as a representational model of a particular theory, has been the subject of some research in the communication field, but there has been little material published on the uses of simulation as a research tool. Simulations are considered helpful in closing gaps between field studies and laboratory research, serving to increase coherence and consolidate theories. A simulation will be representative of the theory it serves only to the extent that it fits a well-constructed, representative model and accounts for the interaction of variables consistent with the theory. If data from a simulation do not support the hypotheses of the theory, either the hypotheses or the simulation should be adjusted according to the experimenter's goals and his degree of objectivity. The validity of simulation must be tested for specific objectives. Many simulations are more correctly identified as games or metaphorical extensions of man's social behavior. Important considerations in the use of games as simulations include control of game behavior consistent with the reference system, proper introduction of subjects to the game activity, and determination of whether or not role playing behavior best serves the game. (RN)

TOWARD MEASUREMENT OF HUMAN PROBLEM SOLVING IN SIMULATIONS

by

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The social scientist has tended to model his research techniques on those methods used in the physical and natural sciences. The apparent goal of such modeling has been to achieve precision and exactness often found in the physical and natural sciences. Unfortunately, the nature of social behavior has, so far, eluded the methodological efforts by the social scientist. Nevertheless, he continues to pursue his goal and sometimes discovers, to his embarrassment and to his profession's embarrassment, that certain important studies are either impossible to conduct or that certain studies modeled from natural science methodologies have yielded absurd and often useless results.

Research in communication seems particularly vulnerable to these problems. In spite of some innovative and ingenious efforts, the speech-communication field still falls far short of a sufficient scientific methodology capable of the power found in other sciences. Partly as a result of simple frustration, a considerable segment of the speech-communicationist's efforts have been to abandon creative methodological alternatives and to turn instead to speculation, anecdotal evidence, and empirical testing under severely restrictive paradigmatic procedures.

Sessions such as this one are heartening because they allow creative explorations of alternative research methodologies that might be conducive to ideal social behavior research. In the spirit of creative exploration, this paper seeks to discuss some implications of the growing interest in the use of simulations as an alternative research paradigm. The particular constraints given to this paper are to identify for the speech-communication professional those general problems and issues important in considering simulations for research and to identify, where possible, the resolution given those issues by others.

The number of scientists involved directly or indirectly in the use of simulation and gaming has increased dramatically in the last several years. Interest and involvement in simulations has increased in the field of speech-communication as well, although not as much as one might have hoped. A variety of published articles and papers indicate the use of simulations and games used as a research tool. The most ambitious study undertaken by a speech-communication specialist appears to be the Hylton and Lashbrook attempt to simulate in a man-machine operation different audience conditions in a study of saliency in attitude change.[1] Although not identified as a simulation, Leathers' experiment involving trust creation and destruction utilized most of the essential characteristics of a simulation.[2] Similarly, Tubbs' study of interpersonal trust and its relation to behavior under differing message conditions required a simulated condition for manipulating the growth and deterioration of trust behavior.[3] Tubbs used the commonly employed Prisoner's Dilemma game as the basis for his investigation. Other researchers have used the PD game and other aspects of game theory for their research foundations. Stainfatt[4] used the PD as a generator for his communication study and later with Frye[5] he again used the PD as a generator in a related communication study. Beisecker turned to game theory in general for his studies of verbal communication on the outcome of ongoing interactions; however, Beisecker's efforts are probably outside of the definition for simulation.[6]

Several articles and papers have devoted their purpose to the discussion of the appropriateness of simulation to communication research. The earliest and one of the very best efforts was Tucker's discussion of the use for simulation in the speech field.[7] Kline spoke directly to an issue followed

up here: the difficulty of achieving isomorphism between simulation and theory.[8] Smith briefly outlined potentials and limitations for research in the speech communication field.[9] Jandt provided a thorough listing of appropriate references for anyone interested in simulation sources, particularly computer simulation,[10] and provided a brief analysis of the appropriateness of simulation in the study of conflict behavior.[11]

However, some serious shortcomings are evident within the speech-communication field as to the dissemination of useful material about simulations as a research tool. In a casual review of commonly used research texts and books published within the field, none contained any substantive reference to simulations with the exception of Emmert and Brooks' short discussion of computer simulations.[12]

This shortcoming is a little surprising since most users are quick to point out that simulations are particularly helpful in closing gaps between field studies and laboratory research, a particularly essential feature for most thorough communication studies. Furthermore, simulations can be helpful in increasing coherence within and among theories as well as serving to consolidate or unite theories.

