MoCog1: A Computer Simulation of Recognition-Primed Human Decision Making, Considering Emotions

WILLIAM B. GEVARTER
AI RESEARCH BRANCH, MAIL STOP 269-2
NASA AMES RESEARCH CENTER
MOFFETT FIELD, CA 94025, USA

(NASA-TM-107859) MoCog1: A COMPUTER SIMULATION OF RECOGNITION-PRIMED HUMAN DECISION MAKING, CONSIDERING EMOTIONS (NASA) 51 p

N92-28758

Unclas

G3/61 0091487

NASA Ames Research Center

Artificial Intelligence Research Branch

Technical Report FIA-92-13

April, 1992

MoCog1: A COMPUTER SIMULATION OF RECOGNITION-PRIMED HUMAN DECISION MAKING, CONSIDERING EMOTIONS

William B. Gevarter

Abstract--This paper reports the successful results of the first stage of a research effort to develop a versatile computer model of motivated human cognitive behavior. Most human decision making appears to be an experience-based, relatively straightforward, largely automatic, response to situations, utilizing cues and opportunities perceived from the current environment. The development, considering emotions, of the architecture and computer program associated with such "recognition-primed" decision-making is described. The resultant computer program (MoCog1) was successfully utilized as a vehicle to simulate earlier findings that relate how an individual's implicit theories orient the individual toward particular goals, with resultant cognitions, affects and behavior in response to their environment.

I. INTRODUCTION

Society's need to understand, predict, plan for, design for, and respond to human behavior is widely accepted. NASA, in its lead role in manned space activities (and associated ground operations), and its role in research for manned aircraft operations, has a similar need. Further, the approaching era of manned space stations and space exploration carries with it the promise of advanced automation featuring intelligent computer programs and machines. If such systems are to achieve a truly symbiotic relation with humans, Polson [30] and Connors [9] indicate that these systems will require sophisticated modeling of their human partners. They state that such models must incorporate information processing models of the task and the user. Issues include operator attention and vigilance, safe transition from automatic to manual modes of operation, and allocation of functions between man and machine that exploit the complementary strengths of human and machine, permitting one to compensate for the weaknesses of the other. (One of the human weaknesses listed by Polson [30, p. 190] is emotional and motivational problems). The need for sophisticated human-modeling can be expected to become even more important as manned long-range space missions are considered with their potential for associated psychological problems (cf. [19]).

To help support these needs, a computer model that adequately simulates (and aids in explaining) human behavior during activities associated with NASA's missions would be a valuable asset. However, no model adequately simulating internal motivations as well as external behavior has been found. Therefore, we have begun the process of constructing such a simulation. As this is a formable task, considering our current level of knowledge, we have chosen to proceed incrementally. This paper describes MoCog1, a successful computer simulation associated with the first stage of our research effort. However, before discussing MoCog1, we will briefly review some relevant aspects of human decision making and the role of emotions.

II. HUMAN BEHAVIOR

A. Decision Making

Based on the work of Buck, Lazarus, McClelland and Mueller [6, 22, 23, and 24], human decision making and action can be viewed as a response to an individual's activated goals. The importance to the individual of these goals is reflected in their accompanying emotions. Which goal is salient is determined by the associated emotional level. Goal salience shifts as an encounter unfolds. Based on the individual's coping potential, there is an associated action potential. Success or failure in achieving these activated goals is accompanied by a response emotion of related strength. Success of a goal does not automatically lead to an action, but the resulting positive emotion could potentiate other decisions. Failure of a goal and its resulting negative emotion can engender recovery goals.

Decision making is a result, not only of the goal being pursued, but of the knowledge, resources and perception that is made salient. The knowledge that is made salient is a function of the activated schemas and episodes in long term memory. Schema activations tend to decay with time.

Schema activation is facilitated by [31, pp. 52, 99]:

1. Emotions that tap into past experiences having the same emotions,

2. Perceived external cues.

3. Focussed attention that results in schema calling (accessing) conditions.

4. Spillover to other schemas from activated schemas having shared features.

5. Remaining activations in schemas recently activated.

6. Schemas that have frequently been used, so their their activation threshold is very low.

Attention is very much a function of the schema activations that have sufficient intensity so that they reach the individual's (limited capacity) conscious working memory. Activated emotions tend to focus attention on some concerns and in the process distract attention from other concerns that are not so pressing [22, p. 17].

B. Emotions

Based on the work of Baron, Buck and Lazarus [3, 6, and 22], we conclude that emotions are an individual's reactions to his/her appraisal of how one is doing in one's lifelong effort to survive and flourish. Emotions depend on appraisal and the resulting coping process. Emotion influences cognition and cognition influences emotion. Emotions bias all decisions. Emotions not only provide an indication of the personal importance of an event, but the associated subjective experience provides a feedback for self-regulation, and the external expressive behavior serves as a basis for social coordination.

Primary appraisal of a situation addresses whether and how an encounter is relevant to a person's well-being . Lazarus [22, p. 39] lists the primary appraisal components as:

- o goal relevance
- o goal congruency or incongruency
- o type of ego-involvement.

Secondary appraisal is an evaluation of a person's options and resources for coping with the situation and future prospects. The secondary appraisal components are:

- o blame or credit
- o coping potential
- o future expectations.

There are two kinds of appraisal processes -- one that operates automatically without awareness or volitional control, and another that is conscious, deliberate, and volitional [22, p. 169]. "Appraisal does not imply rationality, deliberateness, or consciousness" [22, p. 152].

Lazarus [22, p. 108] reports that emotion can often be generated by the mere memory of a prior emotional state or occasion. The feature of a current transaction that could have been " . . . responsible for the memory could be the emotional response pattern, the psychological situation and personal meanings that have generated the emotion, which are similar in some sense to what happened in the earlier encounter. . ."

C. Motivations

Drawing on the work of Buck, Lazarus, and McClelland [6, 22, and 23] we conclude that it is a person's pattern of motivation that gives encounters their valence and power to provoke emotion. Individuals have different goals, such as different levels of of needs for achievement, affiliation, and power, and a desire to maintain a certain kind of ego identity. It is one's motives that make one active in pursuing a goal, sensitive to cues relating to a goal, and quick to learn what is necessary to reach a goal.

In addition to inborn primes (basic motives) [6], implicit motives (which can not readily be verbally elicited from an individual) are acquired early in life on the basis of important nonverbal affective experiences. Self-attributed (explicit) motives, which can verbally be reported by individuals, are acquired later in life from social, linguistically conceptualized experiences.

McClelland's (cf. [23]) work on implicit motivation has focussed on the needs for achievement, power, and affiliation, and their associated emotional and cognitive aspects. Weinberger and McClelland [36] contrast McClelland's traditional implicit motivation "needs" approach, which is predictive of long term behavior, with that of the explicit cognitive-based "self-schemas" which provide characterizations of individuals which result in more situation-oriented behavior.

In regard to explicit motives, Lazarus concludes that the most important personality variables affecting emotion are motives and beliefs about self and the world that have been acquired in the course of living [22, p. 87]. Lazarus [22, p. 150] reports that these explicit motives (associated with ego-involvement) refer to diverse aspects of ego-identity, such as:

self- and social-esteem
moral values
ego-ideals
meanings and ideas
other persons and their well-being and
life goals.

D. Coping

Lazarus [22] observes that coping consists of cognitive and behavioral efforts to manage specific external or internal demands (and conflicts between them) that the individual appraises as taxing or exceeding the individual's resources. It is a response to the specific goals being threatened.

Coping strategies can be problem-focussed or emotion-focussed. Coping flows from emotion and follows an initial appraisal of such factors as harm, threat, or challenge. It can modify the subsequent appraisal, thereby changing or even short-circuiting the emotional reaction.

Problem-focussed coping changes the relationship, and hence the emotion, by actively doing something to either the environment or the person. Emotion-focussed coping changes the relationship by attention deployment, as in avoidance, or by altering the personal meaning on which the emotion is predicated [22, p. 125].

III. APPROACH

A computer model that adequately simulates human cognition and behavior depending upon environmental factors, the individual, and the individual's goals would be very desirable for many purposes. However, we have not yet found such a model. Izard [18], and others, suggest that emotions are primary in human behavior. However, Eysenck and Keane [12, p. 496] report that most Cognitive Psychologists have not considered emotional factors. Nevertheless, there have been attempts at modeling cognition, usually focussing on abstract thinking, and largely ignoring the influence of emotions. An early effort was ACT* by Anderson [2] which had a declarative memory in the form of a semantic net. ACT* focussed on the memory and processing structures that form the basis of human task performances. A more recent effort to develop a unified theory of cognition is SOAR [25] that focuses on universal subgoaling for cognition, and "chunking" for learning. Another approach [10], not yet developed into a working computer program, has taken the neural net operation of the brain as a basis for developing a general theory of human behavior.

We begin our effort toward developing the needed model by defining "motivated cognition" as the process that emphasizes the role of affects in human cognition and decision making. Unfortunately,there appears to be no universal definition of affects. For example, Baron [3, p. 454] states that, "An affect is any mental state that biases a behavior," while Lazarus [22, p. 57] observes that, "... it is fashionable to speak of affect ... to refer to the subjective quality of an emotional experience." Though the terms affects and emotions are often used interchangeably, we will try to use the terms so that their meanings are clear from the context. In general, we will follow the lead of Buck [6] and define affects as the motivational system underlying emotion. In Buck's framework, emotions are interpreted as the readout process -- self-awareness and outward expression -- carrying information about motivation.

