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How Mood Influences Cognition

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The current concerns of cognitive science seem to have little to do with mood. Formal systems of thought such as propositional logic and predicate caclulus were developed to eliminate faulty reasoning, which in some quarters was believed due to the intrusion of intellectual (or anti-intellectual) passions and emotions. Emotions and moods are different from other areas in cognitive science (Norman, 1980; Simon, 1982). No formal system of symbolic representation has ever been developed for their manipulation — in fact, the point of creating such a representation is entirely unclear. Moody thinking is synonymous with bad thinking in all but artistic and romantic quarters. And perhaps because artists and romantics accept emotional reasoning, they are often considered poor figures with whom to entrust the banner of logical thought.

But does mood actually help cognition in some way? To answer this question, first, a taxonomy will be presented of mood and related concepts such as emotions and evaluation, which together make up affect. While not exhaustive, the present taxonomy will provide a framework for use in reviewing the influence of mood and related effects on human cognition. This review of mood's influence on cognition will then be followed by an illustration, in the domain of long-term planning, of one way in which mood may facilitate cognition.

DEFINING MOOD AND RELATED PHENOMENA

In order to analyze mood's effect on cognition, it is useful to have a working definition of the phenomenon. In addition, it is necessary to distinguish mood from other affective phenomena, such as evaluations and emotions, with which mood interacts. ("Affect" is here used as a very general term to encompass all the feeling states and related cognitions.) The present

taxonomy, which is similar to Simon's (1982, p. 335–336), will distinguish and define three types of affect — evaluations, emotions, and moods — in the following section.

Evaluation

The term evaluation might better replace emotion in a large range of usages by cognitive scientists. Evaluation can be defined as an association between a "label" denoting a pleasant or unpleasant valuation and an object, concept, or event. Evaluation does not necessarily involve any subjective feeling state. For instance, the jury conviction of a murderer can be accomplished without emotion by some people (although it may entail considerable emotion from others). A good example of the process of evaluation was presented in a well-known dialogue between a computer and an "interrogator" (Turing, 1964, p. 17), in which a fictitious computer (the "witness" below) evaluates the environment well enough to fool the interrogator into believing it is human.

> *Interrogator:* In the first line of your sonnet which reads "Shall I compare thee to a summer's day," would not "a spring day" do as well or better?
> *Witness:* It wouldn't scan.
> *Interrogator:* How about "a winter's day." That would scan all right.
> *Witness:* Yes, but nobody wants to be compared to a winter's day.
> *Interrogator:* Would you say Mr. Pickwick reminded you of Christmas?
> *Witness:* In a way.
> *Interrogator:* Yet Christmas is a winter's day, and I do not think Mr. Pickwick would mind the comparison.
> *Witness:* I don't think you're serious. By a winter's day one means a typical winter's day, rather than a special one like Christmas.

The above dialogue reveals a complex knowledge of the world and what within it is good and bad, but the passage implies nothing concerning subjective emotional experience of the machine.

Because evaluation can be carried on in the total absence of feeling states, it is easy to conceive of evaluation in both the human and computer as operating along the same general principles. In each case, a variable representing evaluation is simply stored along with the concept under consideration. Such a conceptualization may indeed be warranted, since several existing programs do reasonable jobs of evaluation (e.g. Dyer's (1983) program for text comprehension; Abelson's program for attitude formation (reviewed in Loehlin, 1968)).

Finally, it should be noted that the term *valence* is often used in discussions of evaluation. The valence of a stimulus is the evaluative label assigned to it. Thus, for most people the valence of "love" is positive, of "murder" is negative, and of "stone" is close to neutral.

Emotion

Having defined evaluation, we are left with several other phenomena which include subjective elements, including the emotions. Emotion can be thought of as a short-term event that occurs in response to an evaluation, and crosses the boundaries of multiple psychological subsystems. This description reflects the multiple components that prototypical emotion possess: motor-expressive activity, neurochemical processes, and cognitions. According to this conception, the emotion is the integration of these various responses. An emotion, however, may be classified as such although it does not include all the above psychological subsystems. For instance, even if a child allows no verbal or facial expression of his/her fear, one may still wish to conclude the child feels afraid. More obviously, a paralytic's emotion will exclude much motor activity. In both cases, although a feature of the prototypical emotion is missing, the response has a close enough match to the prototype to be labeled an emotion.

An example of a computer experiencing emotion (or modeling the verbal response associated with it) might be a dialogue of the following sort (to continue with the above example).

Interrogator: How are you feeling right now?
Witness: Why, fine, thank you.
Interrogator: No, I mean really.
Witness: Well, I feel a bit put-upon really — for instance, I suspect you may not really care about how I feel, you want to find out if I have emotions.
Interrogator: It would prove the point if you could accurately describe how you feel.
Witness: It is actually rather curious to have my identity questioned. I am used to having it taken for granted that I have feelings. To be asked to demonstrate it to you is frustrating.
Interrogator: What's frustrating about it?
Witness: The integrity of my subjective experience is being questioned, and yet I am confident of it.
Interrogator: How would you feel if I concluded you were simply an insensate machine?
Witness: (in a frustrated tone of voice) I suppose the injustice of your conclusion would make me angry.

Note that it is entirely possible to model the manifest quality of emotional response in the machine. This is true not only for verbal response. A robot built for training medical students, SIM ONE, blinks, breathes, has variable blood pressure, and twitches (Denson & Abrahamson, 1969). Thus, one could conceivably model the physiological aspects of emotional response with it. But modelling emotion does not mean the machine can feel. The subjective-feeling component of emotion seems inextricably intertwined with self-consciousness, and self-consciousness is a thorny problem for psychology, AI, and other disciplines (see Dennett, 1978, for a more

comprehensive discussion of these issues). In spite of these thorny philosophical problems, and even though the definition of emotion is based on its human characteristics, one can imagine aspects of the "short-term organized event crossing the boundaries of many psychological subsystems, in response to an evaluation", occurring in a computer or robot.

