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THE INFLUENCE OF INDUCED POSITIVE AND NEGATIVE MOOD ON LEFT- AND RIGHT-HEMISPHERIC TASK PERFORMANCE

by

Deleri Springer

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

1989

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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Abstract

THE INFLUENCE OF INDUCED POSITIVE AND NEGATIVE MOOD ON LEFT- AND RIGHT-HEMISPHERIC TASK PERFORMANCE

by

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Advisor: Professor Howard Ehrlichman

There is general agreement that many cognitive functions are lateralized to one or the other cerebral hemisphere and further, that these processes can be localized to the more posterior aspects of the brain. It is also believed that emotion is asymmetrically distributed although the specific pattern of lateralization is still debated. Most workers do agree though that the anterior cortical zones are primarily involved in affective processes.

Two theories have been advanced which propose that neural activity in one cortical region is accompanied by predictable changes in neural activity at other cortical sites. Since emotional and cognitive activity are associated with increased neural excitation in the brain region representing it, it follows from these theories that activation of one mental process, and hence its underlying neural structure, should influence the behavioral expression of other processes served by connected brain regions. Based on these models and on what is known about hemispheric specialization, it was hypothesized that positive and negative moods would differentially affect the performance of tasks

sensitive to left and right hemispheric functions. To test these predictions, 72 right-handed females were given 3 timed tests of left hemisphere function and 3 timed tests of right hemisphere function in an initial session. At a later date, the subjects were exposed to either the elation, depression or neutral Velten Mood Induction Procedure (MIP) and administered parallel versions of the 6 cognitive tests. Self-report measures of mood were obtained before the induction procedure and then immediately before each test. Change in test score from the first to the second administration served as the dependent variable. The results did not support the predicted interactions between type of mood and type of cognitive task. With one exception, there were no significant changes in test peformance. A significant main (group) effect was observed for the Arithmetic test with the neutral subjects showing improved performance and both emotion groups deteriorated performance. These findings suggest that the Velten MIP may not be an appropriate analogue of natually occuring mood. The data also seem to suggest that reported mood effects on cognitive performance may be better understood from an information processing perspective than from a neuropsychological one.

Were it not for the following people, this paper, and all that led up to it, would not have been. For all they have given, I acknowledge and thank

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and lastly, Harry W. Springer, my father and William G. Spiros, "the wind beneath my wings" to whom this work is dedicated.

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AFFECT AND COGNITION

It is not surprising that research has supported the intuitively appealing notion that one's emotional state influences his or her behavior in a wide variety of situations ranging from altruism (see Barden et al, 1985; Isen, 1984) to reaction time (Ladavas et al, 1984). The bulk of attention, however, has focused on the relationship between affect and cognition (Boyle, 1983; Dobson and Dobson, 1981; Dunn, 1968; Ellis et al, 1984; Galassi et al, 1981; Heinrich, 1979; Isen and Daubman, 1984; Masters et al, 1979; Samuel et al, 1978), especially memory.

The idea that people's mood can affect their memory processes is the most widely researched topic in the affect-cognition area (Hoffman, 1986). Depending on the study, mood may be present naturally as in clinical depression (Weingartner et al, 1977) or induced by any one of a variety of techniques including hypnosis (Bower, 1981; Bower et al, 1978), imagining or recollecting emotional events (Gage and Safer, 1985), exposure to mood inducing statements (Ellis et al, 1984; Snyder and White, 1982; Sutherland et al, 1982; Teasdale et al, 1980), success or failure on a task (Isen et al, 1978), offering a gift or refreshments (Isen, 1984), exposure to emotion evoking films (Boyle, 1983; Isen et al, 1985) or music (Clark and Teasdale, 1985; Sutherland et al, 1982; Teasdale and Russell, 1983) or the presentation of positive and negative olfactory stimuli (Ehrlichman, 1984, 1986). An examination of the mood-memory literature will reveal two theoretical perspectives: state-dependency and mood congruency.