A characteristic of simulation that helps yield these advantages is its generally close tie to the original theory. By definition, a simulation is a representational model of a particular theory. However because the simulation is only representational, it is susceptable to several methodological questions. The remainder of this paper will pursue some of the more important questions.

Does the simulation represent the theory?

This may seem like a simple and, therefore, unnecessary question. However, this question poses rather serious implications. Often a simulation is constructed to serve one theory and is currently being used to serve another theory unrelated (except possibly in a most general way) to the original theory. For example, much of the research using the PD game seems wholly unrelated to the original theory associated with the PD game and wholly unrealistic for the theory being tested. Simulations are representational of theories and are dependent on theory for their analysis. When isolated from theory or transplanted for use with another theory the simulation can easily fail to serve the researcher. Consequently, the researcher who pirates a simulation without making an analysis of the simulation's appropriateness for the research question can obtain absurd results.

Kline raises this question by indicating the importance in seeking an isomorphic relationship between theory and simulation. A step commonly forgotten is that, for most theories, a model must be constructed before the simulation is designed. From the model a dynamic simulation is constructed. This means the simulation is a second level representation of the original theory and is susceptible to all the compounding influences conferred in each stage of representation. In all probability, the simulation's approximation of the model's approximation of the theory may yield a simulation not representative of the theory. Of course, the better the simulation fits the model and the model fits the theory the more closely the simulation will be representative of the theory.

Does the simulation represent the theory fairly?

The previous paragraph relates closely to this question. For the simulation to represent the theory fairly, the simulation must transcend the model. To do so, the simulation most account for the interaction of variables in the same way the theory accounts for them, the simulation's operationalization of variables must be consistent with the theory, and the scenario for the simulation must allow behavior typical of that behavior referenced by the theory.

The simulation must account for the interaction of variables consistent with the way theory or reality accounts for the variables. This is a difficult challenge to meet as should be clear after consideration of the next question. The attempt should be to achieve realism in the experimental setting so that the system behaves exactly as its real counterpart. For example, if the theory is descriptive of behavior found in collectives then the simulation should deal with like collectives. Although this example seems rather straight forward, a surprising number of research studies do not fulfill this consideration. Sufficient research evidence exists to the interactive effects from group activity that alters the behavioral outcomes of individuals. Consequently, like behavioral conditions should exist between theory and simulation. In my own research, I adjust the simulation to account for both group-induced and non-group-induced behavioral patterns as a test for these effects.

The operationalization of variables is also important in the design of the simulation. Often this is a difficult task requiring reconsideration of the original theoretical framework. Too often care is not given this essential step and the datum given from the simulation proves to be worthless.

Here is an opportunity to utilize one advantage of simulations--the ability to operationalize certain conditions not normally possible in other research paradigms. My own research in simulations started specifically as an answer to an inadequacy seen in another's research with trust. Where others were assigning levels of trust to subjects I felt it was important for the subjects to internalize those levels of trust. Leathers apparently feels the same way since he went to great pains in simulating an environment for creating and destroying levels of trust held by subjects.

Finally, the simulation cannot represent the theory fairly if the scenario does not allow behavior typical of that referenced by the theory. The scenario is the context for the model. The construction of the scenario has an important influence on the behavior within the model. For example, a war setting elicits different response patterns than a business setting.[13] Benson, McMahon, and Sinnreich have written an excellent article on scenario design and the important considerations that must be given to scenario planning.[14]

In any scenario planning the experimenter must face the issue of mundane realism versus experimental realism. Only the quality and degree of care given the scenario will determine if experimental realism is achieved. Drabek and Haas have identified five characteristics necessary for a realistic simulation in the study of group behavior. These characteristics are useful for any researcher to consider: (1) use a real group, preferably a natural group in a natural setting, that can be manipulated by the experimenter; (2) keep the type of task, activity, or demand placed on the group realistic and within their capacity; (3) reflect a reasonable ecological setting appropriate for this group; (4) keep the input, information, feedback data,

etc., at a meaningful level for the subjects; and (5) inform the subjects that they are participating in an experiment.[15] This last characteristic will be more fully discussed later. The essence of at least four of these characteristics is to respond to John Kennedy's statement that " . . . people start behaving like people only when the environment they are behaving in has 'reality' for them . . . ."[16]

Does the simulation serve the theory, the experimenter, or itself?