Affects appear to be a major contributor to the distinctly different way in which human decision making is done relative to the more rational approaches generally considered in artificial intelligence. To date there has been a dearth of computer programs emphasizing the role of affects, though Colby [8], Thagard and Kunda [35], Woods, et al. [38], O'Rorke, et al. [26], and Sanders [33] have all made contributions in this direction. DAYDREAMER [24] is the most sophisticated such program thus far developed, and Pfeifer [29] recently reviewed artificial intelligence computer models of emotion.

Reason [31] indicates that human decision making, in response to a task, can be viewed as consisting of three levels -- Skill-based (procedural), Rule-based (or analogical), and Knowledge-based (conscious abstract decision making).

Most human decision making appears to be of the experience-based, relatively straight-forward, largely automatic, type of response to internal goals and drives, given cues, situations, and opportunities perceived from the current environment. This automatic, basically non-analytic, decision making in response to environmental factors is very common in humans, particularly when they are under stress. Such decision making has been referred to by Klein [20] as "recognition-primed decisions," while Jacoby and Kelley [17] see such behavior as episode-guided, and we can also relate this form of behavior to Reason's [31] Rule-based behavior. In this paper we will, for the sake of simplicity, group this general form of decision making under the name "recognition-primed."

Recognition-primed decision making is not only common in everyday life, it is also the type of decision making that separates experts from novices. Whereas experts are often able to automatically find a solution based on past experience, novices usually must laboriously think through a situation to reach an answer. Thus, Klein [20] found, that for experts working under time constraints, problem recognition and resultant goal selection was largely automatic (with occasional deeper sequential evaluation of automatically-recalled procedures taking place until a "satisficing" solution was found). One can expect similar behavior among experienced pilots, astronauts, and ground controllers responding to stressful time-constrained situations. {This type of behavior is in contrast to those incidents of human decision making in which planning -- associated with Reason's Knowledge-based level -- is a central ingredient (cf. [5]).}

Jacoby and Kelley [17, pp. 454, 456] also report findings supportive of situation-primed decision making, arguing that, "When the current situation is very similar to a past situation, it effectively functions as a retrieval cue for the past situation. However, retrieval of the past situation need not be experienced as conscious remembering. Instead, the past experience can unconsciously guide responses to the current situation. . . . The difference between a schema and the episodic view is the level of abstraction of the memory representation that is said to guide behavior." An episodic view refers to a specific single past experience. A schema refers to a generalization of such experiences.

Though, it is not necessary to emphasize it for recognition-primed decisions, the ultimate decision-maker in humans (cf. [14]) is the structure provided by the combination of innate motivations and those programmed into the human unconscious during the human growth and maturation process. Associated with these motivations are emotional charges which tend to direct our thoughts and behaviors. Mueller's [24] computer program, DAYDREAMER, is a good initial approach to an artificial intelligence program that simulates the resultant response. The focus of his program is emotionally-based control of the human "train of thought." Processes of this type -- which control how the mind recalls associated information and moves its focus of attention about as it attends to the current situation -- are central to our follow-on report and its accompanying simulation (MoCog2). MoCog2 is being designed to handle much more complex thought and decision processes than the relatively automatic, single-pass, recognition-primed decision making described in this current paper.

Pursuant to the long term goal of developing a sophisticated model of humans, the aim of our initial research has been to develop a computer model of human decision making that focuses on the impact of affects. Following our incremental approach, we have first devised a simulation of recognition-primed decision making, considering the role of emotions. We then tested this simulation against Dweck and Leggett's [11] real psychological data to see if this paradigm was adequate to describe the reported behavior.

Our longer term plan is to couple the human decision making approach from the perspective of information processing in the human brain (cf. [3], [15], [28], and [10]), with a synthesis of current psychological theories in motivated cognition (cf. [21], [1], [6], [11], [16], [22], [23], and [21]), the long and short term memory conceptualizations of Reason [31], and the emotional control of attention work of Mueller [24].

It is important to note that at this stage of our knowledge, much of what is discussed in this paper should be treated as hypothetical rather than as fact. However, if based on these hypotheses our resultant computer models show adequate predictability and explanatory capability when applied to existing studies and future experiments, then our purposes will have been served.

IV. DERIVING A MODEL FROM BRAIN RESEARCH

Affects are the motivational systems most commonly associated with emotions. From emotions, arise subjective experience and expressive behavior (and autonomic physiological response). Humans appear to be born with (or with the potential for) basic affect characteristics. Basic affects are associated with the lower levels of brain development, particularly with that of the limbic system.

Based on Baron [3], Buck [6] and McClelland [23], Fig. 1 is a simplified flow diagram of what might be considered basic inborn human responses to internal body and brain states. "Primary emotions are those that emerge at birth or at least within the first year of life. They express the most important adaptational tasks of animals such as protection from danger, reproduction, orientation, and exploration" [22, p. 79].

Derived from the work of Buck [6], Baron [3], and others, Fig. 2 illustrates our view of some of the affects encountered as one moves from the lower levels to the higher levels of the brain, though several of these affects are not available until later in the maturation process.

Based on the preceding, and on Baron's [3] treatise, we have augmented the elementary flow diagram of Fig. 1 for motivated behavior to include the higher levels of the brain, as indicated in Fig. 3. Fig. 3 depicts the basic sequential information processing flow between various portions of the brain (detailed in Baron's treatise) having different functions, timing, and other characteristics. One way of viewing Fig. 3 is as a linked structure of brain memory and processsing components appropriate for studying sequential eposodic and schema activations, considering emotions, in response to internal or external stimuli. The structure includes a function by which the brain attempts to produce a favorable output affect vector by automatic unconscious selection from available coping strategies. The affect patterns referred to in the diagram can be considered to be vectors of affects indicating their degree of activation.

An individual responds to the world based not only on the current event but also on the individual's internal physiological and mental states. Thus, both of the lower two paths shown in Fig. 3 provide inputs to the brain's decision making mechanism. But before elaborating on these paths and the resultant decision making, let us briefly review some of the fundamental aspects of brain functioning on which our approach is based (cf. [3], and [15]).

Baron [3] and others suggest that the brain stores all experiences to which the individual pays conscious attention. In addition, Restak [32, p. 264] concludes that "First, information can be incorporated into the mind without access to conscious awareness. Secondly, conscious intention cannot modify certain aspects of cognition." Restak also observes (p. 243) that " . . . such memories are 'stored,' but in most instances they cannot consciously be voluntarily recollected."

In the brain, stored along with each experience are the affects that were present at the initiation of the experience and those that resulted from the experience. The affect patterns thus associated with the pre-conditions and post-conditions of the experience are accessible during future interactions. Thus, when an event is perceived it is automatically compared with the store of past events and depending upon similarity conditions [3, p. 57], the associated affect patterns are activated. Thus, the brain automatically renders a judgment on the degree to which this event is "for me or against me." (This pattern is consistent with Jacoby and Kelley's [17] episode guided control of behavior, but contrasts with the consciously-oriented cognitive appraisal emotion taxonomy of Ortony et al. [27]).

With this view, we can now follow the lower path in Fig. 3. Attributes of an event are observed by the sensory system, and the resulting sensory signals are compared with stored visual, auditory and other sense experiences. These then elicit past situations and associated affect patterns which had similar patterns of sensory signals. This results in the current situation being perceived in terms of similar past situations and their associated affect patterns. The resulting inputs to the stored events yield a perceived event. The perceived event and its associated affect pattern may then activate associated ideas, concepts, and their stored affect patterns. These serve as a prediction of the consequence of the current event and its resultant affect pattern.

Following the middle path of Fig. 3, receptors sense the body's internal physiological state and the individual's current mental state, thereby activating the associated affect centers. This activation is combined with the activation induced by the affect patterns from the perceptions associated with the bottom path. The combined result is a current emotional state, or affect pattern (indicated in the top path of the figure).

We view an emotional "need" as the difference between this current (or predicted) affect state and the optimal affect state (defined in a manner similar to that used by Baron, [3, pp. 468-470]). Emotional "goals" can be viewed as the things that if achieved will satisfy emotional needs. "Procedures" are actions or strategies to achieve such goals.

The current affect state and the expected affect states resulting from the current event act as inputs to the brain's control mechanism, which generates needs and goals to move the anticipated resultant affect state to a more desirable condition. These needs and the current context elicit applicable stored procedures. (This is in keeping with Sharkey and Bower's [34] findings indicating that goals and plans are stored in memory as associative structures.) The predicted results and affiliated affect patterns (associated with the various applicable procedures) are then fed to the decision making mechanism. This mechanism then seeks to select procedures that would produce the most desirable overall satisfaction of the generated emotional needs, considering the weights or priorities given each affect and their current degree of activation.

V. SIMPLIFICATIONS USED IN DEVELOPING MOCOG1

To develop MoCog1, the simulation of recognition-primed human decision making (our initial computer program), several simplifications were made.

