THE STRUCTURE OF INTERPERSONAL RULES FOR MEANING AND ACTION: A COMPUTER SIMULATION OF "LOGICAL FORCE" IN COMMUNICATION

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ABSTRACT

This paper reports on the application of computer modeling in the development of a communication theory under the ancestral term "the coordinated management of meaning". Human actors constitute component subsystems with the ability to organize their cognitions into constitutive and regulative rules. The conjoining of the individuals rule sets forms the logic of the system.

A simulation model was constructed in APL to study the conversations possible given the interpersonal system produced by specified forms of interpersonal rule sets. This paper reports on an analysis of three different interpersonal systems. Variables examined include the interpenetration or "goodness of fit" between various forms of intrapersonal rule sets, and the structure of rule sets including equifinality, multi-finality, symbolic differentiation and hierarchical differentiation. A comparison is drawn between the results of experimentation in a laboratory setting.

The results of the analysis lead to a set of statements describing (a) the relationship between the forms of interpenetration and forms of conversation and (b) the relationship between forms of rule structure and amount of interpenetration. Extensions in subsequent research are briefly outlined.

INTRODUCTION

This is the first report of a project which integrates the techniques of artificial intelligence with behavioral research about the patterns of interpersonal communication. The purposes of this phase of the project were (1) to demonstrate the feasibility of a coordinated research project including both computer simulation and observations of human subjects; (2) to develop necessary computer software and experimental protocols for later phases of the project; and (3) to develop evidence for the construct "logical force" which is hypothesized to constrain human communication.

The project originated in the development of a theory of human communication, the content of which is unexpectedly well adapted for representation in computer programming. Following this realization, an extension of the research program to include simulation seemed natural.

Our focus on processes of interpersonal communication is based on the recognition that all individual action (except for the possible exception of that by so-called "feral children") is social, in one or more of three ways: (1) the development of personality is largely a matter of acquiring and internalizing patterns of interpersonal behavior (14); (2) the performance of particular acts is in a social context populated by real persons, abstracted "generalized others" (8) or potentially complex patterns of interpersonal networks (16); and (3) human behavior is intentional, at least to the extent of being contextualized as part of a "plan" in which the anticipated responses of other persons is taken into account. (9)(15) As a subject for study, interpersonal communication includes the various forms of the interface between the individual and his/her social environment.

The development of the theory of interpersonal communication with which we are working is based on three observations. First, we accept as given that human social behavior is patterned and subject to "plastic control." Specifically: although particular instances of communication may be rigidly structured (as in a "high church" ritual) or chaotic (as in many attempts at intergenerational or intercultural communication), a "social order" exists such that persons are generally able to coordinate their behavior so that they do not surprise each other very often, they are able to participate in conjoint acts, and they frequently believe that they "understand" each other. Second, we accept as given that the social order is differentiated. Persons from particular cultures or small communities within a culture tend to resemble each other in communication style much more than they resemble persons from other cultures. Even within speech communities, there are "pockets" of greater order superimposed on the ambiant commonality: thus we speak of "types" of families; "forms" of relationships; and organizational "climates." Third, we accept as given that various social orders differ in the extent to which they facilitate or impede particular forms of interpersonal communication and thus the development of personality traits, social institutions, etc. For example, the flexible team of organizations of NASA is precluded among the Malagasay, whose "social order" prohibits free exchange of information. (10)

There have been a number of conceptual schemas developed to account for these phenomena, which comprise a set of alternative "mythologies." One important function of theorists in any discipline is to sift through the available mythologies and ascertain their usefulness. For reasons beyond the scope of this paper, we have found unproductive the mythologies of "attitudes," "cognitions," "communication patterns" (e.g., in Bales, (1) sense), "managerial grids," personality "traits," recurrent social situations, leadership "styles," unspecificable but demonstable "interpretive procedures," etc., and have invented our own myths (11) (12) (3), the usefulness of which we are presently attempting to determine.

The crucial aspects of this theory may be briefly stated in propositional form.