There is a certain paradox present in any experimental paradigm that seems to be particularly obvious with simulations. When the datum from the simulation does not support the hypotheses or the theory, does one adjust the simulation or the theory? Consider the more overlooked case of the simulation yielding data that does support the hypotheses or theory. Then, does the researcher claim the simulation is isomorphic with the theory? At some point the researcher must decide that the simulation answers the first two questions and the data supports rejection of the theory or that the simulation needs further fine-tuning to yield data supportive of the theory.

Tinkering, adjusting, modifying the simulation is a necessary task in achieving a satisfactory answer to the first two questions. In fact, simulations offer the advantage of being able to sustain repetitive runs in order for the researcher to make adjustments--a condition directly lacking in some social research paradigms. Robert Abelson states the argument succintly:

> If a simulation could be "right for the wrong reasons," that is, fit the data by virtue of compensating errors, then in what sense can a good fit be regarded as supportive for the theory underlying the simulation model? Can one ever "prove" a simulation theory by displaying good imitations of particular outcomes?[17]

Actually, to manipulate the simulation to achieve good imitation of particular outcomes is a partial sacrifice of an appropriate advantage to using simulations in the first place. Abelson has noted that: "The simulation of a model is most worthwhile when the simulation is capable of producing consequences unanticipated by the investigator."[18]

Another issue closely related to this question is the experimenter's goals. Assuming total objectivity is impossible, there is always the issue of the simulation operating favorably because of a self-fulfilling propheey. In designing, constructing, operating, testing, and validating the simulation there are sufficient opportunities for experimenter bias. The extent and pervasiveness of such a bias is well documented for other experimental paradigms but little attention has been given the documentation of such bias for simulation experimentation.

Furthermore, the experimenter bias can take other forms related to the goals of the simulation project. As has been well documented for many social science research projects outside pressures can have pervasive influence on whether the research effort will contribute to the status quo or social change. This is a particularly sensitive issue for communication research, particularly in the areas of conflict and persuasion.[19]

Does the simulation meet standards of validity?

This question has been touched on in discussion of the preceding question. It is singled out here to further emphasize its overriding importance to simulation research. Validity is defined as the degree of correspondence between the model and the reference system.

Hermann[20] has attempted to identify five approaches to satisfying questions about validity. He qualifies his approaches by noting that each

simulation must face issues of validity directly related to the specific objectives for that simulation. The first validity test he mentions is internal validity. This is a test for assuring between-run variance is low. Therefore, internal validity is attempted by replications of the simulation run. The second test is for face validity. This is a commonly reported validity based on the impression by the experimenter, observers, or participants that "things are going all right." This validity is, at best, a rough test improved upon by observations stated in advance of what is expected and by the experimenter's attempts at objectivity. The third validity issue is "variable-parameter validity." This test is a comparison of the simulation's variables and parameters with counterparts in the reference system. The fourth validity issue is event validity. This test is important to prediction from the theory for it checks for a comparison between events, occurrences, or patterns of behavior occurring in both the reference system and the simulation. The fifth issue Hermann outlines is hypothesis validity. This is a test for relationships between variables. The test is based on discovering if systematic differences develop between the hypothesized relationship as seen in the reference system and the simulation.

Validation is always a matter of degree. Techniques for testing validity issues such as Hermann and others have advanced are not very well established nor widely used. Subjectivity becomes a ruling force and the matter of degree accepted tends to widen further and further.

One of the more common techniques of validity testing is the comparison of the simulation data output with data output from some other empirical test. Recognizing the danger in dealing with output comparisons as mentioned by Abelson, there appears to be a second important danger. Since the simulation is not confirmed as being isomorphic with the theory (otherwise

this test is not necessary) then reliance is placed on the comparative data, assumed to be the product of a valid method. This is a tenuous assumption. At best the researcher is dealing with three issues: (1) the extent the other empirical method achieves validity with the theory, (2) the extent the simulation achieves validity with the theory, and (3) the extent the other empirical method relates to the simulation. If simulation is a uniquely beneficial social research tool, then the likelihood of the third issue being resolved is doubtful. In most cases, the simulation is expected to produce different results, hopefully more sophisticated results, than other methods. This sort of validity testing violates that expectation.

Does the metaphorical use of "games" imply conditions not acceptable to the theory in question?

Many simulations in use today are more correctly defined as games. Since games imply conditions and assumptions of their own, it becomes appropriate to deal here with this special case of simulations.

Games, as commonly played, are metaphorical extensions of man's social behavior. They serve as "dramatic models of our psychological lives providing release of particular tensions."[21] They are used and abused by participants and spectators as a means of direct and vicarious satisfaction. In our lives, games provide a useful function but they do so more empathically than fundamentally.