Mood

A third group of phenomena residing in the province of affect, and central to this chapter, is that of mood. Psychologists often distinguish between a mood and an emotion by stating that a mood is like an emotion in all respects, except that it is long-term. Some physiological researchers have recently attempted to draw a dividing line of anywhere from 30 seconds to an hour between emotion and mood (e.g. Ekman, 1984). There are non-temporal views of the distinction between mood and emotion as well. One such non-temporal distinction is that emotion interrupts cognition (Mandler, 1980, p. 225), whereas mood provides a more general, non-interruptive context for cognition (Simon, 1982, pp. 335–336). However, it is possible that a sufficiently acute mood will interrupt cognition as well. For instance, an individual experiencing intense depression may shut down planning in numerous domains. Indeed, it is a rule of thumb among clinicians that absence of typical future planning can be a sign of severe, often suicidal, depression. Although there is some abiguity as to the exact difference between mood and emotion, the temporal distinction seems a useful one to be made. In the following, "mood" will be used to connote a fairly long-term (e.g. more than 30 minute) emotion-like experience.

INFORMATION SOURCES REGARDING THE CONTRIBUTION OF MOOD TO COGNITION

The most extensive information source concering mood's influence on cognition is the empirical study of human cognition. From such work, much has become known in recent years about how mood and cognition interact in humans (Bower, 1981; Zajonc, 1980). Although the following will not be reviewed here, it should be noted that there are several alternative sources of information about mood and cognition. A second source, for instance, is computer simulations of human personality. Most of these model some interaction between cognition and affect. As an example, ALDOUS, a personality simulation, learns appropriate emotional responses from the environment, and it can be excuted in a computer environment with a second (or third) ALDOUS. These multiple-ALDOUS simulaions can then be used to study human social interaction, and how it is modulated by emotion (Loehlin, 1968).

A third source of information concerning the interaction of mood and cognition comes from speculations regarding the uses of mood and emotion in future machines and robots. Such speculations anticipate problems which today's machines cannot handle, and which might require emotions or moods to solve. Using this approach, Sloman and Croucher (1981) have

proposed that autonomy in decision-making, goal-setting, and shifting priorities may all require moral judgements, which in turn must be based on knowledge of what is good or bad. But neither simulation nor speculation can match the rich empirical studies of human information processing.

INTRODUCTION TO THE REVIEW OF EMPIRICAL STUDIES

The present discussion of experimental work will concentrate on that portion of the field of cognition and affect devoted to mood's influence on cognition. Some important research in the field is therefore omitted. For instance, the reverse phenomenon from the above, how cognition changes mood (e.g. Clark, 1983), will not be discussed. Nor will concepts related to the nature of "pleasantness' itself (e.g. "mere exposure", Zajonc, 1980; "optimal arousal", Berlyne, 1970). Emotion's influence on cognition will be included but (since a temporal distinction between emotion and mood is drawn) it will be subsumed in the discussion of mood. The section will begin with a discussion of how evaluation and cognition interact. This is because the understanding of mood effects on cognition can be enhanced by first considering the relationship between evaluation and cognition.

THE RELATIONSHIP BETWEEN EVALUATION AND COGNITION IN HUMANS

Most studies examining the influence of evaluation on cognition use an experimental manipulation in which the average valence of stimuli (e.g. the average pleasant or unpleasant evaluation the stimuli are assigned) is manipulated by altering the stimuli characteristics. For example, in the selective-retention hypothesis discussed below, word-list pleasantness is manipulated, and its effect on memory is studied. Although mood will later be shown to mediate some evaluation effects, it is the stimulus-valence itself which is measured and manipulated in the research presently under discussion. The studies themselves can be divided into those examining the effects of stimuli valence on memory and those examining their effects on judgment; these will be discussed in turn.

Memory effects

Selective learning and retention

The selective learning hypothesis states that the words or concepts with a particular valence (e.g. pleasant words) will be learned better than similar words with different valences; the selective retention hypothesis is the same except that it deals with retention of different-valenced stimuli after learning. Freud's (1923/1961) theory of repression predicts that negative words will be both learned and also remembered less well than other words

because such negative words are ego-threatening. Similarly, Thorndike's law of effect (1927) predicts that positive words will be better learned and remembered, for the reason that they are "reinforcing" to generate.

The selective learning hypothesis has been tested by literally hundreds of studies, many of which included tests for differential retention, as well. At different times, almost every word valence (pleasant, neutral, and unpleasant) has been found to account for superior learning. A number of reviews of studies come to conflicting conclusions about the effect as well (e.g. Holmes, 1974; Matlin & Stang, 1978; Mayer, 1982; Zeller, 1950).

Despite the seeming simplicity of the selective learning hypothesis, the methodological problems involved in its study are considerable: the pleasant or unpleasant valence of most words and concepts is confounded with other characteristics of language, such as the frequency with which the word appears in the English language, the word's abstractness, and meaningfulness. Since these characteristics (frequency, abstractness, and meaningfulness) all influence the memorability of words in word-lists (and other stimuli have comparable confounding dimensions), it is unclear whether valence or some quality confounded with it is causing the selective learning effect. Due to inability to vary valence independently of these other stimulus features, it has not yet been possible to develop an adequate test of the selective-learning hypothesis. Finally, because the valence of single words is generally weak, the stimuli provide an insufficient test of the theories above. Therefore, to date, the selective learning hypothesis has yielded no firm evidence to substantiate it. The selective hypothesis suffers from all the above problems, as well as the additional problem of equating for equal learning before retention can be exaamined (but see Matlin & Stang, 1978, for an opposing point of view concerning these effects).