1. Individuals act on the basis of their construal of themselves, others and situations. (7)
2. Construals of particular events take place according to the individual's rules for meaning and action. (Rules are summary descriptions of cognitive functions, thus they describe the consequent of entities identified by other theorists as attitudes, motives, etc., without accepting the frequently problematical burden of proof for demonstrating the existence of these entities.)
   - 2.1 There are two types of rules, each representing a different cognitive function.
     - 2.1.1 Constitutive rules represent the cognitive function of identifying a meaning at one level of abstraction as a token of a meaning at a higher level of abstraction (e.g., saying "you turkey!" counts as one way to perform an "insult").
     - 2.1.2 Regulative rules represent the cognitive function of identifying appropriate sequences of events at given levels of abstraction (e.g., "if insulted, then it is legitimate to hit the speaker").
   - 2.2 Rules may differ in internal structure. A formal model of rule structure is given in Illustration 1, in which the simplest forms of rules are depicted. More complex rules exhibit equifinality and/or multifinality.
     - 2.2.1 The degree of equifinality describes the number of entities which "count as" or "lead to" other entities. For example: "A or B→C" is more equifinal than "A→C."
     - 2.2.2 The degree of multifinality describes the number of entities which a particular entity "counts as" or "leads to." For example, "A→B and C" is more multifinal than "A→C."
   - 2.3 Individual's rule systems differ in structure.
     - 2.3.1 The degree of hierarchical entailment describes the strength of the linkage between lower level abstractions (e.g., for a highly hierarchically integrated person, a failure on a tennis court affects their self-esteem while for a lowly integrated person it would be irrelevant to self-esteem).
     - 2.3.2 The degree of differentiation describes the number of contexts perceived by the individual (e.g., lowly differentiated persons perceive a rule as applying everywhere while a highly differentiated person perceives any rule as situationally appropriate).

ILLUSTRATION 1

A Formal Model of the Structure of Rules

Episode: "friendly chat"

Speech act (e.g., "compliment")	⊃	Deontic operator speech act (e.g., "return compliment")	⊃	Show other that you are socially skilled
↕		↕		
Speech event (e.g., "that's good work")		Speech event (e.g., "I drew heavily from your work")		

Where:
- ⌐ = "in the context of"
- ↕ = "counts as," the operation of constitutive rules
- ⊃ = "if-then," the operation of regulative rules

Deontic operator = a statement of perceived "oughtness," e.g., obligatory, legitimate, irrelevant, prohibited

(Note: constitutive rules define each of the elements of which regulative rules are comprised; regulative rules organize these predefined elements.)

3. The juxtaposition of two or more persons produces an interpersonal rule system.
   - 3.1 The characteristics of the interpersonal rule system is determined by the nature of the "fit" between the individual rule systems. As in any system, the whole is not the simple sum of its parts.
   - 3.2 Social behavior is constrained by the interpersonal rule system. The predominant feature of social behavior is alternation: (4) each person's behavior is both the antecedent and consequent of the other's, in sometimes complex patterns. (6) Given the structure of rules, alternation produces a "logic" of behavior in which an act by one person is interpreted by the constitutive rules of the other as the antecedent condition of a regulative rule, the regulative rule guides the selection of a next act in the context of expected consequences;

and constitutive rules describe the way to enact the next act; and so on. Illustration 2 depicts the form of the logic.

3.3 The amount of "logical force" impelling particular acts is a function of the structure of individual rules and the symmetry in content and structure be-between rule systems. (The precise relationships among "logical foıce" and various forms of rules is to be determined by various phases of this project.)

4. Individuals act in the context of the logic of the social order in which they find themselves, but are not necessarily limited to that logic. Their performance may be judged as "minimally competent" if their own rule structure is less complex than the interpersonal system; "satisfactorily competent" if it is functionally equivalent; and "optimally competent" if they are able to transcend the interpersonal logic. (5) Individual performance must be described in relation to the social order.

Proposition 3.3 is, of course, the point of departure for this study. Our understanding of the processes of communication are enhanced if we can specify the structure of individuals' rules and the relations among rule systems which make the social order restrictive or facilitative; or internally consistent or paradoxical.

The complexity and changeability of rule systems constitute major impediments for the development of research testing this theory. As a result, we are producing simultaneously along two convergent lines. Naturalistic research, both field and laboratory studies, is being done to determine epirically the content and structure of rules of meaning and action among various groups and to relate those findings to observed patterns of communication. In addition, simulation studies are attempting to ascertain relations among variables in deliberately simplified systems.

The primary virtues of simulations for our purposes are the ability to construct a system simple enough to observe economically, which is subject to our manipulations, and which is isomorphic with our analysis of interpersonal rule systems.

