TOWARDS A SIMULATION MODEL OF MOTIVATION AND ADJUSTMENT

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Abstract

A model of human motivation is formulated on the basis of Maslow's need theory. Additionally, behaviors are selected by degree of tension and are reinforced by environmental reactions which facilitate or frustrate reduction of tension according to the aggressiveness of behavior. Comparisons of alternative environments support the internal consistency of the model. Recommendations are made to improve the stability of the model and for behavioral research that would be necessary for validation.

INTRODUCTION

During the past several years, computer simulations of personality have been developed. The personality theorist is concerned with attempting to identify and classify similarities and differences between people. But it is not merely transitory similarities and differences among people that intrigue the personality theorist. The data he wishes to interprete and understand are abstracted from characteristics showing continuity over a period of time. The important characteristics which he focuses upon seem to have psychological importance to the individual, such as feelings, needs, actions, leaving to the biological scientist such continuous aspects of functioning as acetylcholine cycles and blood pressure.

All of these simulation efforts are laudable as long as there is a possibility of testing the predictions of a personality theorist's model against reality. If the model is untestable, then it is a futile exercise to simulate it and then to attempt a proper validation. For example, what evidence is offered by Freud or his disciples that the basic variables--id, ego and superego--postulated by them exist? Do people truly pass through the oral, anal, phallic, and genital phases of development? Unfortunately, most of the empirical data of psychoanalysts are available in the form of psychotherapy and not as results of statistically analyzed nor operationalized constructs. For these reasons the verification of computer simulations of personality are subject not only to the limitations of statistical analysis but even more to the problem of getting data for validation.

Recognizing these limitations we feel that the process of systematic modeling, such as one must perform in computer simulation, contributes to the operationality of vaguely-defined theories. By exposing a tentative set of intuitive mechanisms to open criticism, perhaps we can move closer to a fuller understanding of personality theories. It was also our intention to show the utility of a computer simulation as a vehicle for <u>integrating</u> theoretical concepts of motivation and adjustment. Therefore our simulation is limited here to validation utilizing merely <u>potentially</u> operational constructs. The data gathered from the simulation may be evaluated only at the level of subjective comparison from obtainable reports and other research findings.

One of the determinants of an individual's personality is a need. A need, drive, motive or habit are alternative ways of conceptualizing subunits of personality whose interplay define the course of an individual's action and development. A need then may be capable of accounting for a variety of behavior. In most of the computer simulations of personality (Loehlin, 1968; Dutton and Starbuck, 1971; Tompkins and Messick, 1963; Colby, 1964 and Moser, et al., 1970), motivational constructs have not been emphasized because these models are not strongly oriented toward action. It is the purpose of this simulation to model Maslow's theory of motivation which emphasizes the behavior of the individual.

The essence of Maslow's theory of motivation (1970) is presented below. According to Maslow (1943), each individual strives to actualize (grow) and avoid deprivation. Deprivation motivation refers to the urge to strive for the goal states, presently unachieved, that are necessary in order to ease the pain and discomfort due to their absence. The aim of deprivation motivation is to decrease the organismic tension buildup through deficit states that represent deviations from homeostatic balance. Actualization has to do with the realization of capabilities or ideals. As the individual strives to realize these ideals, he engages in more complex differentiated behavior that may increase his level of tension. Maslow's theory requires that a goal state be achieved and that the individual will engage in behavior that is instrumental to reaching the goal. The goal states have been defined in terms of five basic needs. These needs, arranged in a hierarchy of ascending order, are: physiological, safety, love, esteem, and self-actualization. This classification of needs is interpreted that if an individual's physiological needs are unsatisfied, he will take action to alleviate this unsatisfied condition because an unsatisfied need introduces tension within the individual which he is trying to avoid and/or reduce (Maslow, 1970). If the need remains unsatisfied for a period of time, the level of tension accumulates within the individual until it reaches some threshold which forces the individual to behave in a manner alleviating the tension. As indicated in Figure 1, behavior can be either passive or aggressive. Passive behavior may take the form of withdrawal from the tension arousing situation and is manifested by such phenomenon as absenteeism, turnover and the like (Vroom, 1964; Fournet, DiStefano and Pryer, 1966, and Lawler, 1970). Aggression is most readily observable as a move outward which attacks the source of tension. Aggressive behavior, such as wild cat strikes, grievances and the like are industrial examples of this type of behavior engaged in by individuals to alleviate tension (Lawler, 1970). But behavior is not necessarily confined to dysfunctional acts. The individual who cannot satisfy his need may engage in constructive search-directed behavior that will attempt to satisfy the need. Empirical evidence suggests that limited deprivation of need satisfaction can lead to improved decision-making processes, greater motivational force, and the like (Kolasa, 1969).