1. Because data on the day-to-day variations in the internal affect state indicated by the middle path of Fig. 3 are often not available, this path has not been simulated. Instead it has been approximated by assigning initial values to the individual's relatively stable base (normal) affects such as self-image, happiness, and self esteem.

2. Each of the affect levels are taken to range linearly from -9 to 9 (from very negative to very positive) or from -9 to 0 or 0 to 9, as appropriate.

3. As a first approximation, the value of the total affect state has simply been taken as the sum of the individual affect states.

4. Affects have not been prioritized.

5. Because of the lack of actual data, the vectors of incremental affect values that procedures can be expected to produce are chosen subjectively.

6. In addition to the task preconditions, only the salient needs (those above a critical level) are considered necessary to access applicable procedures.

With these simplifications, Fig. 3 reduces to Fig. 4 for simulating an individual's response to a task.

VI. A RELEVANT PSYCHOLOGICAL STUDY

As a test of the validity of recognition-primed decision making and MoCog1, it was necessary to find a psychological study, of human responses to a task, that includes the necessary attributes. Such a study should include a characterization of the task and the individuals, and a report of their responses, behavior and emotions. As sufficiently detailed such studies appear hard to find, the published psychological study by Dweck and Leggett [11] of upper-level grade school children responding to academic tests, was chosen as appearing to have the required ingredients. We have used their work as a first test of our framework.

A significant computer program mirroring human behavior must be able to simulate real psychological experiments and observations. However, if an individual's response is based not only on the stimuli, but also on the individual's inherent nature and life experiences, then programming an individual's response means that these, or some attribute set or schema that meaningfully summarizes them for the current situation being simulated, have to be entered into the program. One approach has been to try to characterize people by personality types with attributes such as introvert and extrovert. Dweck and Leggett [11] have instead tried to build a system based on the individual's world view.

Dweck and Leggett suggest that one's behavior is very much influenced by how one views the world (a result of the world's responses to one's past behavior). In particular, they focus on two views: (1) things in the world being malleable and therefore subject to control and change, and (2) things being relatively fixed and therefore relatively uncontrollable. If we categorize something important to us as being uncontrollable, then our relationship to it is to monitor, measure, or judge its attributes. Whereas, if we view something important to us as controllable, then our response tends to be to act on or develop it -- to understand and improve it. Table 1 indicates the cognitions, behaviors, and affects associated with these two views.

Dweck and Leggett observe that behavior is situation-dependent and is aimed at maximizing the composite positive affect (or minimizing the negative affect) resulting from trying to balance the multiple goals in response to the demands of the situation. This is consistent with Fig. 3 where the approach is to optimize a complex affect pattern.

Dweck and Leggett imply that their theory is applicable to many domains, such as intelligence, social, moral, physical skills and even physical attractiveness. Their theory is supported by observations of upper-level grade-school children called upon to do intellectual tasks. Stemming from the child's view of the world as either being fixed or malleable, the child either has a performance orientation or goal (i.e., to be judged) or a learning orientation or goal. Table 2 indicates this relationship. Based on Dweck and Leggett's report, Table 3 is our depiction of the relationships between (1) the students' general goal, their intelligence, and the task difficulty, and (2) the resultant observed students' behaviors (strategies), and reports by the students of their affects and cognitions. (Dweck and Leggett's findings of observed behavior tend to be in line with the coping strategies reported by Folkman, et al. [13] for adult subjects.) Observe that the observations of Dweck and Leggett cover virtually the entire spectrum of emotions and coping strategies thus far discussed in this paper.

The parameters associated with Dweck and Leggett's characterization of students and tests in a testing situation are (1) general goal (performance, learning); (2) intelligence (high, low); and (3) test difficulty (high, low, very high -- that is beyond the capabilities of any student).

Because Dweck and Leggett's report was an English language description, it was necessary to make many assumptions to transform their non-numerical data into a computer program. As an initial characterization of the student, the student's normal (base level) affect attributes of self-image, happiness and self-esteem were subjectively assigned on a scale of -9 to 9 to vary from

self-image = 7
happiness = 7
self-esteem = 6

for a high intelligence learning-oriented individual to

self-image = 3
happiness = 3
self-esteem = 2

for a low intelligence performance-oriented individual.

Self-image is defined as "the self as the individual pictures or imagines it to be. The self-image may differ widely from the true self," [7, p. 478]. "Self-esteem is a positive attitude towards oneself and one's behavior. Quite often it is a lasting personal disposition, but the self evaluation may shift depending on one's environment," [37, p. 309].

VII. THE COMPUTER PROGRAM

MoCog1, the computer program we devised to simulate Dweck and Leggett's student responses to intellectual tasks, consists primarily of heuristic PROLOG rules to calculate responses from input data at each input-output module shown in the flow diagram in Fig. 4. {As an alternative, more consistent with the nature of the brain and as a more universal generalization, the modules can be programmed as neural nets or connectionist networks (cf. [4]) rather than by the use of rules. However, little is likely to be gained at this stage through programming in neural nets because the limited psychological data we have been able to find has tended to be suggestive of the rule-based form.}

A. Task Difficulty

Task difficulty was calculated as the students' perceptual responses to attributes of the tests based on the students' past experiences. Thus task difficulty of the various tests was calculated as a function of the subject, number of pages, and test duration.

B. Task Low-level Affect Consequences

The primary low-level task affects of anxiety, pleasure, and boredom associated with perceived task difficulty were subjectively chosen as a function of the perceived task difficulty, the student's intelligence, and the student's general goal (of performance or learning).

C. Mid-level Anticipated Success or Failure Response

The predicted mid-level cognitive response for the performance-oriented students was chosen as success for students whose ability (intelligence) was equal to or greater than that required by the test, and as failure for those students whose capabilities were inadequate for the test. All the learning-oriented students anticipated success.

D. Mid-level Affect Response

The mid-level affect response (of pride, shame, and self-image increment) to the anticipated event outcome was computed as a function of the low-level affects, the student's general goal of learning or performance, the student's intelligence, and the student's perceived task difficulty.

E. Predicted Outcome

The predicted outcome for all the students with a general goal of learning was taken as "learned." The performance-oriented students' predicted outcome was "judged positively" for those who anticipated success, and "judged negatively" for those who anticipated failure.

F. Predicted Outcome Affects

The high level affect response -- of happiness and self esteem increments -- associated with the students' view of the anticipated outcome was subjectively chosen as (1) high level affect increments of +1 each if the anticipated outcome was learned or judged positively; or (2) happiness reduced by 3, and self esteem by 1, if the outcome was judged negatively.

G. Needs

The overall affect pattern was simply the vector constructed by appending the base and low and mid level affects to the high level affects. The need list was constructed by subtracting the resultant affect vector from the ideal affect vector. Relevant needs were then taken to be all elements of the need list that exceeded a value of 3 (which appeared to be a good dividing point based upon the simulation results).

H. Procedures

Procedures are the learned techniques accessible to the students to contend with their current situation (considering their needs and the context). The procedure chosen for execution is the procedure that maximizes the resultant affect total.

VIII. RESULTS OBTAINED USING MOCOG1 WITH DWECK AND LEGGETT'S DATA

Fig. 5 is a printout of a trace of an interaction between a computer user and the MoCog1 program as applied to the data of Dweck and Leggett [11]. Following step by step through this interaction will help illuminate our simulation.

Based on the Dweck and Leggett data and the present model, Jan (considered in Fig. 5) is a construct of the high intelligence, learning-oriented type of individual. Fig. 6 is a projection onto Fig. 4 of the computer simulation of Jan's response to a difficult test. Based on the test's attributes of subject, length, etc., Jan perceives the example mathematics test as being of high difficulty. Associated with this difficulty, Jan's previous experiences cause Jan to experience some anxiety, but also the pleasure of impending challenge. At the next level, experience with this degree of difficulty, causes Jan to anticipate a successful outcome, resulting in an associated mid-level affect pattern of pride and bolstered self-image. Based on feelings (and automatic perceptions) associated with the event, Jan views the test as a likely successful learning experience, and experiences a feeling of increased happiness and self-esteem. The relatively diminutive level of needs resulting from Jan's composite affect pattern facilitates access to Jan's rational capabilities (procedures). Thus, high persistence and self-mastery are open to Jan, and the automatic choice of maximum need satisfaction results in Jan exhibiting self-mastery. The associated affect total (shown on the Fig. 6 simulation flow diagram) is the result of assuming that the affect effects of a procedure can be simply vectorially added to the existing overall affect structure and then totaled by linearly adding up the resultant components.

Rob (Fig. 7) is a construct of the low intelligence, performance-oriented individual. Based on the history test's attributes, Rob perceives it as being difficult. As shown in Figs. 7 and 8, Rob's experience with difficult tests results in a low-level affect response of anxiety, negative pleasure, and boredom with another frustrating task. Sensing the task difficulty results in a mid-level response of expected failure with associated shame and decreased self image. Based on the feelings and insights resulting from the event, Rob's view of the outcome is that Rob will again be judged negatively with resultant loss of happiness and self-esteem. Rob's high level of needs opens up a whole range of defensive response strategies that can be used to reduce the stress. Self-aggrandizement, with its associated rebuilding of self-image and self-esteem, appears to be the most optimal. This is consistent with Dweck and Leggett's data that show that some two thirds of the performance-oriented students engaged in self-aggrandizement or diversionary behavior. [Note: Rob's response to a test of very high difficulty (not shown) results in such an emotional upset that, in our simulation, Rob has access to only one procedure -- ineffective strategies.]