ILLUSTRATION 2

Diagram of the Interpersonal "Logic" of Conversation Produced By Constitutive and Regulative Rules

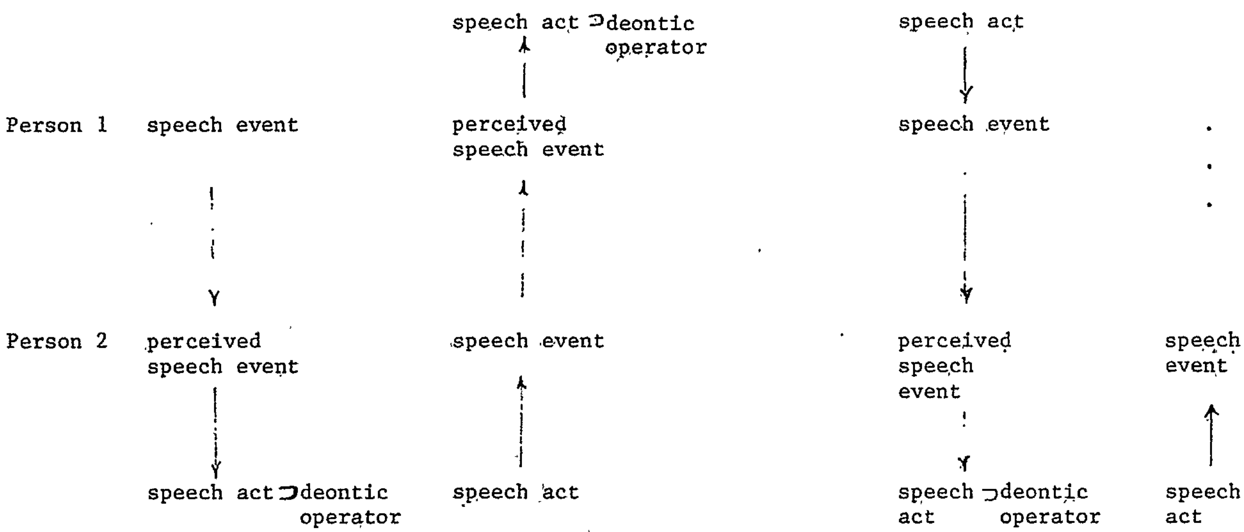
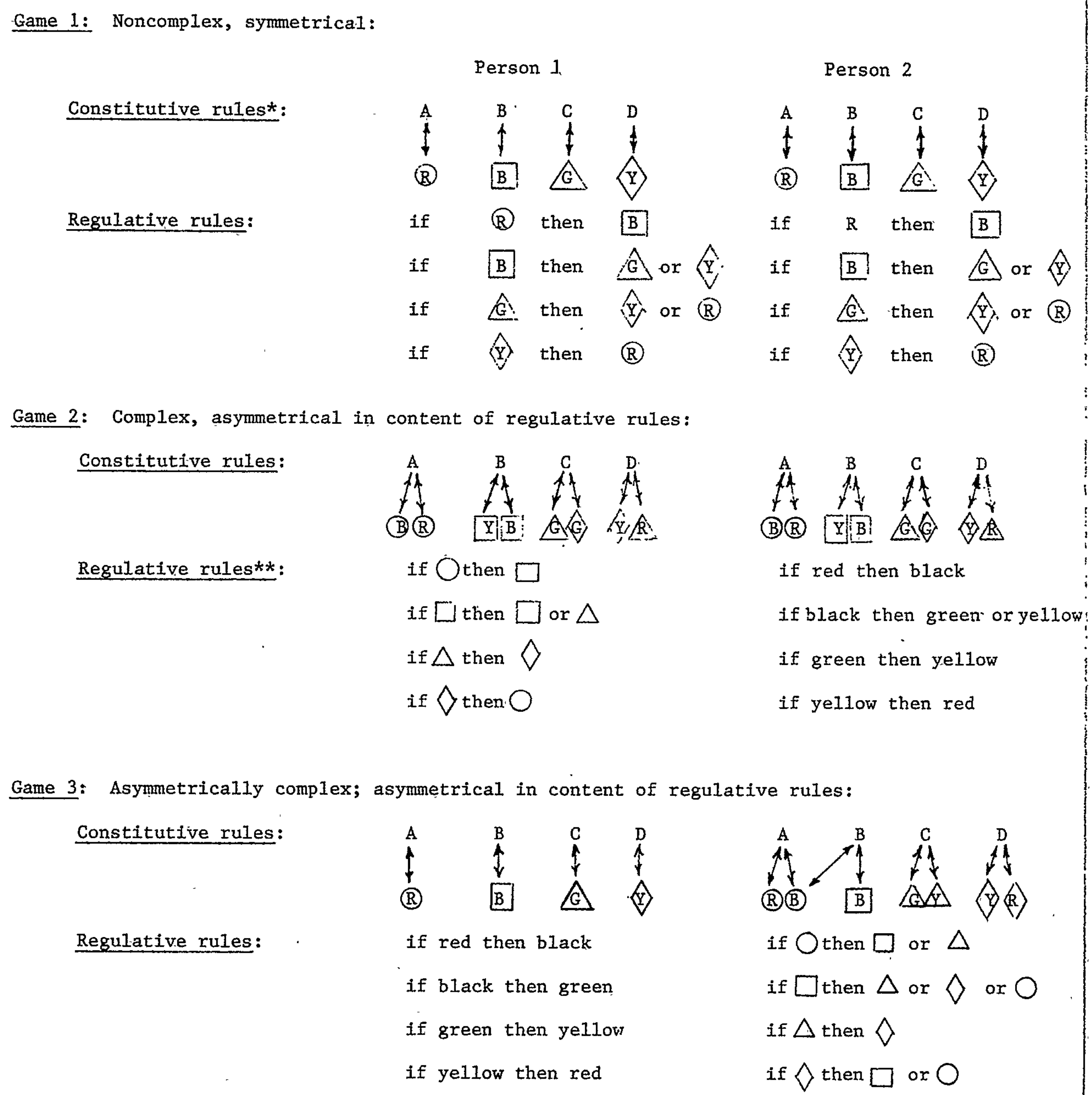