As for the emergence of a new need after the satisfaction of the most prepotent need, this emergence is not sudden but rather gradual, occurring by slow degrees from nothingness to some level of tension. This new need then directs the person's behavior until it has been reduced to a "satisfactory" tension level (Slocum, 1971).

PROBLEM SITUATION

The purpose of this simulation is to represent an individual experiencing needs, being motivated by a need toward a behavior, and having that behavior and an environment influence the level of needs. The fundamental notion to be examined is the variation in the need levels of an individual and the change in his degree of aggressiveness toward a given environment. The flow chart in Figure 1 shows the various components and inter-relations of components included in the model.

To develop a simulation model to explain Maslow's theory, in SIMSCRIPT II, we defined needs as entities with attributes of tension. Each need enters a conscious state at some threshold level. Tensions are held to grow exponentially over time. Tension release can modify the threshold level of the need, thus, providing a feedback effect. Needs are selected for action on the basis of the greatest tension. Each of several possible behaviors has a perceived degree of justifiable aggressiveness. The most aggressive action is merited by the total motivational force. Tensions and threshold level are modified by environmental reactions, which are favorable if the action corresponds to what society sees as justifiable aggressiveness. If an action successfully reduces tension below the threshold, the behavior is reinforced. Thus, an operant conditioning feature is built into the model. The variables studied include the time path of tensions as well as an aggregate measure of the perceived justifiable degree of aggressiveness. These time series are evaluated for equilibrium and degree of variability. The model is programmed in SIMSCRIPT II using entity-set features with a fixed-time increment time flow mechanism (Kiviat et al., 1968).

MODEL DETAILS

Propensity for Action

Each need has an associated tension which, if unfulfilled, increases exponentially over time (Maslow, 1970). The tension of the i^{th} need is modeled as follows:

$$\text{Tension}_i = a_i \exp(b_i t) \qquad (1)$$

where a_i denotes the initial level (at time $t=0$) of Tension_i and b_i denotes the rate of tension increase. The amount of change in tension is computed as the derivative of Eq. (1) times a fixed time increment Δt. The total tension is then a summation of all individual tensions.

Threshold and Sensitivity to Tension

For values of Tension_i less than Threshold_i, the individual may be aware that Tension_i exists but its magnitude is such that the individual ignores it. Upon exceeding Threshold_i, however, the individual experiences such discomfort that he must recognize Tension_i and take action to reduce it. An increase in sensitivity to tension is modeled by lowering the value of Threshold_i. If an individual has been successful in satisfying Need_i then he will be less sensitive to Tension_i in the future. This is represented in the model by raising the value of Threshold_i.

The Fundamental Cycle

The propensity to act on Need_i as a result of Tension_i is given by:

$$P_i = 1.0 - (\text{Threshold}_i/\text{Tension}_i) \qquad (2)$$

Tension_i and Threshold_i are initialized at values of 1.0. As time increases by Δt, successive values of P_i are calculated for successive values of Tension_i. As each Tension_i exceeds its particular Threshold_i, it will be recognized and compared to all tensions that have exceeded their threshold value by examining only the needs with P_i's>0. The need with the largest P_i (the greatest recognized tension) will motivate action. If two or more needs have the same tension, then the most potent need is determined by Maslow's need hierarchy.

As a result of the given action, selected Tension_i's will be positively or negatively changed representing the reaction of the environment to the action. In addition, b_i the rate of change of Tension_i may be changed. Success in eliminating tension will result in an increased tendency to adopt that behavior in the future.

We assume that each action requires a minimum of one time increment (1 hour) to perform. At each increment of time, the values of all P_i's are re-evaluated to determine which need will be responded to next. If no need demands attention, then time continues to be incremented.

If an action requires more than one time increment then the relevant $Need_i$ is removed from the "set" of needs requiring attention until the action is completed. Tension for the removed need decreases at each time increment.