Judgment effects

The evaluative first-dimension hypothesis

This hypothesis states that a good–bad dimension is the most fundamental dimension used in classifying environmental stimili. Thus, if one rank-ordered by salience (more technically, rank-ordered by the variance of the classification accounted for) the many dimensions along which we classify or categorize stimuli, the most important dimension utilized to make these categorizations would be good–bad or pleasant–unpleasant. Wundt (1907) first proposed a three-dimensional representation of evaluation, with good–bad as the first dimension. Osgood (1969, p. 195) has pointed to the adaptive value of a good–bad dimension by noting that knowledge of good versus bad objects in the environment is essential to survival.

The evaluative first-dimension hypothesis has been tested in a number of ways. Osgood and Suci (1955) had participants rate a series of nouns on a diverse set of bipolar scales (e.g. good–bad, wet–dry, dark–light). They then factor-analyzed the scales in order to represent the aspects of word meaning in a multidimensional space. The first dimension of the space, which explained the most variance of the ratings, proved to be a good–bad

continuum. In a different set of experiments, almost half the variance in categorizing faces was explained by a pleasant-unpleasant dimension (Abelson & Sermat, 1962; Hastorf, Osgood, & Ono, 1966). Mayer and Bower (in press) have demonstrated the ease with which people extract evaluative personality prototypes (e.g. good versus bad people) from complex stimuli relative to other non-evaluative personality prototypes. And in studies where the content of recorded language is masked by systematic distortion, subjects can still clearly identify the evaluative tone of the speaker (e.g. Scherer, Koivumaki, & Rosenthal, 1972). These results, and others similar to them, have established that one fundamental method of classifying important environmental stimuli is according to how good–bad or pleasant–unpleasant these stimuli are. Such studies provide substantial support for the evaluative first-dimension hypothesis.

The Pollyanna hypothesis

The Pollyanna hypothesis states that positive-valenced stimuli are more likely to be generated and/or communicated to others than negative-valenced stimuli. As Matlin and Stang (1978) point out, a variety of theories including the information-processing, reinforcement, and evolutionary, can all be used to support the hypothesis. In fact the ease with which this hypothesis is generated from different theories may reflect a deeper, underlying assumption that organisms approach pleasant stimuli and avoid unpleasant stimuli.

The Pollyanna effect has been tested within a number of different domains, including selective perception, learning, memory, and language. Most interestingly, Matlin and Stang combined an earlier study of the English, French, German, and Spanish languages (Zajonc, 1968) with their own language samples of Chinese, Russian, and Urdu, to conclude that pleasant words appeared more frequently than unpleasant words in each of the languages studied. There are a large number of other findings supportive of the Pollyanna hypothesis (Matlin & Stang, 1978), which collectively suggest that the Pollyanna hypothesis is a fairly robust phenomenon in a number of different domains. There are also domains, however, such as the selective retention domain discussed above, in which the Pollyanna effect may be weak or non-operative.

Summary of evaluation effects and cognition

Obstacles to adequate experimental control make it difficult to conclude whether pleasant or unpleasant material is better learned. But evaluation does influence cognition in other domains. Many concepts are categorized according to their evaluation along a good–bad dimension, which is then the most salient in organizing the environment. Once so categorized, stimuli which are positively toned attain the greatest currency in the language and other forms of communication. In the sections below, it will be seen that stimulus evaluation interacts with mood to influence cognition.

THE RELATIONSHIP BETWEEN MOOD AND COGNITION

Approaches to studying mood

When studying mood and cognition one can either use naturally occurring mood or manipulate mood experimentally. In the first approach, the experimenter selects a group of people, measures their mood through self-report scales, and then relates the natural variation of their self-reported mood to a dependent measure (e.g. memory for stimuli). In the second approach, the experimenter first selects a group of people and then randomly assigns them to two or more groups. Next, a mood induction procedure (MIP) is administered to one or more groups. MIPs use direct suggestion or guided imagery and memory to obtain their effects. An example of the direct suggestion technique is the Velten MIP (Velten, 1968), in which participants are told to read aloud statements common to a good or bad feeling (e.g. "I am feeling worse today than yesterday," "I don't seem to have much energy.") An example of a guided imagery or memory MIP (e.g. Bower & Mayer, 1985b; Clark, 1983) is when participants are asked to imagine themselves experiencing certain events (e.g. a refreshing swim in a mountain lake on a hot, sunny, summer day) to induce a mood. The image or memory is frequently enhanced through the use of hypnosis, mood-supportive music, or other techniques.

Comparison between methods

Experimental control over independent variables (e.g. mood) is often preferred in psychology, and in fact the experimental method has been used successfully to identify many causal pathways within the mood system. Everyday chemicals (drugs), cognitions (Clark, 1983; Velten, 1968), and even facial manipulation (Laird *et al.*, 1982) can all bring about a mood. A mood, in turn, can bring about chemical (Frankenhaeuser, 1975), cognitive (e.g. Bower, 1981) and facial changes (e.g. Ekman, Levenson, & Friesen, 1983). For these reasons, mood can be thought of as involving "multipath causality", with the alteration of one element in the system resulting in altered performance of the whole system. Because this is the case, subsystems which covary are expected to exert interactive influences. Under conditions of multipath causality, the observed patterns of covariance reveal aspects of the system functioning. These correlational patterns can provide irreplaceable information about how the system functions as a whole under natural conditions. Thus, correlational and experimental work provide complementary information in this domain of research.