Taking their lead from state-dependent learning effects in which an organism cannot recall previously learned material unless it is returned to the physiological condition (e.g. drug intoxicated) present when the material was originally learned, several investigators (Bartlett et al, 1982; Bower et al, 1978; Clark et al, 1983; Gage and Safer, 1985; Nasby and Yando, 1982; Weingartner et al, 1977) have shown that one's emotional state could similarly serve as a retrieval cue. The mood congruency perspective (Bower et al, 1981; Clark and Teasdale, 1985; Isen et al, 1978; Teasdale and Russell, 1983) holds that material whose emotional tone is compatible with the mood state at testing will be better recalled than will incompatible or neutral material. Thus, in the state-dependent model, the emotional valence of the target information is unimportant. As long as acquisition and testing occur in the same mood state, memory will be enhanced. On the other hand, the emotionality of the target material is of primary importance in the mood congruity model where, for example, a happy mood will lead to greater recall of positive trait words compared to other words.

Even though a more complete discussion is beyond the scope of this paper, it should be noted that these two approaches may not be incompatible. Several workers (Blaney, 1986; Bower, 1981; Clark et al, 1983; Gilligan and Bower, 1984; Teasdale and Russell, 1983, but see also Isen, 1984) have discussed how both the models and the data generated by them can be integrated.

Other work exploring the relationship between neural organization, particularly cerebral asymmetry, and behavior has revealed that certain cognitive and affective processes are associated with specific brain regions. An appreciation of these brain-behavior patterns may make possible a better understanding of how feeling influences thinking. A recent experiment by Gage and Safer (1985) can illustrate this.

Based on the different processes and strategies believed to be characteristic of the two cerebral hemispheres (see Bradshaw and Nettleton, 1983 and page 5 here), Gage and Safer (1985) hypothesized that the right, but not the left, hemisphere stores the mood present at the time of encoding along with the specific information encoded as part of the total memory representation. Consequently, if during recall a different mood prevails, right hemisphere performance would suffer while left hemisphere functioning would remain unaffected. To test this prediction, male and female subjects were exposed to mood inducing tape recordings which encouraged them to imagine very pleasant, very unpleasant or neutral situations. Following this first mood induction, the subjects were asked to look at 10 faces each depicting one of five emotions. The pictures were presented for five seconds in the center of the visual field. After a brief relaxation period, a second induction was administered to create a mood opposite to that experenced initially. This was followed by the presentation of a second set of 10 faces. A third mood induction preceeded the recognition test. For some subjects, the recognition test mood matched the first induced mood; for others, the second induced mood was recreated for testing. The subject's task was to indicate which of 40 faces presented for 200 msec to the left or right visual field was an old (familiar) face and which was a new one.

The results supported the prediction. Left hemisphere accuracy was equivalent in both the same and different conditions. That is, subjects who were tested in a mood different from that present during learning performed as well as those whose learning and test mood were compatible when the test stimuli appeared in the right visual field (left hemisphere). When the faces were projected to the right hemsphere however a different pattern of results was observed. When learning and recognition moods matched, left visual field (right hemisphere) performance was equivalent to right visual field performance. When recognition mood was different from learning mood, left visual field accuracy was significantly impaired.

The study that will be proposed here is designed to extend the understanding of mood effects on cognitive processing by examining their relationship from such a neuropsychological standpoint; however, unlike most other studies, [1] this one will vary both the nature of the mood and the nature of the cognitive task. Based on what is known about hemispheric specialization, localization of function within the hemispheres, and the observations (Davidson, 1984a; Kinsbourne and Hicks, 1978: Kinsbourne and Hiscock, 1983) that activity in one brain region affects activity in other brain regions, a differential effect of mood state on cognitive processing dependent on the interaction between type of mood and type of cognitive task is predicted. More specifically, a positive mood is expected to influence verbal-analytic (left hemisphere) task performance differently than it will gestalt-holistic (right hemisphere)

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[1] An exception is Ehrlichman, 1984

task performance and differently than will a negative mood. A negative mood is also expected to produce differences between the performance of left hemisphere tasks and right hemisphere tasks. The two theoretical models (Davidson, 1984a; Kinsbourne and Hicks, 1978; Kinsbourne and Hiscock, 1983) that can be called upon to indicate the direction of change however make opposite predictions. Thus, in addition to exploring relationships between affect and cognition per se, the proposed study may serve as a test of these alternative views.