The Determination of Behavior

The individual's motivation to undertake a particular action is related to the amount of tension the individual experiences because of his most potent need (P_i') and his general state of tension (ST). The propensity to act, P_i' of equation (2) is combined with the state of tension (ST) to represent the total motivating force of $Need_i$. The total motivating force, TMF_i, is conceived as the sum of P_i and ST, i.e.,

$$TMF_i = P_i' + ST \qquad (3)$$

where P_i' = current P_i of the selected need

and $ST = \Sigma_i \overline{P}_i$

where $\overline{P}_i$ = time averaged value of past P_i's

For each need there is a unique set of actions from which one action is chosen to satisfy the need. An action is selected using the value of TMF_i (3). Every action has an attribute X_{ij} which symbolizes the individual's perception of the TMF_i required to justify the aggressiveness of the j^{th} action to satisfy the i^{th} need. The X_{ij} values have been assigned so that larger numbers correspond to more aggressive acts. In our example we let the X_{ij} values be 0.1, 0.2, 0.3, 0.5, 0.7, and 0.9 for the six acts of each need. That act will be chosen whose X_{ij} is just larger than the TMF_i value.

In principle, the X_{ij}'s could be determined empirically by asking subjects to rank order a set of specific behavior descriptions. By anchoring weights of extreme behavioral incidents, "perceived justifiable aggressiveness could be operationalized.

The Environmental Reaction

This environment in which the individual is placed provides a matrix of approving and disapproving forces for every action he may take. If society approves a behavior, then tension is more effectively reduced than if society disapproves a behavior. Each behavior can either increase tension or reduce tension depending on the environmental reaction. A behavior has direct impact on the need toward which it is oriented, but it may have side effects on the tensions of other needs. For instance, if a person is exceedingly hungry, he may steal to satisfy his hunger, but in so doing his environment may cause his need for safety and self-esteem to increase.

The j^{th} action has associated with it a set of environmental factors, E_{ij} (one per need) which modify the corresponding $Tension_i$. To represent the environmental reaction, $Tension_i$'s are multiplied by the corresponding E_{ij} of the selected j^{th} action. These E_{ij} factors range in scale from 0.25 to 1.75.

The E_{ij} could be measured, in principle, by a panel of qualified judges who rank the tension-reducing or increasing effect that the environment (both physical and social) would exert in response to a set of specified behaviors. Again, these effects could be rank ordered and related to a set of anchored critical incidents to obtain estimates of the E_{ij}'s for a given set of actions.

The environmental reaction is defined as being critical, non-critical, or neutral. If the environment is critical, then it will change tension values by a larger amount than if it were non-critical. Hence, there are five possible reactions:

1. Critical Reduction
2. Non-critical Reduction
3. Neutral
4. Critical Increase
5. Non-critical Increase

For the purpose of this simulation, a given action will provoke either all critical reactions or all non-critical reactions. This implies the environment will react consistently to any given action. Table 1 shows the values assigned to each environmental reaction.

REINFORCEMENT OF BEHAVIOR

In each time cycle the P_i are first computed. Next a "revised" $Threshold_i$ is calculated. For the need selected for action, tension may be reduced below the revised $Threshold_i$. If this is the case, the $Threshold_i$ is increased to reflect reduced sensitivity to this tension in the future. If $Tension_i$ remains above the $Threshold_i$, then the $Threshold_i$ is carried into the next time cycle unmodified. For the needs not selected for action, the "revised" threshold is also carried forward into the next time cycle hence the $Threshold_i$'s of these needs are being lowered thus reflecting to tension in the future.

For the need singled out for action, the behavior may be successful in reducing $Tension_i$ below $Threshold_i$ as noted above. If this occurs then the appropriate X_{ij} is reduced by .001, so that less total motivational force TMF_i will be necessary to select a behavior of similar aggressiveness in the future.

PROBLEM STATEMENT

One of the important dependent variables of this model is BI_i the value of the behavioral index for $Need_i$. For each need, the BI_i value is equal to the average value of X_{ij}'s of those actions which can be selected to satisfy $Need_i$.

For the purpose of this paper, questions regarding the following cause and effect relationships will be posed:

1. Given initial values for the propensities to act, P_i's, behavior index, BI_i's, and state of tension, ST, what is the effect of varying patterns of environmental responsiveness on the propensities to act (P_i's)?
2. Given the same initial conditions, what is the effect on the behavior aggressiveness index, BI_i, for varying patterns of environmental responsiveness?
3. Given the same initial conditions, what is the effect on the state of tension, ST, for varying patterns of environmental responsiveness?