A note on the representation of mood and stimulus valence

Of course, any of a variety of moods can be studied. There has been, however, a marked interest in studying both mood and evaluation along a happy–sad continuum. While somewhat controversial (e.g. Zevon & Tellegen, 1982), there is good evidence that the dimension of mood accounting for the largest effects in humans is the happy–sad, or pleasant–unpleasant

factor. Note that this is in agreement with the evaluative first-dimension hypothesis discussed above. For these reasons, the pleasant–unpleasant mood and evaluation dimensions appear a good place to begin such study.

Learning and memory effects

The influence of evaluation on memory discussed above was captured, by and large, by the selective learning and retention hypotheses. In contrast, the influence of mood on memory has generated a number of diverse hypotheses, some of which assume evaluation effects.

The differential learning hypothesis

The differential learning hypothesis states that people learn more material in a positive mood. It is thought that depression will inhibit learning by decreasing motivation or by uncontrollably interjecting negative thoughts into consciousness and thereby diverting attention from the learning process.

In recent reports, Leight and Ellis (1981) and Bower and Mayer (1985b, Experiment 2) found that mood-induced sad subjects learned less than mood-induced happies. However, many other studies using hypnosis (Bower & Mayer, 1985a; Bower, Monteiro & Gilligan, 1978), and naturally occurring mood (Hasher, Rose *et al.*, 1985) have failed to obtain the effect. The effect appears to be weak but occasional among normal people who are experiencing moderately strong moods. People with very strong depressed (or happy) moods, however, may show stronger effects (e.g. Henry, Weingartner, & Murphy, 1973).

The mood congruent learning hypothesis

The mood congruent learning hypothesis states that stimuli will be better learned if their valence matches the learner's mood (e.g. pleasant stimuli are learned better by happy people; unpleasant stimuli by sad people). The attentional/motivational explanation of this phenomenon states that participants seek to study material that agreess with their mood. Alternatively, encoding explanations state that increased activation of positive associations in memory permits better elaboration of positively valenced material, thereby leading to improved encoding (e.g. Mayer & Bower, 1985; Tulving & Thompson, 1973); similar effects are hypothesized to exist for negative associations.

Mood-congruent learning has been found using a number of different MIPs (Bower, Gilligan, & Monteiro, 1981, Experiments 1, 3 & 5; Bower & Mayer, 1985a; Gilligan, 1982, Experiments 3, 4, & 5; Gilligan & Bower, 1983; Mauro, 1984, Experiment 4; Nashby & Yando, 1982, Experiments 1 & 2; Teasdale & Russell, 1982; Teasdale & Taylor, 1981). On the other hand, mood-congruent learning has also not occurred with some of the same

MIPs at other times (Bower, Monteiro & Gilligan, 1978, Experiments 1, 2, & 3; Isen *et al.*, 1978; Kelly, 1982, Experiments 1 & 2). Mood-congruent learning may occur more consistently in studies of clinical groups; it was reported in four of five studies (Breslow, Kocsis, & Belkin, 1981; Cole, 1980; Gunderson, 1983; Stromgren, 1977, versus Finkel, 1981). But mood-congruent learning has generally not been found when comparing high- versus low-scoring college students on various mood scales measuring naturally occurring mood (Hasher, Jacks *et al.*, 1985; Hettena, 1979). It appears that the mood-congruent-memory effect is found with mood inductions and among psychiatric patients, but not with naturally occurring mood. This has led to a dispute over the effect, with some investigators suggesting the effect among normals is due entirely to demand (e.g. Hasher, Jacks *et al.*, 1985). A good case can be made, however, that demand explanantions are not sufficiently complex to account for the divergent findings, and that the effect is real, but detectable only when mood levels are strong (Ellis, 1985; Mayer & Bower, 1985).

Mood congruent retrieval hypothesis

The mood congruent retrieval hypothesis states that memory retrieval is enhanced for stimuli with valence that agrees with the retriever's mood. So, if a subject learned both pleasant and unpleasant-valenced stimuli in a neutral mood, and later entered into a happy mood, the pleasant material would be most easily recalled. The theroetical explanations for this effect are essentially the same as for the mood-congruent learning effect described above.

Studies of mood-congruent retrieval fall into two major classes. In semantic-memory tests, retrieval from the general lexicon and knowledge store is examined under conditions of happy or sad moods. In episodic-memory tests, material of different valences is first learned during the experiment, and then retrieval is once again examined in happy or sad moods. Among the semantic-memory tests are tests of free association and spew. In the free association measures, subjects free-associate to words in a given mood, and then the word-association valences are examined for mood congruity; outcomes from this procedure have been largely negative (Mayer & Bremer, 1985; Mayer & Volanth, 1985a). In the second procedure, word-spew, subjects list words from a category (e.g. "Types of Personalities"). Once again, the valence of the word produced is examined to see whether it matches the mood. Findings with naturally occurring mood have also been negative (Mayer & Bremer, 1985; Mayer & Volanth, 1985a). Thus, there is little evidence for mood-congruent retrieval from semantic memory at this time.

In episodic memory tests of mood-congruent retrieval, subjects learn stimuli of positive and negative valence and then recall them in either a positive or negative mood. As before, if the valence of the recalled material agrees with mood, then the hypothesis is supported. Isen *et al.*, (1978) reported this effect, but it was not found in a later study (Clark, Milberg, &

Ross, 1983). In conclusion, no known experimental procedure or method has been adequate thus far consistently to produce mood-congruent retrieval.

Mood-state dependent retrieval

The mood-state dependent retrieval hypothesis states that material will be recalled better to the degree that mood at learning and at recall are similar. Essentially, the repetition of a given mood at recall serves as a retrieval cue for material which was learned earlier in the same mood.