LATERALIZATION, LOCALIZATION AND BEHAVIOR

Although it was not until 1885 that Broca proclaimed "we speak with the left hemisphere" (Walsh, 1975 in Bradshaw and Nettleton, 1983, p. 36), suspicion of lateralized brain function existed as far back as the ancient Egyptians (Hecaen and Albert, 1978). The term "lateralization" refers to the degree to which a mental process is predominantly served by one or the other cerebral hemisphere. The more lateralized a task, the more exclusively is one hemisphere presumed to be involved in that task.

Lateralization can be assessed in a variety of ways. Obviously there are the direct observations of loss of function associated with damage to specific brain regions. Other evidence comes from studies of patients undergoing brain surgery when, for example, electrical stimuli are applied to intact cortical sites temporarily producing a very localized functional lesion in order to determine effects on on-going cognitive activity. Reports on the behavior of patients whose corpus callosum has been surgically disconnected to help alleviate intractable epileptic seizures have provided some of the most interesting findings in the field.

There are several methods available to explore asymmetrical functioning in normal populations as well. Generally, they can be conceptualized as follows: the techniques that are physiological in nature, such as EEG, cerebral blood flow, etc. typically vary the cognitive tasks and measure bilaterally changes in brain activity as a function of the tasks. Behaviorally oriented methods such as tachistoscopic recognition, dichotic listening, etc. control the laterality of the stimulus and/or response and compare reaction time and/or accuracy as a function of where the stimulus and/or response occurs.[2]

As the list of tasks found to be asymmetrically distributed grew, it occurred to several researchers that the activities handled by one or the other hemisphere had in common certain processing requirements. Thus, many workers (see Bryden, 1982; Bradshaw and Nettleton, 1981, 1983) have proposed that each hemisphere be viewed not as specialized for a specific task(s) per se but rather as having a preferred processing strategy: tasks which demand a logical-analytical approach, such a language, will be under left hemisphere control while those for which a more gestalt-holistic strategy is appropriate, such as spatial relations, will primarily engage the right hemisphere. According to Wood (1983), though

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[2] It could be argued that the Lateral Eye Movement (LEM) technique violates this classification design as it is a behavioral measure essentialy relying on the same principles as do the physiological approaches. If however, we can accept LEMs as an indirect measure of cerebral activation (see Kinsbourne, 1972) then this scheme remains justifiable.

> Laterality of function is probably a meaningless concept unless there is some geographically localized concentration of activity in one of the two hemispheres. Thus, in most cases, lateralization of function also implies some intrahemispheric localization (p. 388).

Tucker (1984) has made a similar point stressing that "anterior-posterior differences can no longer be ignored and may be crucial to understanding hemispheric specialization itself (p. 229)."

The central sulcus is the feature most commonly used to divide the brain along an anterior-posterior dimension. As will be reviewed in the sections that follow, there is considerable evidence that many cognitive activities generally involve the more posteriorly located regions (Davidson et al, 1979a; Furst, 1976; Ornstein et al, 1980) while emotional experience occupies the anterior frontal zones (Ahern and Schwartz, 1985; Bennett et al, 1981; Davidson, 1984a; Davidson and Fox, 1982, Davidson et al, 1979b; Meyers and Smith, 1986; Robinson and Benson, 1981; Robinson et al, 1984; Schaffer et al, 1983; Tucker et al, 1981 but see Tucker and Dawson, 1984. See also Flor-Henry, 1979.) There is also evidence, both physiological and behavioral (see Davidson, 1984a) that changes in frontal activity are associated with changes in ipsilaterial and contralateral posterior activity. This too will be explored in greater detail.