For each pattern of environmental responsiveness a time series of values was generated for P_i, ST, and BI_i. A tabular comparison was made showing the differences in the time series as a result of the four different environments.

EXPERIMENTAL DESIGN AND RESULTS OF VERIFICATION

The environmental "patterns" take on four levels. Each level depicts two values the EW's one for increasing tensions and a second for decreasing tensions. Table 2 gives these values with the starting values for the propensities to act, behavior index (dispositions for aggressiveness), and state of tension, ST.

The environments have been chosen to be either critical both in reducing and increasing tension or non-critical both in reducing and increasing tension. The initial values for the propensity to act are determined from tension values equal to the threshold values. The initial behavior index is defined as the average of initial X_{ij}'s (justifiable aggressiveness) equal to 0.1, 0.2, 0.3, 0.5, 0.7, 0.9 for each need.

Table 3 depicts the results of our experimental runs. For those environments tested, the values of all $Tension_i$'s became very large. Corresponding to this increase, there is also an increase in the state of tension. As the propensity to act and the state of tension increase, the behavior index tends to decrease, indicating that the disposition for aggressiveness increases directly with tension accumulation, as expected.

The results indicate that further experiments will have to be run to determine if any environmental factors exist which will permit a stabilization of tension. It is quite possible that the exponential function of time is not appropriate for this type of simulation and that such a function prevents stability after long periods of time. This is suspected because for large values of time, the growth of tension becomes very rapid.

CONCLUSIONS AND RECOMMENDATIONS

The basic model provides results that are consistent with the fundamental expectations of the simulation. The behavior index decreases for increasing values of tension. The point in time at which the $Tension_i$'s become unstable is prolonged for an environment which causes a larger reduction in tension. Also the increase in the state of tension for all experiments depicts lack of success in satisfying needs, not an uncommon situation.

Our present results indicate that the model becomes unstable with time. It is felt that the function for tension growth requires modification in this simulation. It is suggested that the exponential function of time is not appropriate or that the value of the exponent in Equation 1, should be modified. It is recommended that such an investigation be conducted to determine a time function which does provide stability.

A great deal of benefit of simulation results from the modeling process itself, rather than solely from numeric results of the simulation. We made several assumptions in the course of our modeling process to provide necessary constructs for integrating the concept of motivation, learning, and socialization theory. We now recommend investigation of the following assumptions by psychological and behavioral research to evaluate the merit of our model's structure: the existence of a tension threshold; the notion of a changeable "threshold"; effects of successful action on perceived justifiable aggressiveness;

the summative effect of individual tensions upon motivation; and the exponential rate of growth of tension resulting from need deprivation. While the model is admittedly embryonic in its state of development, we feel the exercise has been worthwhile for the benefits of conceptual integration that it has stimulated.