ILLUSTRATION 3

Three Versions of Rule Sets for the "Coordination" Game



* The "vocabulary" of the artificial communication system consisted of colored shapes, here represented by R(red), B(black), G(green), and Y(yellow). In the game, these appeared as colors shaped appropriately.

** "Empty" shapes indicate that subjects were given rules keyed to shape and ambiguous to color; color labels indicate that subjects were given rules keyed to color (depicted by an amorphous smear) and ambiguous to shape.

PROCEDURE

For the purpose of the simulation, we constructed an artificial communication system in which "messages" took the form of colored shapes on index cards and "meanings" took the form of capital letters. The meaning of each message was specified by constitutive rules (e.g., red circle counts as A), and sequences of action were specified by regulative rules (e.g., if circle, then square).

Three interpersonal systems were modeled, differing in complexity and symmetry (See Illustration 3). In system #1, both "persons" were modeled as very simple (e.g., there was little equifinality or multifinality incorporated in their rules) and the interpersonal system was symmetrical (e.g., $P_1=P_2$). In system #2, both persons were modeled as having complex constitutive rules, and the interpersonal system represented as fully symmetrical in structure but asymmetrical in content (e.g., Person 1 was "sensitive" to colors, Person 2 to shapes). System #3 was asymmetrical in both content and structure. The specification of these three systems provided an opportunity to create the software necessary for subsequent manipulations of individual rule structures and interpersonal rule systems.

By simulating sequences of interaction by the persons represented within these systems, an index of logical force can be derived. Specifically, logical force is considered as the reciprocal of the number of patterns possible in a given system, or:

$$\text{logical force} = \frac{1}{\#\text{ patterns}}\ (100)$$

For convenience, the equation is multiplied by the constant 100.

The process described in Illustration 2 was modeled in APL in two stages. The first stage involved the construction of programs specifically designed to perform according to the rules specified in Illustration 3. These programs were used to evaluate the logical force represented by the three different systems. The second stage involved the construction of a program which basically performs the same functions as in the first stage. This program, however, is more flexible in that the regulative and constitutive rules are not preprogrammed and must be specified at run time.

The operation of the programs are relatively straightforward. Each person has a desired sequence of meanings and the messages selected by the simulated individuals are chosen, as constrained by constitutive and regulative rules, to achieve their desired ends. When a message is recieved, it is interpreted and the current sequence is compared to the desired meaning to determine if a satisfactory end has been achieved. If it has not been, it is evaluated to determine what portion of the desired sequence has been attained. Based on this information and the constraints of the regulative rules the next message is selected. Should there be no match, if the regulative rules allow, the individual will attempt to initiate the sequence. If the rules prevent initiating the sequence, then a random choice is made from the available messages. Control is then passed to the other simulated individual who cycles through the same process.

Presently, the model represents simple-minded individuals. Learning from one's previous experience is not incorporated into the program. This will be incorporated in the next stage of development. In addition, subsequent programs will evaluate individuals with several different constitutive rule sets who may change rule sets in the process of conversation as learning occurs.

RESULTS

All simulations were started by having person #1 initiate a sequence with the message "red circle." Each simulation consisted of a string of 103 messages produced according to the rules. Since patterns of meanings were examined in groups of four, there were 100 potential patterns in each game. The actual number of non-repetitive patterns is an index of the logical force within the system.