Cognitive Processing: The Left Hemsiphere

Language A quarter of a century ago Hecaen (1962) stated "...it is impossible to question the fact that the region of language is situated in the left hemisphere...(p. 217)." Since left hemisphere dominance for language is the most strongly supported observation in the field of cerebral asymmetry (see Bryden, 1982; Benson, 1985; Bradshaw and Nettleton, 1983) let us continue to where, within the left hemisphere, the various language processes occur.

Studies of brain-damaged individuals have resulted in the identification of at least nine different aphasic syndromes each characterized by specific dysfunctions and each involving different brain regions. (Benson, 1985). Although it is certainly an oversimiplication (Benson, 1985) it may be helpful to categorize language functions as "expressive" or "receptive," the former referring to the production or output side of language and the latter to the comprehension or input side. As we move along the anterior to posterior axis, the associated language processes correspondingly shift from those involved with output (e.g. articulation) to those concerned with input (e.g. comprehension). For example, damage to the most anteriorly located region implicated in language, which is situated immediately in front of Broca's area in the posterior inferior frontal lobe produces transcortical motor aphasia. This is characterized by a reduction in the quality and quantity of spontaneous speech and writing. Comprehension of language, whether spoken or written remains intact (Rubens and Kertesz, 1985; see also Ojemann and Whitaker, 1978). The opposite pattern, both behaviorally and anatomically, is seen in transcortical sensory aphasia which accompanies damage to the most posterior aspect of the brain in the tempero-occipital areas (Rubens and Kertesz, 1985). Here, comprehension of spoken or written material is severely impaired although the patient is completely fluent. What the patients says however is unrelated to the topic at hand.

As for the areas inbetween these two zones, virtually all have been implicated in some aspect of language functioning (see Benson, 1985; Hecaen and Albert, 1978).

Another approach to the study of brain-behavior relationships called stimulation mapping involves electrical stimulation of various sites in awake patients undergoing brain surgery. In this procedure, short bursts of electrical current are applied to various cortical areas while the patient is engaged in a task. Performance during stimulation is compared to performance without stimulation. A major advantage of this technique is that it allows much more specific spatial and temporal localization than does any other (Fried et al, 1982).

Ojemann and Whitaker (1978) used this method to study right hemisphere functioning in two patients and left hemisphere functioning in nine patients as they performed a naming task. The subjects were shown a drawing of a common object with a sentence like "This is a ____" or "Here is a ____" printed on the page. The subjects had to read the sentence and complete it with the appropriate word.

Analysis of the data revealed that the amount of cortex involved in language in any one patient may be more extensive than previously believed. Interestingly, those regions found to be involved which were outside of the "classical" language zone tended to reach posteriorly toward the parietal lobe. "On the other hand, in our patients the language area seldom extended as far anteriorly into the temporal lobe...as Penfield and Roberts (1959, in Ojemann and Whitaker, 1978) indicated" (Ojemann and Whitaker, 1978, p. 248).

Ojemann and Whitaker also observed considerable variability between subjects with marked localization within subjects. That is, a site at which stimulation disrupted performance on every trial in one subject might have been totally unimpaired by stimulation in another. Futhermore, stimulation at one site might result in 100% error while stimulation 1/2 cm away was without effect. When the langauge area maps of all the patients were superimposed, only one site was found where stimulation disrupted performance in all subjects: a narrow band in the posterior inferior frontal lobe right in front of the central fissure. The investigators believe though that this impairment was due to interference in the articulation rather than comprehension aspect of speech.

Using the same electrical stimulation mapping technique with a more detailed scoring system, Manteer (1983a) and Ojemann (1983) analyzed articulatory, semantic and grammatical language functions in three types of tasks: a facial mimicry task, a phoneme indentification task and a task that consisted of object-naming, sentence-reading and short-term memory. Generally speaking, both sets of data confirmed the earlier findings of Ojemann and Whitaker (1978). Although the language area was found to be fairly uniform across patients overall, considerable variablity between subjects with discrete localization within subjects was observed. In other words, stimulation at one site may have affected certain aspects of the task, for example, grammar but not articulation. The function affected at that site, however, could be different in different patients. When all of the stimulation mapping data is considered together, a picture somewhat different from, but consistent with the classical anterior-posterior distinction derived from aphasia studies emerges. According to Manteer (1983a; see also Ojemann, 1983), langauge functions seem to be arranged coencentrically around the lateral fissure.