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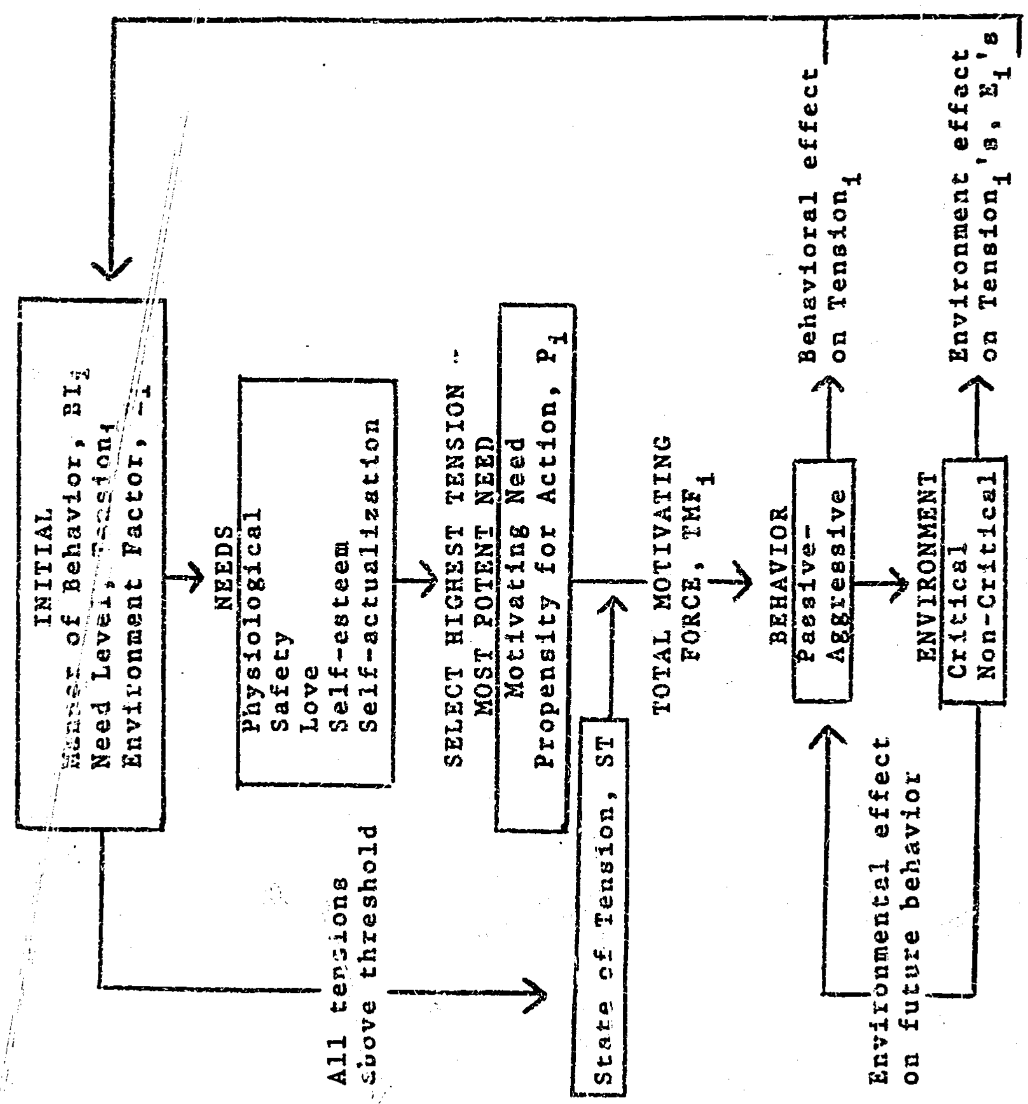

Figure 1
Flow Chart of Model

	Value of Tension Reducing Factors	Value of Tension Increasing Factors
Critical Environment	0.25	1.75
Non-critical Environment	0.75	1.25
Neutral	1.00	1.00

Table 1 - Environmental Factors, E_i

	EXPERIMENTS			
Initial Values	1	2	3	4
Propensity to act for all needs	0.0	0.0	0.0	0.0
Behavior index for all needs	0.45	0.45	0.45	0.45
State of Tension	0.0	0.0	0.0	0.0
Environment factors (average E_i's)	Non-critical	Critical	Non-critical	Critical
Increasing	1.0	1.0	1.25	1.75
Decreasing	0.75	0.25	0.75	0.25

Table 2 - Experiments for Simulation

Table 3
Effect of Environmental Reaction
on Simulation Time Series

Environmental Effect on Increasing Tension	Reducing Tension											
	Critical Environment						Non-Critical Environment					
	Neutral			Critical			Neutral			Non-Critical		
Simulated Time (Hrs.)	P_i*	ST*	BI*	P_i	ST	BI	P_i	ST	BI	P_i	ST	BI
300	0**	0	.48	.001	0	.50	0	0	.45	.005	0	.50
400	0	0	.46	.003	0	.48	0	0	.40	.006	0	.42
500	0	0	.47	.005	0	.42	.002	0	.40	.015	.002	.35
600	.006	0	.40	.010	0	.40	.100	0	.39	.090	.005	.32
700	.018	0	.39	.020	.002	.39	.250	.005	.37	1.00	.050	.30
800	.060	.005	.32	.110	.005	.33	.800	.040	.33	***		
900	.500	.020	.30	1.00	.020	.33	.900	.100	.31			
1000	1.00	.100	.27	***			1.00	.200	.28			
1100	1.00	.180	.21				1.00	.250	.28			
1200	1.00	.200	.20				1.00	.270	.30			

*The following explains the series symbols:

P_i = Propensity to Act

ST = State of Tension

BI = Behavior Index

(all have the range 0 to 1)

** All entries with "0" indicate values are less than .001.

*** All entries left blank are due to termination of the simulation at these points.