Consequently, when the concept "game" is brought into the laboratory it brings with it, for the participants, qualities that may or may not be a part of the game's reference system. By definition, a game is a less complex social model usually involving different sides with conflicting interests. If the theory or reference system does not tolerate behavior consistent with

metaphorical concepts of the game being used, the research effort is useless. The experimenter's handling of certain key parameters determines behavior within the game. Among the key parameters are: (1) control of payoff possibilities and whether they are based on a zero-sum or non-zero-sum condition; (2) control of rules and requirements necessary for the game that are realistic in terms of the reference system; (3) the handling of the subjects prior to initiating the game activity; and (4) whether role-playing behavior or deception is necessary for the game and whether it is realistic for the subjects and valid for the reference system.

In the discussion of validity, questions could have been raised about the necessary assumptions required by simulations to operate, in and of themselves. Those questions were deferred for discussion here under a consideration of games because they are more obvious with games. Surely the rules of behavior in a game must be consistent with the rules of behavior in the reference system. For example, this consistency is particularly important if game theory serves as a foundation for a research game. If this consistency is imcomplete or faulty then game theory would be inappropriate or misleading as a research foundation.

Furthermore, as Drabek and Haas note, the demands made on the subjects must be both realistic for the subjects and realistic for the referende system. If the behavior is different or complicated for the subjects, the experimenter faces a serious problem. He may not be able to distinguish the subjects' behavior in coping with the different or complex demands from the behavior energized by those demands. For example, after working with several hundred people in the use of PD-type games, I have come to the conclusion that even when subjects tell the experimenter they are familiar, knowledgeable, or otherwise competent with reading and interpreting a payoff matrix (even

after the experimenter has explained the matrix) there will still be a significant number who are unable to follow the matrix logic. The result is for this group of subjects to devote their efforts to a problem-solving behavior concerned with handling the matrix while, concurrently, the experimenter is interpreting the behavior as a game-playing behavior.

Although the rules and requirements may call for one particular behavior, the perception by the subjects of the type of simulation may induce another form of behavior. This seems particularly true for games. Therefore, the experimenter must be careful in how he handles the subjects prior to initiating the game activity. The possibility for experimenter-induced bias has been documented for learning games.[22] The effect in PD games of introducing the two subjects in the dyad as "opponents" or "partners" is known to also affect the subjects' perception of the game.

The final issue discussed under this question is the perplexing question of whether role-playing behavior or deception best serves the game or simulation. There has been considerable concern expressed recently about the use of human subjects in experimental research and the effect such experiments might have on the subjects. Simulations are not immune to this concern particularly since one major use of simulation is to alter attitudes of the participants.[23]

Role-playing has been advocated as an alternative to typical deception practices.[24] Role-playing is of particular interest in simulation and game research since many of the human components in the simulation or game correspond to a role or character in the reference system--politician, teacher, businessman, diplomat, etc. Again the metaphorical concept of game, now with surrogate participants, plays an important part in achieving validity.

For the purposes of most decision-making problems, the researcher must be cautious to employ roles not dramatically inconsistent with the particular subject's own life style or parameters of behavior. Subjects cannot be expected to produce "honest" behavior patterns consistent for the assigned role if they cannot, under the best of circumstances, identify with the role. The subject is left with choosing between his own behavior or displaying a behavior he thinks is appropriate for his role. Even if the subject tells the experimenter he has behaved as he thought the character he played would behave, the experimenter does not know if such behavior is realistic or stereotypic. On the other hand, if the subject faces one of these self-role incongruencies he might induce conflict inappropriate for the game. More than likely, he will display behavior inappropriate for either the role or his self behavior.[25]

In this brief paper, five basic questions and issues related to them have been raised. No claim is made that positive answers to these questions will assure research success with simulations. For some of these questions there are answers and for some there are no answers. As efforts are made to cope with these questions simulation will take an appropriate place with other accepted research paradigms as an attractive methodological contribution to the study of human communication and human decision-making behavior. Theodore Clevenger identified for the communication specialist the essential value yet to be realized from simulation techniques:

> Simulation is particularly appropriate where theory is complex and where direct experimentation on some of the variables is difficult or impossible because of the dynamic nature of the process. Since it is widely recognized that any adequate analysis of communication will prove both complex and dynamic, it seems likely that simulation holds the key to future theoretical development in the field and thus will play a significant role in the development of communication research.[26]

FOOTNOTES

[1]Cal Hylton and William Lashbrook, "Apathetic and Neutral Audiences: A Computer Simulation and Validation," Speech Monographs, 39 (June, 1972), 105-113.