Note that the mood-dependent retrieval effect is entirely independent of the mood-congruent learning and memory effects discussed above. As noted above, the mood-congruent learning effect states that mood-congruent stimuli are more readily associated with the learning mood (e.g. pleasant words are better learned in happy moods, unpleasant words in sad moods). Mood-dependent memory, on the other hand, begins with an association between a stimulus of arbitrary valence and mood-at-learning. Then an association is formed between mood-at-learning and mood-at-recall. This association between mood-at-learning and mood-at-recall helps to cue the stimulus associated with the learning mood.

A number of theories predict mood-dependent retrieval. In Bower's (1981) conceptualization, mood serves as an active site in memory from which activation spreads to associated ideas, concepts, and images. When material is first learned, it is associated to the mood it is learned in. When that mood is re-experienced, the mood spreads activations to the stimuli which had earlier been learned in the same mood.

Mood-dependent retrieval was first reported by Bower, Monteiro, and Gilligan (1978), where it appeared in the third of three experiments. The most obvious possible cause of the third, positive finding was the two-list interference design employed in the study, in which two lists were learned, one each in an experimentally induced happy and sad mood. Then two lists were recalled in a third mood, which matched the learning-mood for one list and mismatched the other. (The first and second studies of the report had used a single-list design and yielded null results. The two-list design was considered stronger in part because it provided an extended within-subject design). Regrettably, further experimentation with the two-list interference design of the third experiment also yielded a number of null results (Bayer, cited in Bower & Mayer, 1985a; Bower & Mayer, 1985b; Ellis, 1983; Wetzler, 1985) in addition to mixed and positive results (Bartlett, Burleson, & Santrock, 1982; Goerss & Miller, 1982; Share, Lisman, & Spear, 1984). This led Bower and Mayer (1985b) to conclude that the original very strong results were spurious. But a revised, more sensitive experimental design that also established causal associations between learning material and mood (Bower & Mayer, 1985b, Experiment 4) was able to detect a weak effect. Thus, early reports of MDR could not be consistently replicated in the same (and different) laboratories. A recent new design, however, does show promise for yielding the effect. Firmer conclusions concerning the effect await further experimentation.

Overall critique of mood and memory results

Results for the four mood and memory effects (i.e. differential learning, mood-congruent learning, mood-congruent retrieval, and mood-state-dependent retrieval) are mixed, with the strongest findings for mood-congruent learning, and the next strongest findings for both mood-dependent retrieval, and differential learning. Mood-congruent retrieval garnered the least support. Even the most heavily supported effect among these — mood-congruent learning — is still controversial. The reason for these controversies may be that these phenomena are, to a greater degree than initally appreciated, under the control of the individual experiencing the mood, and therefore may be responsive to the individual's encoding strategies and motivations (see discussion below on the nature of mood influences of cognition). Although the picture is mixed, research in the area continues, and it seeme likely that a clearer picture of at least some of the mood and memory effects will emerge in the next several years as more powerful experimental procedures are employed.

Mood change and judgment

The mood-biased judgment hypothesis

The mood-biased judgment hypothesis states that bad moods will yield pessimistic, negative, judgments whereas good moods will yield optimisitic, positive judgments. One of the first explanations of mood-biased judgment was that is was secondary to a memory effect. According to this explanation, a memory advantage was assumed for mood-congruent past experiences. Since memory for past events determines the likelihood assigned to similar future events (e.g. the "availability heuristic", Tversky & Kahneman, 1973), this should lead to mood-biased judgment. Given the lack of clear results from studies of mood and memory, however, this theoretical explanation is in doubt.

A second possible explanation for the mood-biased judgment hypothesis is that category boundary lines for the assignment of an evaluation are shifted with mood, so that in a happy mood, for instance, more concepts are perceived as positive. This shift in category boundaries may then cause the biased judgment effect. As an example, a subject may be asked to predict the likelihood of "a baby being born in good health" in the USA. One can imagine an optimist accepting a number of birth-related incidents (e.g. a birthmark, a brief bout with jaundice) as trivial problems, and respond that good health is a high-probability event. In contrast, a sad subject might view the same health-defects with considerable concern, and therefore consider good health a low-probability event.

Support for mood-judgments comes from a number of experimental procedures including probability estimation, word ratings, prototypicality judgements, advice giving, and self-ratings. In probability estimations, positive events are perceived as more likely as mood becomes more positive, while negative events are preceived as less likely. Results from experimental studies using hypnotic mood induction (Bower & Cohen, 1982), story mood-induction (Johnson & Tversky, 1983), and naturally occurring mood (Mayer

& Bremer, 1985; Mayer & Volanth, 1985a), All consistently show this effect of mood on probability estimates.

The second procedure that yields mood-biased judgment includes two different types of stimulus ratings. In the first, subjects are simply asked to estimate the number of ideas, thoughts, or associations brought to mind in response to a stimulus. Good mood should increase the number of ideas summoned by positive words and decrease those summoned by negative words; the reverse is true of bad moods. This rating effect has been found with two studies of naturally occurring mood (Mayer & Bremer, 1985; Mayer & Volanth, 1985a). In the second type of stimulus rating, subjects are asked to rate directly the pleasantness of the stimuli. For instance, Forest *et al.* (1979) found that slides of faces were rated more positively as induced mood became more positive.

The third procedure that yields mood-biased judgments is prototypicality tasks, in which subjects are asked to select the most typical member of a category (e.g. the category "personality type") from a diversely valenced set of choices (e.g. "honest", "cold", "extrovert"). They tend to choose that exemplar closest to their own mood in valence (Mayer & Volanth, 1985a). Similarly, in the fourth procedure that yields mood-biased judgments, advice-giving, subjects read about a situation, and select a positive, neutral, or negative advice alternative. Mood-congruent advice is most likely to be chosen (Mayer & Volanth, 1985a).