Table 4 lists the author's subjective assumptions of the effects on need reduction of the procedures utilized in the computer runs for these two examples. Comparable procedure effects have been employed for the other computer runs, which cover the full range of categories covered by Dweck and Leggett's results. It should be noted that the influence on affects of applying various procedures can be expected to be somewhat student specific, which coupled with the students' idiosyncratic backgrounds and the day-to-day variations in students' affect levels, would help to account for the various procedural choices observed in Dweck and Leggett's study for the same situations.

IX. DISCUSSION

To obtain a computer simulation of human responses to situations it is evident that it is necessary to:

1. Characterize the individual using such attributes as intelligence, personality, views, belief systems. Unfortunately, Lazarus [22, p. 6] observes, "Personality is seldom explored as a complex, integrated system. . . . Instead, research in personality tends to be about one or a few traits with little or no attention paid to how they are organized in an individual." Methods for characterizing an individual, other than the Dweck and Leggett's approach used in our simulation, include Jung's Personality Typology with associated responsive strategies and the Woods et al. [38] typology of problem solvers. However focussing on aspects of the ego-identity structure reported by Lazarus [22, pp. 87, 150], quoted earlier, appears most promising.

2. Develop transformations based on the individual's characterization, that take the sensory input and develop perceptions of situations, events and concepts, and their associated affect patterns.

3. Provide procedures or strategies (and their affect consequences) that the individual is likely to be able to access via needs (associated with the composite affect state) and the context.

For simulating Dweck and Leggett's theory, we were guided by their observations in choosing such things as applicable procedures, and used our simulations to highlight how affects select from among the reachable procedures. Obviously more work is needed to succinctly characterize individuals and their available procedures as a function of generic contexts.

In the process of constructing this simulation, the central finding was that with relatively straightforward assumptions, it is possible to represent and manipulate affect structures and resultant behavior to provide a plausible simulation of affective behavior associated with recognition-primed human decision making. To develop a computer program for the Dweck and Leggett example, given the lack of numerical data, a great many assumptions had to be made. These subjective assumptions were chosen to be as consistent as possible with likely numerical data, had they been available. The basic agreement with Dweck and Leggett's findings of this computer simulation (see observed behaviors indicated by asterisks in Table 3) obtained by the simple subjective assignment of attributes (with virtually no tuning) to the various individual types, is an indication that our normal views of individual characteristics may be in good agreement with reality for studies of this type. It also suggests that relatively simple computer programs may provide adequate simulations of many studies. An interactive version of our simulation, providing examples that cover the full range of categories in Dweck and Leggett's findings, has been packaged on a DOS diskette and is available for study.

Simulations, such as MoCog1 (and the more advanced simulations to follow), can act as structures to help organize various psychological theories, as well as multiple verbally-reported observations from different studies, into a consistent natural framework in which an individual's theories, affects and behavior are integrated into an orderly and logical flow. The relationships between variables in such simulations can be expressed in any degree of rule-based, mathematical, or connectionist specificity, allowing one to study human behavior in an explicit manner.

In MoCog1, we have run the gamut from implicit motivations (and associated emotions) common to all animals species, to explicit motivations involved with ego (mediated by language, and with associated higher order affects) only found in humans (see [36]).

The numerous assumptions that we made to construct our computer simulation, provide a good indication of some of the research required. First, it would be helpful to get a better representation of the affect structure (perhaps pursuing the taxonomy suggested by Ortony, et al. [27], and observing how it ties in with the work of Buck [6] and Lazarus [22]). This should include which affects play a major role in cognition and behavior, their relative priority, and how they should be combined in obtaining an overall indication of need level. Further, though in our simulation the chosen range (from -9 to 9, negative to positive) of each affect was considered to be linear with limit cutoffs, it is more likely that these ranges are nonlinear, perhaps approximating a sigmoid shape similar to that employed by Colby [8]. Thus, in generating the overall total need level or the effects of procedures, it would be desirable to find appropriate nonlinear weighting functions.

In the MoCog1 simulation of Dweck and Leggett's findings, the effect of day-to-day individual variations in internal psychological and mental states (represented by the middle path in Fig. 3) has been omitted. Again it is likely that these affects are not simply additive with those from the lower path, but that they interact in a nonlinear fashion. This may be particularly true when such factors as general arousal level are considered. In addition, initial affects may not only influence procedural choice, but may color initial perceptions as well (an effect not currently included in Fig. 3).

MoCog1 considers only one aspect of motivated decision making, that of being automatically guided by past experience and its associated emotions. One way of viewing MoCog1 is as a structure appropriate for studying sequential episodic and schema activations considering emotions, with automatic unconscious selection from available coping strategies to produce a favorable associated affect vector. Though MoCog1 appears to be an adequate approach to simulating motivated recognition-primed human decision making, it is focussed on the unconscious, or what Reason [31] refers to as the schematic control mode associated with long term memory. To achieve real-time abstract thinking, we must focus on consciousness, associated with working memory, or what Reason refers to as the attentional control mode. It is the interaction between these two modes, plus the schema activations associated with emotions, that is needed to produce the motivated Knowledge-based reasoning of MoCog2 -- our follow-on computer program.

X. CONCLUSIONS

In this paper we have reviewed our development of a conceptual architecture for recognition-primed human decision making, considering emotions, and our efforts at programming Dweck and Leggett's findings as an example based upon it. We have shown that it is possible to develop a plausible simulation of the Dweck and Leggett findings based on recognition-primed decision making (associated with automatic responses derived from an individual's experiences). Our work also illustrates that it is possible to develop computer programs incorporating affects that show promise of being consistent both with our current knowledge of information processing in the brain and with actual psychological findings. Further, the nature of such simulations not only provides new ways of thinking about human mental and behavioral aspects, but strongly points the way to needed research. Though very common, recognition-primed decision making is only one type of human decision making. The success of our simulation efforts for this simple form of motivated decision making has encouraged us to proceed with our next simulation stage which will incorporate more complex motivational factors, and their resultant affects, in conjunction with more complex decision making.

References

[1] R. P. Abelson, "Conviction," *American Psychologist*, vol. 43, no. 4, pp. 267-275, April 1988.

[2] J. R. Anderson, *The Architecture of Cognition*. Cambridge, MA: Harvard University Press, 1983.

[3] R. J. Baron, *The Cerebral Computer: An Introduction to the Computational Structure of the Human Brain*. Hillsdale, NJ: Laurence Erlbaum Associates, 1987.

[4] W. Bechtel and A. Abrahamsen, *Connectionism and the Mind*. Cambridge, MA: Basil Blackwell, 1991.

[5] M. E. Bratman, *Intention, Plans and Practical Reason*. Cambridge, MA: Harvard University Press, 1987.

[6] R. Buck, *Human Motivation and Emotion*, Second Edition. New York: Wiley, 1988.

[7] J. P. Chaplin, *Dictionary of Psychology*. New York: Dell, 1975.

[8] K, M. Colby, "Simulations of Belief Systems," *In Computer Models of Thought and Language*, R. C. Shank and K. M. Colby Eds. San Francisco: W. H. Freeman, 1973, pp. 251-286.

[9] M. Connors, "Crew Systems Dynamics: Combining Humans and Automation," *SAE Technical Paper Series 89150*, 19th Intersociety Conference on Environmental Systems, San Diego, CA, July 24-26, 1989.

[10] L. A. Coward, *Pattern Thinking*. New York: Praeger, 1990.

[11] C. S. Dweck, and E. L. Leggett, "A Social-Cognitive Approach to Motivation and Personality," *Psychological Review*, vol. 95, no. 2, pp. 256-273, 1988.

[12] W. M. Eyseneck, and M. T. Keane, *Cognitive Psychology*. London: LEA, 1990.

[13] S. Folkman, R. S. Lazarus, R. Gruen, and A. DeLongis, "Appraisal, Coping, Health Status, and Psychological Symptoms," *J. of Personality and Social Psychology*, 50, Pp. 571-579, 1986.

[14] W. B. Gevarter, "Humans: Their Brain and their Freedom," *J. Humanistic Psychology*, vol. 15., no. 4, pp. 79-90, Fall 1975.

[15] W. B. Gevarter, "Psychotherapy and the Brain," *Man-Environment Systems*, vol. 12, nos. 2&3, pp. 73-88, 1982.

[16] E. T. Higgins, and R. M. Sorrentino, Eds., *Motivation and Cognition, Vol. II*. New York: Guilford, 1990.

[17] L. L. Jacoby and C. M. Kelley, "An Episodic View of Motivation," *Motivation and Cognition, Vol. II,* E. T. Higgins znd R.M. Sorrentino, Eds. New York: Guilford, 1990, pp. 451-481.

[18] C. E. Izard, "Emotion-Cognition Relationships and Human Development," *Emotions, Cognition and Behavior,* C. E. Izard, J. Kagan and R. B. Zajonc Eds. Cambridge, MA: Cambridge University Press, 1984, pp. 17-37.