[2]Dale Leathers, "The Process Effects of Trust-Destroying Behavior in the Small Group," Speech Monographs, 37 (1970), 180-187.

[3]Stewart Tubbs, "Two-Person Game Behavior, Conformity-Inducing Messages and Interpersonal Trust," Journal of Communication, 21 (December, 1971), 326-341.

[4]Thomas Steinfatt, "The Prisoner's Dilemma and Creative Alternative Games: The Effect of Communication," (paper presented at the Speech Communication Association Convention, Chicago, 1972).

[5]Thomas Steinfatt and Jerry Frye, "The Prisoner's Dilemma and Creative Alternative Games: The Effects of Real and Imaginary Rewards Under Full Communication," (paper presented at the Speech Communication Association Convention, Chicago, 1972).

[6]Thomas Beisecker, "Verbal Persuasive Strategies in Mixed-Motive Interactions," Quarterly Journal of Speech, 56 (April, 1970), 149-160.

[7]Raymond Tucker, "Computer Simulations and Simulation Games: Their Place in the Speech Curriculum," Speech Teacher, 17 (March, 1968), 128-133.

[8]John Kline, "Communication Games: A Plea for Isomorphism With Theory," Western Speech, 36 (Summer, 1972), 181-186.

[9]Robert Smith, "Communication Variables Appropriate to Gaming and Simulation," (paper presented at the Speech Communication Association Convention, Chicago, 1972).

[10]Fred Jandt, "Sources for Computer Utilization in Interpersonal Communication Instruction and Research," Today's Speech, 20 (Spring, 1972), 25-31.

[11]Fred Jandt, "The Simulation of Social Conflict," (paper presented at the Speech Communication Association Conference on Conflict, Philadelphia, 1972).

[12]The books reviewed are as follows: Larry Barker and Robert Kibler, (eds.), Speech Communication Behavior: Perspectives and Principles, (Englewood Cliffs, New Jersey: Prentice-Hall), 1971; Ernest Bormann, Theory and Research in the Communicative Arts, (New York: Holt, Rinehart, and Winston), 1965; Philip Emmert and William Brooks, (eds.), Methods of Research in Communication (New York: Houghton-Mifflin, Co.) 1970, a brief description of computer simulation 472-475; Paul Ried (ed.), The Frontiers in Experimental Speech-Communication Research, (Syracuse, New York: University Division of the Summer Sessions,

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[13]Roger Simon, "Scenarios and Functional Forms: Considerations for the Design of Experimental Games," Simulation and Games, 3 (March, 1972), 3-16.

[14]Dennis Benson, Colleen McMahon, and Richard Sinnreich, "The Art of Scenario Design," Simulation and Games, 3 (December, 1972), 439-463.

[15]Thomas Drabek and J. Eugene Haas, "Realism in Laboratory Simulation: Myth or Method?" Social Forces, 46 (March, 1967), 342-344.

[16]John L. Kennedy, "A 'Transition-Model' Laboratory for Research on Cultural Change," Human Organization, 14 (1955), 17.

[17]Robert Abelson, "Simulation of Social Behavior," The Handbook of Social Psychology, Vol. II, Gardner Lindzey and Elliot Aronson, (eds.), (Reading, Massachusetts: Addison-Wesley, 1968), 343.

[18]Abelson, 286.

[19]See: Herbert W. Simons, "Persuasion in Social Conflicts: A Critique of Prevailing Conceptions and a Framework for Future Research," Speech Monographs, 39 (1972), 227-247.

[20]Charles Hermann, "Validation Problems in Games and Simulations With Special References to Models of International Politics," Behavioral Science, 12 (1967), 216-231.

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[22]Michael Inbar, "Individual and Group Effects on Enjoyment and Learning in a Game Simulating a Community Disaster," Simulation Games in Learning, Sarane S. Boocock and E. O. Schild (eds.), (Beverly Hills, California: Sage Publications, 1968), 182-183.

[23]See: Samuel Livingston and Steven Kidder, "Role Identification and Game Structure: Effects on Political Attitudes," Simulation and Games, 4 (June, 1973), 131-144.

[24]Richard Willis and Yolanda Willis, "Role Playing Versus Deception: An Experimental Comparison," Journal of Personality and Social Psychology, 16 (1970), 472-477.

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