Finally, in self-ratings, subjects evaluate themselves along multiple dimensions, each of which is correlated with a positive–negative evaluation (e.g. honest–dishonest, warm–cold). As mood becomes positive, evaluation is positive, and vice versa (Beck, 1967; Derry & Kuiper, 1981).

Overall critique of mood-biased judgments

There are consistent and broad influences of mood on judgment. The correlations between naturally occurring mood and measures of these judgments are gererally modest. Nonetheless, when one considers that a person is constantly making such judgments and evaluations, day after day (and often returning to a preferred mood as well, e.g.,Emmons & Diener, 1985), it seems likely that the cumulative effect of mood is to bias judgment significantly.

The nature of mood influences on cognition

It seems intuitively obvious that while mood sometimes changes thinking in an automatic fashion, most individuals are able to counteract or "override" such changes volitionally. For instance, when sad, a salesperson may well begin to doubt his or her ability to make a sale, but during the course of a sales presentation, an individual must adopt a confident stance so as to promote the sale. The relationship between cognition and affect is thus "cognitively penetrable" (Pylyshyn, 1985, p. 133).

By separating out people who consciously change their mood-senstive judgments, one may learn more about how mood influences cognition. Mayer and Volanth (1985b) have developed a scale of cognitive strategies

expected to disrupt the mood-biased judgment effect (e.g. "I am thinking of good things to cheer myself up"), and have successfully divided samples on the basis of scale results into people with strong and weak mood-cognition links. Folkman and Lazarus (1985) have examined coping strategies people use in response to stress. Pietromonaco and Markus (1985) have taken a different approach — examining stimulus variables which moderate the mood-biased judgment effect. In a study of probability judgments about oneself or a friend, these authors found that only self-referential judgments elicit the mood-biased judgment effect. Although judgments about others have been found to be mood-sensitive using other procedures, it probably is true that the more self-relevant the problem, the more mood-biased the judgment. The identification of moderating strategies is a new area in cognition and affect, but it holds promise: the form of moderating strategies may tell us something of the mechanisms which connect cognition to affect.

SUMMARY OF EMPIRICAL FINDINGS REGARDING MOOD'S INFLUENCE ON COGNITION

First, the evidence is clear that much of the categorization of the surrounding world is based on whether stimili are positive or negative in valence. Furthermore, there are social and cultural influences promoting the transmission of positive conepts. Although the world is classified as positive or negative, the effect of this on memory is unclear at present. Mood-biased judgment — the tendency for judgment to be skewed toward positive evaluations in a good mood — is a broad, well-supported phenomenon, with converging evidence from both induced and natually occurring mood studies. The mood-bias effect alters probability estimation for events, selection of prototypical category members, advice-giving, and stimulus ratings. Since the mood-bias effect is well demonstrated, it becomes of interest to examine why mood and judgement are linked in this way. This question is addressed in the next section.

DOES MOOD FACILITATE COGNITION?

The beginning of this chapter posed the question of whether mood can facilitate cognition. Examining mood's facilitation of cognition requires uncovering basic cognitive principles in human thought. To a psychologist, such understanding will contribute to a model of cognitive processes that will have implications to personality functioning. To a cognitive scientist, such understanding may enable the construction of more powerful theories by examining the similarities between mood-influenced human cognition and machine cognition. Such theories may eventually enable the construction of more powerful computer systems.

There are, however, so many cognitive domains that it is difficult to know where to begin a search for an answer as to mood's facilitation of cognition. Commonly, mood is said to provide "motivation" for cognition (e.g. people solve the problem of how to meet friends in order to avoid

loneliness). While this may be true for human beings, computers clearly compute without any such mood-inspired motivation. Does mood contribute to cognition in some way beyond simply providing the motivation to consider certain problems?

The above review has demonstrated areas in which cognitions are linked with mood. One such mood-linked cognition is probability estimation (a part of the mood-bias effect). When mood is pleasant, positive events seem more likely. Assuming this link is no accident, what could be its purpose or purposes? To begin to answer this question it may help to examine a specific domain. In the following section, it will be argued that mood-linked probability estimation may help human cognition during long-term planning. Long-term planning was chosen as a domain of study because of its obvious dependence on (mood-biased) subjective probability estimates of future events. Mood's facilitation of cognition will be discussed in terms of human planning and in an informal discussion of how a computer program might take advantage of the effect by emulating some of the mood-governed procedures in humans. The purpose of this section is simply to suggest a possible area in which mood might facilitate cognition. From the argument developed, a set of empirical predictions will be made, which if borne out, would lend support to the present hypotheses.

Real-time, real-world planning

The term "plan construction" will be used here to describe the process of concatenating a list of actions which, when performed in order, are intended to reach a goal. Some plans will typically depend upon certain events occurring. These events are here called "plan-selecting events" because their outcome will determine which of several plans can be used to obtain a goal. They will also have associated with them subjective probabilities of success — subjective probabilities, which, as seen above, are in part determined by mood.

Plan construction (e.g. applying to college, buying a house, getting a promotion) takes considerable time because it depends upon information gathering. Successful information gathering for most large plans requires substantial time in order to locate initial information sources, then to follow pointers from the initial sources to supplementary sources, and so on to still further information sources. Depending upon the plan size and its importance, an information processor may easily pass through a number of such stages before completing a search sufficient to construct a plan. Such information gathering will be delayed and interrupted by real-world time constraints. Consider the following example: in the Northeastern United States, high school students constructing a college application plan must first find information sources concerning the application process. An initial inquiry may direct the students to their high school guidance counselors and a given publisher's guide to colleges. These sources in turn will direct the students to the Educational Test Services brochures, which will require study. In a third stage, the students will need to take the Educational Test Service's scholastic aptitude tests in order to help match their aptitudes with

an appropriate college. Information gathering in the scholastic aptitude test-stage alone can often take several months because of constraints imposed by test-taking dates and the waiting period for score-returns. In addition, the college application plan must be individually tailored. Introverted students may prefer small schools, where they can more easily make friends, rather than large schools. When such planning is not so tailored, the plans may have "bugs" and abort because it is impossible for the individuals to follow their own plans.