[19] N. Kanas, "Psychological, Psychiatric, and Interpersonal Aspects of Long-Duration Space Missions," *J. Spacecraft*, vol. 27, no. 5, 1990, pp. 457-463.

[20] G. Klein, "Recognition-Primed Decisions," *Advances in Man-Machine Systems Research, Vol. 5*, W. R. Rouse, Ed. Greenwich, CT: JAI Press, 1989, pp. 47-92.

[21] F. J. Landy and W., S. Becker, *Final Report: Adaptive Motivation Theory*, Report Final 85-1, Department of Psychology, Pennsylvania State University, University Park, PA, June 1985.

[22] R. S. Lazarus, *Emotion and Adaptation.* New York: Oxford U. Press, 1991.

[23] D. C. McClelland, *Human Motivation.* Cambridge, MA: Cambridge University Press, 1985.

[24] E. T. Mueller, *Daydreaming in Humans and Machines.* Norwood, NJ: Ablex, 1990.

[25] A. Newell, *Unified Theories of Cognition.* Cambrdige, MA: Harvard University Press, 1990.

[26] P. O'Rorke, T. Cain and A. Ortony, "Learning to Recognize Plans Involving Affect," in *Proceedings of the Sixth International Workshop on Machine Learning*, Ithica, NY, June 26-27, 1989, pp. 209-212.

[27] A. Ortony, G. L. Clore, and A. Collins, *The Cognitive Structure of Emotions.* New York: Cambridge University Press, 1988.

[28] N. C. Paritsis, "Man as a Hierarchical and Purposeful Intelligent System," *Systems Research*, vol. 4, no. 3, 1987, pp. 169-176.

[29] R. Pfeifer, "Artificial Intelligence Models of Emotion," *Cognitive Perspectives on Emotion and Motivation*, V. Hamilton, N. Frijda, and G. Bower, Eds. Boston, MA: Kluver Academic Publishers, 1988, pp. 287-320.

[30] P. G. Polson, "Cognitive Factors in the Design and Development of Software in the Space Station," in *Proceedings of Symposium on Human Factors in Automated and Robotic Space Systems*, Committee on Human Factors, Commission on Behavioral and Social Sciences and Education, National Research Council, Washington, DC, 1987, pp. 176-200.

[31] J. Reason, *Human Error*. Cambridge: Cambridge University Press, 1990.

[32] R. M. Restak, *The Mind*. Toronto: Bantam Books, 1988.

[33] K. E. Sanders, "A Logic for Emotion: A Basis for Reasoning About Commonsense Psychological Knowledge," in *Proceedings of the 11th Annual Conference of the Cognitive Science Society*, Ann Arbor, MI, Aug. 1989, pp. 357-363.

[34] N. E. Sharkey and G. H. Bower, "A Model of Memory Organization for Interacting Goals, *Modeling Cognition*, P. Morris, Ed. New York: Wiley, 1987, pp. 231-248.

[35] P. Thagard and Z. Kunda, "Hot Cognition: Mechanisms for Motivated Inference," in *Proceedings of the 9th Annual Conference of Cognitive Science*, 1987, pp. 752-763.

[36] J. Weinberger and D. C. McClelland, "Cognitive Versus Traditional Motivational Models," *Motivation and Cognition, Vol. II,* E. T. Higgins and R. M. Sorrentino, Eds. New York: Guilford, 1990, pp. 562-597.

[37] B. J. Wolman, *Dictionary of Behavioral Sciences*. New York: Academic Press, 1989.

[38] D. D. Woods, E. M. Roth and H. Pople, Jr., *Cognitive Environment Simulation: An Artificial Intelligence System for Human Performance Assessment*, Vol. 2, Modelling Human Intention Formation, NUREG/CR-4862, Westinghouse Electric Corporation, Pittsburg, PA, November, 1987.

Table 1. Effect of perceptions of controllability

Category	Response	Affect	Cognition	Behavior
Uncontrollable	Judgmental	Evaluative	Rigid, over-simplified thinking	Low initiation of and persistence toward change
Controllable	Developmental	Empathetic	Process analysis, Sensitivity to situational factors	Mastery-oriented goal pursuit

Table 2. Relationship of students' goals to world view

World view	General goal	Goal orientation
Fixed entity	Performance (cognitive judgment)	Maximize positive judgments and pride in ability, while minimizing negative judgments, anxiety, and shame
Malleable	Learning (competence enhancement)	Maximize growth of ability and pride and pleasure of mastery

Table 3. Relationship of students' behaviors in tests to the students' general goals

General goal	Perceived own attribute level	Task difficulty	Resultant affects	Goal	Students' cognitions	Observed behaviors
Performance (cognitive judgment)	High intelligence [Fran]	High	Pride	Seek positive judgment Maintain and increase self-esteem	Success expected	Mastery oriented* High persistence
		Low	Boredom	Seek positive judgment if available	Success expected	Persistence Task avoidance*
		Very high	Anxiety Boredom Shame Depression Reduced self-esteem	Avoid negative judgment	Failure expected Attribute failure to personal inadequacy Loss of belief in efficacy of effort Divided attention Dislike of task	Defensive withdrawal of effort Self-aggrandizement* Ineffective strategies Low persistence Task avoidance Devalue task and evidence boredom
	Low intelligence [Rob]	Very high	Anxiety Boredom Shame Depression Reduced self-esteem	Avoid negative judgment	Failure expected Attribute failure to personal inadequacy Loss of belief in efficacy of effort Divided attention Dislike of task	Defensive withdrawal of effort Self-aggrandizement* Ineffective strategies Low persistence Task avoidance Devalue task and evidence boredom
		High	Anxiety Boredom Shame Depression Reduced self-esteem	Avoid negative judgment	Failure expected Attribute failure to personal inadequacy Loss of belief in efficacy of effort Divided attention Dislike of task	Defensive withdrawal of effort Self-aggrandizement* Ineffective strategies Low persistence Task avoidance Devalue task and evidence boredom
		Low	Pride	Seek positive judgment	Success expected	Mastery oriented* High persistence
Learning (competence enhancement)	High intelligence [Jan]	High	Pleasure Pride	Seek learning experience	Success expected See task as a challenge to be mastered through effort	Self-mastery (effective problem-solving strategies)* High persistence
		Low	Boredom	Seek better use of time	Seen as an unproductive use of time	Task avoidance* Effort leading to success
		Very high	Pleasure Pride	Seek very satisfying learning experience	Opportunity for more satisfying self-mastery Current failure but future success Continuing belief in efficacy of effort	Revised or upgraded strategy Solution-oriented self-instruction, self-monitoring, and self-mastery*
	Low intelligence [Pat]	Very high	Pleasure Pride	Seek very satisfying learning experience	Opportunity for more satisfying self-mastery Current failure but future success Continuing belief in efficacy of effort	Revised or upgraded strategy Solution-oriented self-instruction, self-monitoring, and self-mastery*
		High	Pleasure Pride	Seek very satisfying learning experience	Opportunity for more satisfying self-mastery Current failure but future success Continuing belief in efficacy of effort	Revised or upgraded strategy Solution-oriented self-instruction, self-monitoring, and self-mastery*
		Low	Pleasure Pride	Seek learning experience	Success expected See task as a challenge to be mastered through effort	Self-mastery* High persistence

*Behavior selected by our simulation.

Table 4. Effect of choice of procedure on affect pattern increment

Situation	Procedure	Anxiety	Pleasure	Boredom	Pride	Shame	Self-Image	Happiness	Self-Esteem
Learning-oriented, high-intelligence individual faced with high-difficulty test (Jan)	Self-mastery	+2	+3	+3	+2	0	+1	+1	+1
	High persistence	+1	+2	0	+2	0	+1	+1	+1
Performance-oriented, low-intelligence individual faced with high-difficulty test (Rob)	Ineffective strategies	−1	−1	0	−1	−2	−1	−1	−1
	Defensive withdrawal	+1	+1	+1	−1	+1	−1	0	+1
	Task avoidance	+2	+1	+1	−1	+1	0	+1	0
	Self-aggrandizement	+2	+1	0	+1	+2	+1	0	+1
	Task devaluement	+1	+1	−1	+1	+1	0	+1	0

MoCog1

Figure Captions

Fig. 1 Elementary Preprogrammed Responses

Fig. 2 Tentative Affect Level Structure

Fig. 3 Flow Diagram of Recognition-Primed Human Decision Making

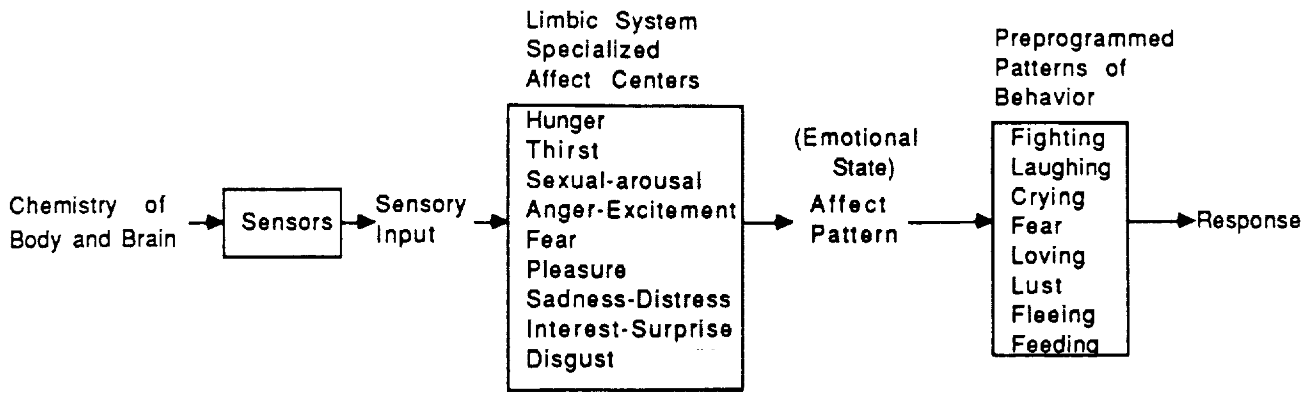
Fig. 4 Simplified Flow Diagram of an Individual's Response to a Task