As shown in Table 1, the logical force in the three systems differed considerably, being highest in system #1, where only 11 different patterns were produced, and lowest in system #3, where person #1 perceived 51 different patterns and person #2, 62.

At this point in our theoretical development, the numerical assessment of logical force is an exciting prospect, but the numbers themselves are of uncertain scalar properties.

TABLE I

Logical Force in Three Interpersonal Rule Systems

System*		Number of different 4-meaning patterns	Logical force**
1		11	9.09
2		27	3.70
3:	Person 1:	51	1.96
	Person 2:	62	1.61

* See Illustration 3

** Based on the formula:

$$\text{logical force} = 100\ \left(\frac{1}{\#\text{ of possible patterns}}\right)$$

DISCUSSION

The development of the software in this study demonstrates the feasibility of using computer simulation of interpersonal rule systems. However, at the present state of development, only very simple systems are practical for simulation. The artificial communication system described here had a very restricted range of messages (at the largest, n=8) and only one level of meanings associated with the messages. Rule systems isomorphic with human communication are much more extensive at each level of phenomena and have many more levels. (13) At present, the complexity of natural systems is prohibitive for simulation.

However, the simulation of simple systems provides an opportunity for the discovery of relationships among variables which may be expressed quantitatively and thus used as a basis for subsequent research. Specifically, this study provided a demonstration of the effect of the hypothetical construct "logical force" and a procedure for quantifying it. Further, the amount of logical force was shown to be a function, as hypothesized, of both the structure of individuals' rules and the symmetry of rule-sets within the interpersonal system. In general, logical force varies inversely with complexity of individual rule systems, and this relationship is stronger when the component systems of the interpersonal system are asymmetrical in structure.

A closer analysis of these results indicates the direction of refinements of this procedure. The formula for quantifying logical force is summative one, useful for constrasting entire systems. There is no reason to assume, however, that logical force within a system is equally distributed. To the contrary, it may be expected that some choices are disproportionately curcial to the generation of alternative patterns. In subsequent analyses, we will explore methods of ascertaining the distribution of logical force in sequences of acts.

Given the asymmetrical content and structure of system #3, the amount of logical force for the persons involved was also asymmetrical. It is appropriate to translate these into phenomenological terms for persons in comparable situations: person 2 was in fact "freer" than person 1, but surely did not feel so, since interacting with such a simple companion made the logical force in the interpersonal system stronger (e.g., more constraining) than that which would have been produced in interaction with a person equally as complex as him/herself. On the other hand, interacting with person 2 reduced the logical force produced by person 1's simple system, and made that interaction either liberating or frightening for person 1. (We think we discern in this the murky structure of many interpersonal relationships.)

Finally, it is instructive to compare the results of these computer simulations of logical force with the way human subjects performed in these artificial communication systems. In a phase of this project reported elsewhere, (13) ten pairs of human subjects each played two iterations of the game "Coordination," in which they were given a deck of cards with colored shapes on them. The rules of one of the three systems described in Illustration 3, and told to alternate messages in such a way as to produce the pattern ADBC.

Although subjects were not allowed to see their partner's rules, were limited to a total of 12 plays, and were prohibited from conversing during the game, all dyads were able to produce the desired sequence. We interpret this as (welcome) evidence of "higher" cognitive functioning among our subjects: they were able to operate strategically <u>within</u> the logical force of the various systems.

After each "Coordination" game, subjects completed a series of questionnaires, the results of which provide a set of clues to the nature of their strategic play. The strongest relationship ($r=.774$) was between "perceived own competence" in playing the game and "perceived other's competence"; the next strongest ($r=.541$) between "rule system" and "perceived unpredictability of the partner," and the third ($r=.354$) between "perceived latitude of choice" and "perceived unpredictability of the partner." This suggests--as our original assumptions asserted--that persons act by triangulating between their own internal factors (rule systems; latitude of choice; own competence) and social factors (unpredictability of partner; other's competence), such that neither of these is independent of the other.

Subsequent studies with computer simulations of interpersonal rules may take three forms. First, more complex rule systems may be created, including multiple levels of meanings. This would permit much stronger manipulations of structural and content asymmetry. Second, systematic manipulations of rule structure may be performed so that quantitative relationships between logical force and the variables equifinality, etc., may be determined. Third, software may be developed to incorporate various types of artificial intelligence, including several patterns of memory, role-taking ability, decision procedures, etc. The value of these simulations of artificial intelligence derive from their continuing association with naturalistic studies of human behavior: particular forms of A.I. may be shown to resemble or differ from human functioning in systems of varying degrees of complexity. These comparisons have value for the development of both artificial and human intelligence.

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