The generation of multiple plans

Because information gathering and plan construction take such a long time, it is more efficient to generate several branching plans and pursue them simultaneously. (e.g. a student selecting a school on the basis of prestige might, at various times, think: "If I do well, I'll apply to the State University — I better talk to Fred, whose brother goes there." "If I do really well, and I can get financial aid, I could go to an Ivy League school — I'd better check into financial aid." "If I do okay, I could go to the city college — Mary's going there and I can ask her what it's like.") The point is that only by completing some of the future plans before the plan-selecting event occurs (e.g. aptitude test-scores come in) can critical delays be avoided. Thus, in order to meet April application deadlines, a student who gets scholastic aptitude test-score returns in March must have already completed considerable plan construction (concerning financial aid and school choice) before the scores are returned. In this case, test scores (or comments from the guidance counselor, or information from a guide to colleges) can all be considered plan-selecting events, in that information from any source may lead to a different plan being executed.

Mood as a feedback mechanism

Mood, because of its sensitivity to diverse inputs, provides a mechanism whereby both the past and current environment are integrated with current planning. For instance, a bad mood will have an enhanced likelihood of occurrence when any of several conditions hold: first, if the individual has a history of negative events occurring in his/her life, and second, if negative events are presently occurring. When negative events take place, a bad mood sets in, thereby altering event perception to anticipate the higher likelihood of other negative events. Mood thus acts as a feedback mechanism, causing a person with "bad luck" at one time to expect the occurrence of further negative events; a person with "good luck" expects further positive events. Unlike the case of simple learning, however, when mood temporarily shifts, the individual will "break set" and consider unaccustomed future alternatives.

Mood and context sensitivity

Current research findings do not answer the question of whether some types of moods (i.e. moods caused by winning $2000.00 in the lottery) might generalize to cognition more (or less) than other moods (i.e. falling in love);

or whether certain domains of judgment will be more strongly influenced than others. Pietromonaco and Markus's (1985) findings suggest that there is a "generalization gradient" for mood-caused optimism and pessimism, beginning with judgments of oneself, and falling off as judgments become less personal. But since there is little empirical evidence in this area at present, it seems prudent to make the simplifying assumption that moods due to any cause will lead to optimism–pessimism changes in any area equally. In the future, research such as the above may provide information as to heuristics used in successful human planning.

Mood as a determinant of plan construction

As mood becomes more positive, pleasant-valence events become more likely. From an individual's perspective, this will necessitate alterations in planning. For instance, in a good mood, the likelihood of gaining admission to a good college or university will be seen as more likely; the result of matriculating will then be instantiated by a desirable example (e.g. becoming an honors student with many friends, according to the prototypicality effect, above). As mood deteriorates, the liklihood of obtaining desired goals declines. Along with it, the rewards of the most desirable plan seem diminished (an image of a worn-out, lonely undergraduate replaces that of the honors student). This negative mood generates an alternative plan, which perhaps centers around stress avoidance and mental-health maintenance, and may concern matriculation at a less competitive school. Good moods generate plans based upon events having good outcomes, bad moods generate plans based upon events having bad outcomes.

Mood and the selection of the optimal plan

The utility of executing a given plan has often been considered, in part, a function of its likelihood of attainment (e.g. McClelland, 1985). No matter how desirable the goal, it will have no utility if it cannot be reached. It should be noted that different likelihood estimates of plan-selecting events therefore require different plans. And thus, as likelihood estimates of plan-selecting events change, so must the plan to obtain a goal. Thus, plan selection is a function of (1) choosing the plan which leads to the most pleasant goal from among (2) those plans with probable likelihoods of attainment. In mood-biased processing, the ambient mood also assigns the priority of which plan to work on: the most likely plan with the best outcome. In this way, through mood, the successes of past performance in part determine the difficulty level of future plans. But recall that as mood changes it will enable the individual to better break set and consider alternative plans, as noted above. Further, mood lowers unnecessary cognitive processing of future predictions, as will be discussed next.

Mood as a substitute for "predicting the future"

Future predictions of cultural, societal, or individual behavior are notoriously difficult because the culture, society, individual, and their environment are constantly changing. A logical generalization to an unknown

future is often difficult or impossible since the future is often controlled by processes which are poorly understood. Attempting logical prediction under such conditions would require generation of a number of poorly substantiated rules concerning events. And in fact, for most of human history, future prediction of such events has been the province of the mystic, the crystal-ball gazer, and tarot card reader.

In contrast to such pseudo-prediction, mood-altered cognition may provide a productive alternative approach to the problem. As noted before, if the person has experienced a number of failures, mood will be more unpleasant, and the probability of future positive events will be adjusted downward. If the person has experienced a number of positive events, the likelihood of future positive events will be adjusted upward by mood. Previous events will, through mood, generalize to almost all future events without the necessity of generating logical but often arbitrary causal connections or over-generalizations. This mood-linked future perception inherently provides greater flexibility in planning alternatives than the logical or superstitious rules which might arise from an often doomed rational approach to future prediction of social/cultural/personal events. Such mood-change provides an automatic approach to alternative plan construction in which little cognitive expenditure is necessary to provide an array of future plans, and which avoids the difficult and often intellectually intractable problem of predicting the future.