Fig. 5 Trace of a User Interaction with a Computer Simulation of a Learning-Oriented, High Intelligence Student's Response to a Test of High Difficulty

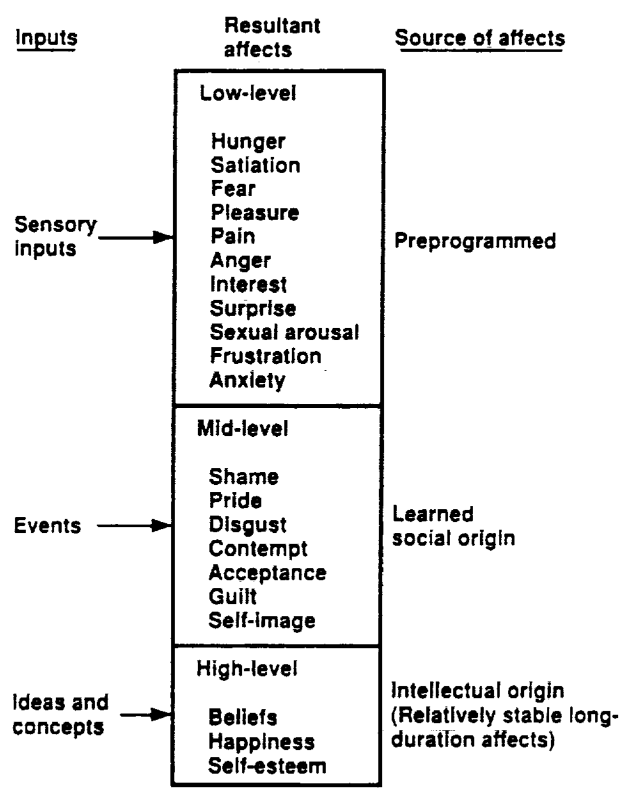
Fig. 6 Projection onto Fig. 4 of a Simulation of a Learning-Oriented, High-Intelligence Student's Response to a Test of High Difficulty

Fig. 7 Trace of a User Interaction with a Computer Simulation of a Performance-Oriented, Low-Intelligence Student's Response to a Test of High Difficulty

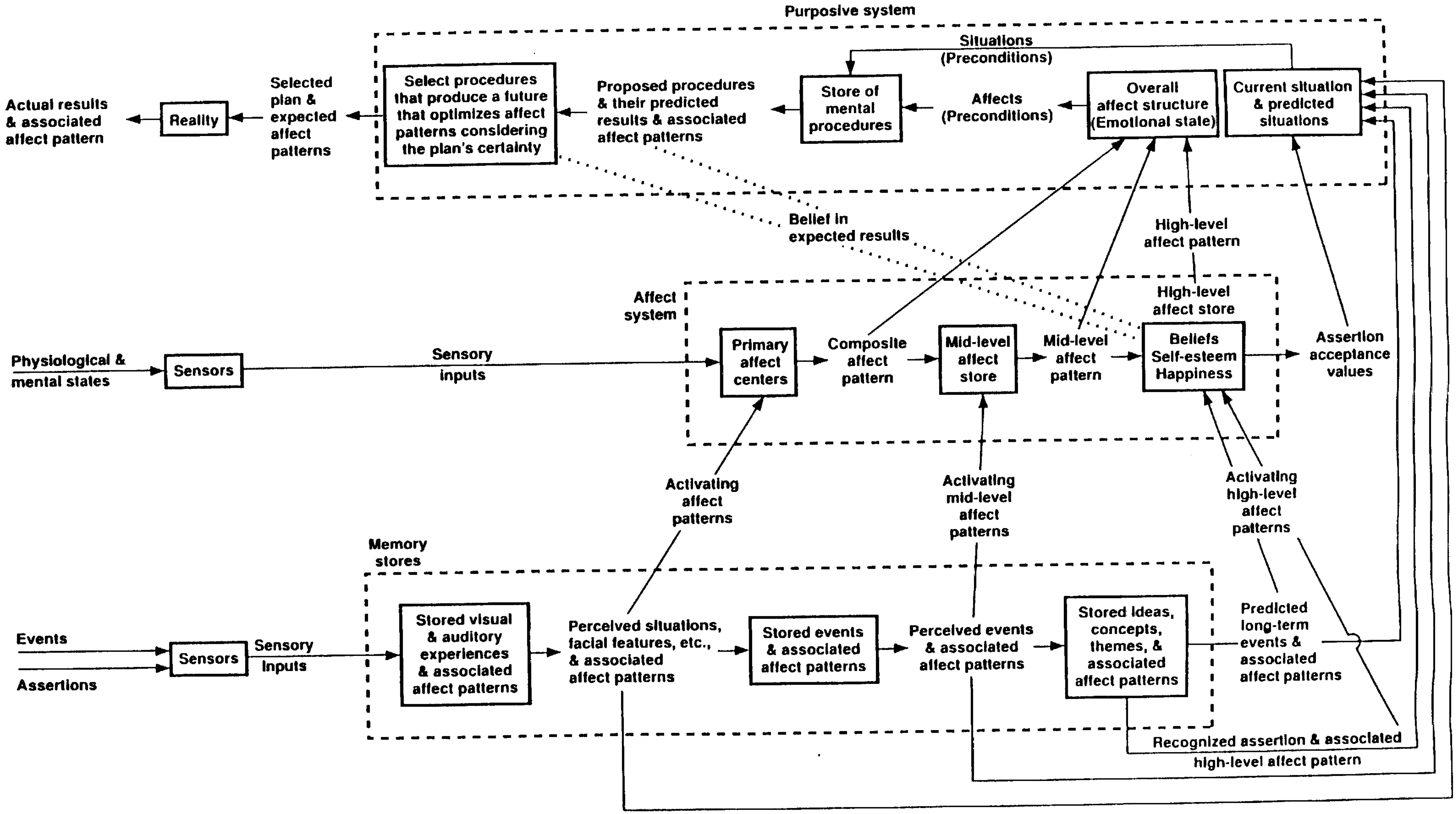
Fig. 8 Projection onto Fig. 4 of a Simulation of a Performance-Oriented, Low-Intelligence Student's Response to a Test of High Difficulty


Chemistry of
Body and Brain
Sensors
Sensory
Input
Limbic System
Specialized
Affect Centers
Hunger
Thirst
Sexual-arousal
Anger-Excitement
Fear
Pleasure
Sadness-Distress
Interest-Surprise
Disgust
(Emotional
State)
Affect
Pattern
Preprogrammed
Patterns of
Behavior
Fighting
Laughing
Crying
Fear
Loving
Lust
Fleeing
Feeding
Response

Gevarter-1

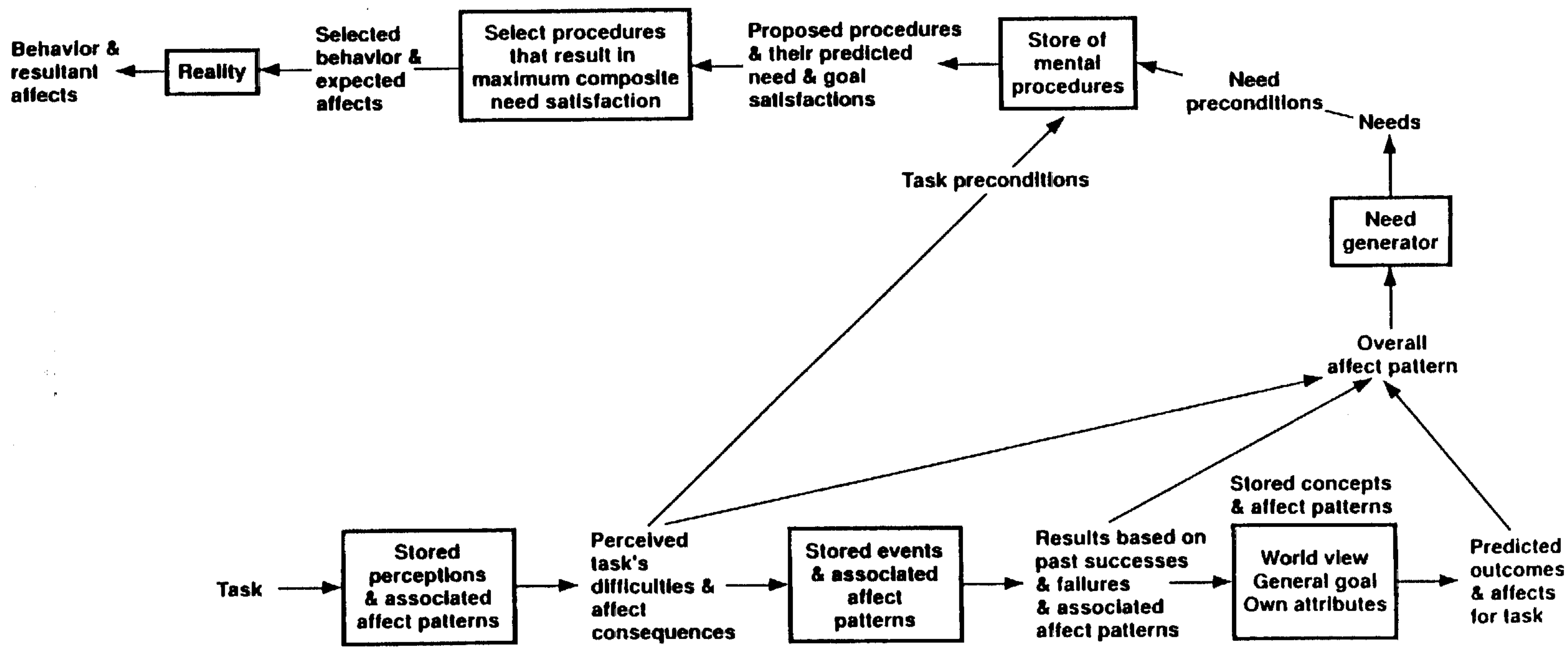

Inputs
Resultant affects
Source of affects
Low-level
Hunger
Satiation
Fear
Pleasure
Pain
Anger
Interest
Surprise
Sexual arousal
Frustration
Anxiety
Sensory inputs
Preprogrammed
Mid-level
Shame
Pride
Disgust
Contempt
Acceptance
Guilt
Self-image
Events
Learned social origin
High-level
Beliefs
Happiness
Self-esteem
Ideas and concepts
Intellectual origin (Relatively stable long-duration affects)

Gevarter-2



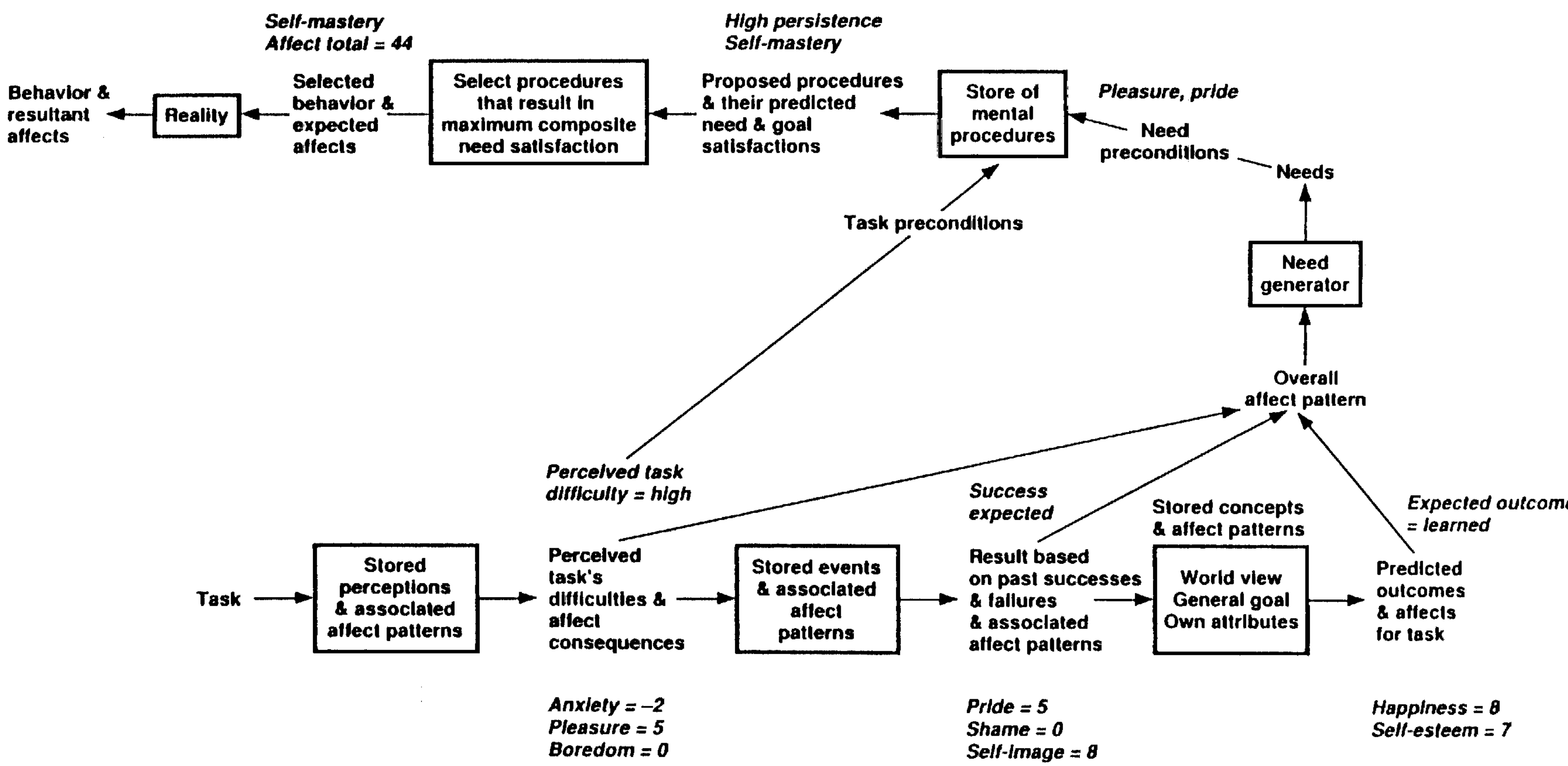
Purposive system
Situations
(Preconditions)
Actual results
& associated
affect pattern
Reality
Selected
plan &
expected
affect
patterns
Select procedures
that produce a future
that optimizes affect
patterns considering
the plan's certainty
Proposed procedures
& their predicted
results & associated
affect patterns
Store of
mental
procedures
Affects
(Preconditions)
Overall
affect structure
(Emotional state)
Current situation
& predicted
situations
Belief in
expected results
High-level
affect pattern
Affect
system
High-level
affect store
Physiological &
mental states
Sensors
Sensory
inputs
Primary
affect
centers
Composite
affect
pattern
Mid-level
affect
store
Mid-level
affect
pattern
Beliefs
Self-esteem
Happiness
Assertion
acceptance
values
Activating
affect
patterns
Activating
mid-level
affect
patterns
Activating
high-level
affect
patterns
Memory
stores
Events
Assertions
Sensors
Sensory
inputs
Stored visual
& auditory
experiences
& associated
affect patterns
Perceived situations,
facial features, etc.,
& associated
affect patterns
Stored events
& associated
affect patterns
Perceived events
& associated
affect patterns
Stored ideas,
concepts,
themes, &
associated
affect patterns
Predicted
long-term
events &
associated
affect patterns
Recognized assertion & associated
high-level affect pattern

Gavarter-3


Behavior & resultant affects
Reality
Selected behavior & expected affects
Select procedures that result in maximum composite need satisfaction
Proposed procedures & their predicted need & goal satisfactions
Store of mental procedures
Need preconditions
Needs
Task preconditions
Need generator
Overall affect pattern
Task
Stored perceptions & associated affect patterns
Perceived task's difficulties & affect consequences
Stored events & associated affect patterns
Results based on past successes & failures & associated affect patterns
Stored concepts & affect patterns
World view
General goal
Own attributes
Predicted outcomes & affects for task