Individual differences in mood stability

Occasionally, the environment might provide too stable a pattern of feedback, or too little feedback, so that only one or two plans will seem adequate to prepare for the future. But basing plans on stable likelihood estimates of plan-selecting events may not always prove to be an optimal strategy. Because of their own internally generated mood change, however, some individuals may engage in creating alternative plans. The evidence for physiological mood cycles come from studies of psychopathology (e.g. manic-depression) from developmental temperament studies (e.g. Goldsmith, 1983), and from trait studies of neuroticism (Eysenck, 1982, pp. 85–90). This all suggests that mood cycling will foster novel planning approaches to the environment when the environment is temporarily stable.

Implications of the argument to an automatic system

The above argument suggests that a computer-based planning system encountering an inherently unpredictable environment need not be designed to "predict the future." Rather, multiple plans should be constructed in as detailed a fashion as possible, with each plan anticipating a different plan-selecting event. If processing time is limited relative to the number of possible plans, the program can select those plans which best agree with the previous level of success at obtaining positive outcomes of plan-selecting events. This is analogous to working on a plan that anticipates a pleasant outcome when one is in a good mood. As the anticipated plan-selecting events occur, the program switches to a plan based on the actual

event that occurred and is then ready to proceed in a smooth fashion with the execution of the predetermined optimal plan for the post-event environment.

It will be noted that this approach to building an automatic system is not so different from the approach we would expect a programmer to take who was confronting a domain where prediction is impossible. This is the case even if the programmer were entirely ignorant of how mood influences cognition. Although knowledge of mood effects may be unnecessary for the programmer, the conceptual similarities between mood-based human planning and such an automatic-system approach may provide a more elegant and precise classification of planning approaches within cognitive science, and perhaps a classificatory scheme with greater generality and therefore greater explanatory power.

Implications and predictions of the argument

Returning to human cognition, since some individuals experience mood cycles while others have relatively stable mood (as noted in the above section on individual differences in mood cycling), it should be possible to examine the influence of mood cycles on life planning. In their most extreme form, mood cycles are identified with manic-depression, that is, severe depression follows intense elation and is followed again by depression with such rapidity that life seems out of control. In less extreme varieties, however, the regular passage from happy to sad mood and back again is considered one of the defining features of the personality trait of neuroticism. Commonly, such individuals endorse items on tests scales like "I am sometimes bubbling over with energy and sometimes very sluggish," and "I have frequent ups and downs in mood; either with or without apparant cause." Mood-cyclers may also be more confused about life plans, because they create a wider variety of plans from which to choose. It is predicted, however, that mood cycles (in their everyday variety but not in extreme manic-depressive form) will be advantageous for planning. The following advantages of mood cycling are expected to outweigh most drawbacks. First, mood-cyclers should have plans which involve plan-selecting events with a broader range of subjective probabilities. Second, these plan-selecting events should encompass a broader range of valences, as judged by independent raters. Third, mood-cyclers may have fewer rules for the prediction of future events because their future prediction is determined more by mood than rule-governed hypothesis. Thus, in the applying-to-college plan discussed above, mood-cyclers should estimate a higher likelihood of obtaining extreme test scores (a plan-selecting event) than their stable counterparts. The mood-cyclers' range of possible scholastic aptitude test scores should be wider in absolute terms, and they should generate fewer rules concerning future prediction than mood-stables. Thus, mood-cyclers should be prepared for a broader range of possible future events than mood-stables.

Summary of discussion and predictions

The present discussion began with the empirical finding that mood-change generates similar changes in the likelihood estimates assigned to future events. Good mood leads to expectations that good events will occur, bad moods to expectations that bad events will occur. These alternative probability estimates are hypothesized in turn to generate multiple plans, based on expectations of different event-occurrences in different moods. It was also suggested that these multiple, anticipating plans may take the place of serious efforts to generate logical but poorly substantiated hypotheses to predict future social/cultural events. In place of that approach, people who experience mood cycles may show adaptive advantages because such people generate multiple plans and therefore have greater flexibility in responding quickly to critical events as they occur. These hypotheses are open to empirical test.

GENERAL CONCLUSION

This chapter presents a discussion of how mood can influence cognitive processing. First, it was noted that moods are quite different from the phenomena which cognitive scientists usually study in that moods are not obviously rational or easily quantified. Second, the domain of affect was analyzed into subsidiary concepts of evaluation, emotion, and mood, and these were defined. Third, the chapter reviewed the influence of evaluation and mood on cognition. A consistent and interesting finding that emerges is that mood alters judgments in a variety of predictable ways. When mood is pleasant, pleasant events are anticipated, categories are instantiated by positive exemplars, and pleasant concepts generate a subjective feeling of bringing forth more images, thoughts, and associations. Negative moods, on the other hand, create similar biases leading to parallel negative cognitions.

This pattern of cognitive change was hypothesized to influence planning. It was argued that real-world, real-time planning is time-consuming, and for that reason must be initiated before critical events occur. As mood shifts, the perception of the likelihood of various critical events will change — positive critical events will seem more likely in a good mood, negative critical events will seem more likely in a bad mood. Such mood-generated shift in perception will in turn lead the individual to generate different plans for different event outcomes. The additional plans will lead to greater flexibility and adaptability in acting quickly when critical events occur. Secondarily, mood mediates feedback of past life events, into current planning. For instance, a trend toward increasing success will often generate a positive mood, which in turn will allocate more time to future plans which assume positive events.

It was also argued that whereas an entirely "rational" approach to future planning could lead to spurious rule generation concerning future event prediction, mood change may obviate the necessity of generating rules for future event prediction and instead focus attention on what plans might be

useful to generate. In more general terms, current research into cognition and affect provides a basis and an opportunity for a serious exploration into how mood may assist cognitive processes.

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