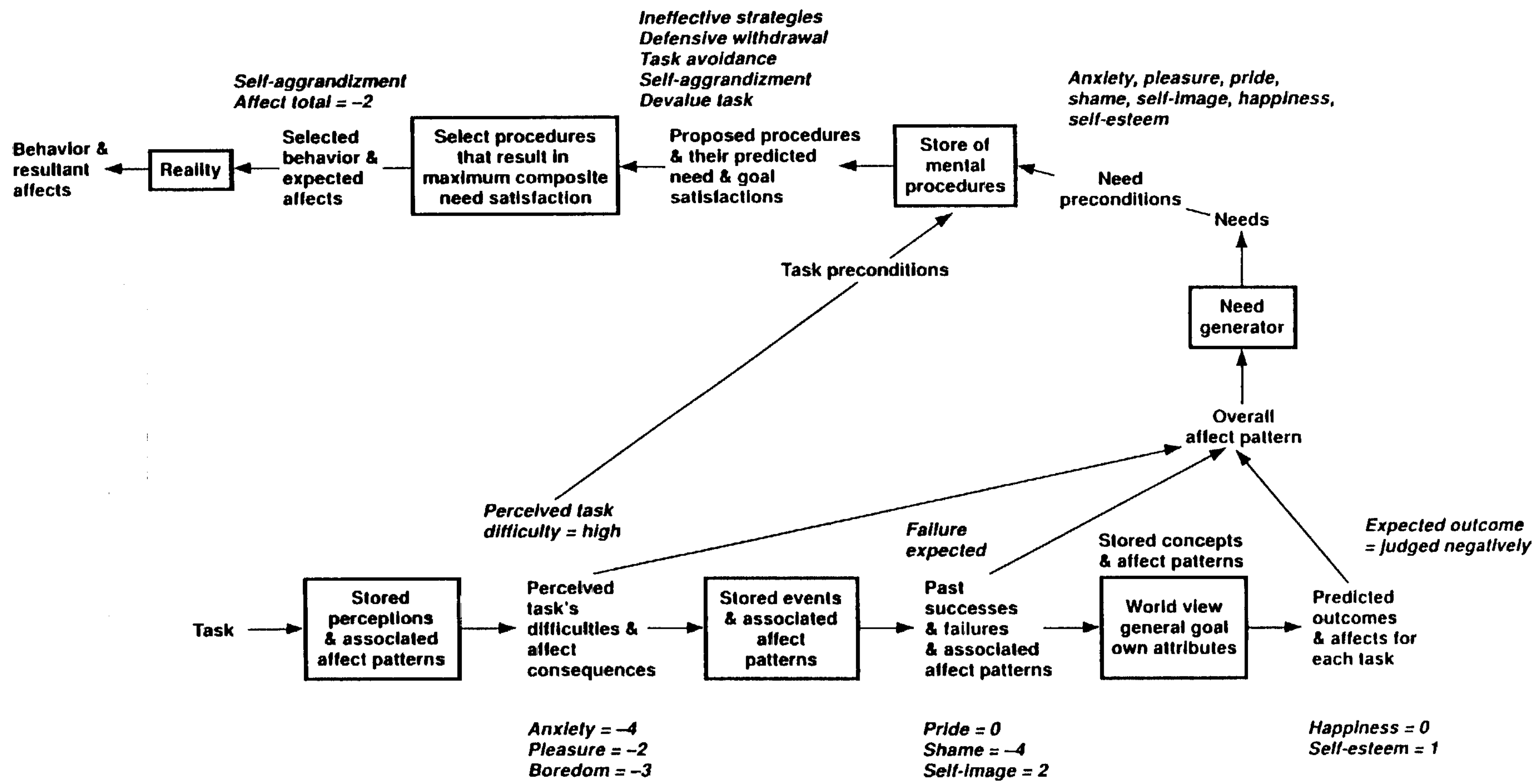
Gevarter-4

```
dldb
Which student are you interested in?
                (fran., rob., jan., pat.)

  Be sure to include the period,
  and do a carriage return after your selection.

jan.

jan, of high intelligence,
 has a  general goal of learning
 a normal mid level affect of self image = 7
 and a normal high level affect pattern of
 happiness = 7 and self esteem = 6,  on a scale of -9 to 9.

Which test are you considering?
                (test1., test2., test3., test4., test5.)
test1.

Based on its attributes, the difficulty of this
math test is perceived by jan to be high

CONTINUE? (yes., no.)
yes.


Perceiving this test produces in jan
a low level affect response of:
 anxiety = -2,  on a scale of -9 to 0
 pleasure = 5,  on a scale of -9 to 9
 boredom  = 0,  on a scale of -9 to 0

CONTINUE? (yes., no.)
yes.


Sensing the task difficulty results in jan
having a feeling of expected success
and an associated mid level affect response of
 pride = 5,  on a scale of 0 to 9
 shame = 0,  on a scale of -9 to 0
 self image  = 8,  on a scale of -9 to 9

CONTINUE? (yes., no.)
yes.


Based on feelings associated with the event,
jans view of the expected outcome is "learned" leading to an

Overall affect pattern = [-2,5,0,5,0,8,8,7]

                       = [Anxiety, Pleasure, Boredom,
                          Pride, Shame, Self_Image_New,
                          Happiness_New, Self_Esteem_New]

and an associated  Need_List = [2,4,0,4,0,1,1,2]
which is the difference between the ideal state and
jans current overall affect pattern

CONTINUE? (yes., no.)
yes.

Based on the preconditions of the task and the relevant
 needs, the following procedures are available to jan

         --- computing ---

procedure1 = high_persistance,   Resultant affect total = 39
procedure2 = self_mastery,   Resultant affect total = 44

          Selected procedure is self_mastery

 If you want to try the program again, type "dldb."


B:\>
```


Self-mastery
Affect total = 44
Behavior & resultant affects
Reality
Selected behavior & expected affects
Select procedures that result in maximum composite need satisfaction
High persistence
Self-mastery
Proposed procedures & their predicted need & goal satisfactions
Store of mental procedures
Pleasure, pride
Need preconditions
Needs
Task preconditions
Need generator
Overall affect pattern
Perceived task difficulty = high
Success expected
Stored concepts & affect patterns
Expected outcome = learned
Task
Stored perceptions & associated affect patterns
Perceived task's difficulties & affect consequences
Stored events & associated affect patterns
Result based on past successes & failures & associated affect patterns
World view
General goal
Own attributes
Predicted outcomes & affects for task
Anxiety = –2
Pleasure = 5
Boredom = 0
Pride = 5
Shame = 0
Self-image = 8
Happiness = 8
Self-esteem = 7

Gevarter-6

```
Which student are you interested in?
                (fran., rob., jan., pat.)

  Be sure to include the period,
  and do a carriage return after your selection.

rob.

rob, of low intelligence,
 has a  general goal of performance
 a normal mid level affect of self image = 3
 and a normal high level affect pattern of
 happiness = 3 and self esteem = 2,  on a scale of -9 to 9.

Which test are you considering?
                (test1., test2., test3., test4., test5.)
test2.

Based on its attributes, the difficulty of this
history test is perceived by rob to be high

CONTINUE? (yes., no.)
yes.


Perceiving this test produces in rob
a low level affect response of:
 anxiety = -4,  on a scale of -9 to 0
 pleasure = -2,  on a scale of -9 to 9
 boredom  = -3,  on a scale of -9 to 0

CONTINUE? (yes., no.)
yes.


Sensing the task difficulty results in rob
having a feeling of expected failure
and an associated mid level affect response of
 pride = 0,  on a scale of 0 to 9
 shame = -4,  on a scale of -9 to 0
 self image  = 2,  on a scale of -9 to 9

CONTINUE? (yes., no.)
yes.


Based on feelings associated with the event,
robs view of the expected outcome is "judged_negatively" leading to an

Overall affect pattern = [-4,-2,-3,0,-4,2,0,1]

                       = [Anxiety, Pleasure, Boredom,
                          Pride, Shame, Self_Image_New,
                          Happiness_New, Self_Esteem_New]

and an associated  Need_List = [4,11,3,9,4,7,9,8]
which is the difference between the ideal state and
robs current overall affect pattern

CONTINUE? (yes., no.)
yes.

Based on the preconditions of the task and the relevant
 needs, the following procedures are available to rob

         --- computing ---

procedure1 = ineffective_strategies,   Resultant affect total = -18
procedure2 = defensive_withdrawal,   Resultant affect total = -9
procedure3 = task_avoidance,   Resultant affect total = -5
procedure4 = self_aggrandizement,   Resultant affect total = -2
procedure5 = devalue_task,   Resultant affect total = -6

          Selected procedure is self_aggrandizement

 If you want to try the program again, type "dldb."

C:\D&L>
```


Ineffective strategies
Defensive withdrawal
Task avoidance
Self-aggrandizment
Devalue task
Self-aggrandizment
Affect total = –2
Anxiety, pleasure, pride,
shame, self-image, happiness,
self-esteem
Behavior & resultant affects
Reality
Selected behavior & expected affects
Select procedures that result in maximum composite need satisfaction
Proposed procedures & their predicted need & goal satisfactions
Store of mental procedures
Need preconditions
Needs
Task preconditions
Need generator
Overall affect pattern
Perceived task difficulty = high
Failure expected
Stored concepts & affect patterns
Expected outcome = judged negatively
Task
Stored perceptions & associated affect patterns
Perceived task's difficulties & affect consequences
Stored events & associated affect patterns
Past successes & failures & associated affect patterns
World view general goal own attributes
Predicted outcomes & affects for each task
Anxiety = –4
Pleasure = –2
Boredom = –3
Pride = 0
Shame = –4
Self-image = 2
Happiness = 0
Self-esteem = 1

Gevarter-8

Footnotes

1. Manuscript received

The author is a member of the Artificial Intelligence Research Branch, NASA Ames Research Center, Moffett Field, CA 94035.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
Dates attached

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE

Titles/Authors - Attached

5. FUNDING NUMBERS

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Code FIA - Artificial Intelligence Research Branch
Information Sciences Division

8. PERFORMING ORGANIZATION REPORT NUMBER

Attached

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Nasa/Ames Research Center
Moffett Field, CA. 94035-1000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Available for Public Distribution

Peter Friedland 5/14/92 BRANCH CHIEF

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Abstracts ATTACHED

14. SUBJECT TERMS

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

PRECEDING PAGE BLANK NOT FILMED