> A small posterior inferior frontal region just anterior to motor face cortex appears to be critical to voluntary oral motor responses. Surrounding this area anteriorly, posteriorly, and inferiorly in the periSylvian cortex of frontal, temporal, and parietal lobes is a broad region with sites important to the sequencing of oral movement and the decoding of speech sounds as well as to accurate articulatory selection and production...Specific features of linguistic usage such as naming and the generation and use of grammatic and semantic structures also appears to have localized representation. These linguistic functions all have some periSylvian representation where they often overlap with eachother...Further away from the periSylvian cortex in all three lobes, sites specific to grammatical accuracy, to semantic appropriateness, or to naming are identified (pp 175-176).

<u>Arithmetical processing</u> "Acalculia" is a general term that has been used to describe several types of calculation impairment. In order to better understand the variety of disturbances comprising this disorder, Hecaen (1962) recommended the following categorization which recent workers (see for example Levin and Spiers, 1985; Strub and Geschwind, 1983) still employ.

(1) Acalculia which results from the inability to read or write numbers or symbols e.g. "+" or "÷" distinct from alexia or agraphia for words.

(2) Acalculia of the spatial type (dyscalculia) in which the patient is unable to complete arithmetic tasks because of inappropriate positioning, such as improper alignment of numbers or reversal (15 vs

51) or inversion (9 vs 6) of digits. The basic principles of calculation, however, remain intact.

(3) Anarithmetrica, representing the purest form of acalculia (Strub and Geschwind, 1983) is seen when the patient no longer understands the basic arithmetical operations, e.g. carrying, borrowing, etc.

Evidence from brain-damaged populations (see Levin and Spiers, 1985; Strub and Geshwind, 1983) has provided the following localization data. Spatial acalculia, especially when there is no aphasic disorder or general intellectual disturbance, is more common and severe with lesions of the right parietal region. Acalculia associated with alexia and/or agraphia for numbers is found with left hemisphere damage, particularly in the parietal zone. Anarithmetrica may be associated with right hemisphere lesions but is far more common with bilateral or unilateral left posterior lesions (see also Warrington et al, 1986). Left hemisphere dominance, particularly in the posterior regions for arithmetical processing receives further support from studies of normal populations (Butler and Glass, 1974; Earle, 1985; Papanicolau et al, 1983; Shepard and Gale, 1983).

Cognitive Processing: The Right Hemisphere

The first documented observations of impaired "spatial" processing and right hemisphere disease appeared at about the same time that Broca asserted the relationship between the left hemisphere and language (Quaglino and Borelli, 1867; Jackson, 1876 both cited in Benton, 1985). Since then several distinct manifestations of spatial disability have been reported and found to be (1) independent of simple perceptual disorders, e.g. color-blindness, hemianopia, etc. and (2) separable, both functionally and anatomically from one another. The types of deficits associated with right hemisphere damage have been classified into three major categories: visuoperceptual, visuospatial, and visuoconstructive. Benton (1985, p. 153; see also Meier and Thompson, 1983)) has provided a summary of the specific kinds of disorder characteristic to each:

I. Visuoperceptual
  A. Visual object agnosia
  B. Defective visual analysis and synthesis
  C. Impairment in facial recognition
    1. facial agnosia (prosopagnosia)
    2. defective discrimination of unfamiliar faces
  D. Impairment in color recognition

II. Visuospatial
  A. Defective localization of points in space
  B. Defective judgement of direction and distance
  C. Defective topographical orientation
  D. Unilateral visual neglect

III. Visuoconstructive
  A. Defective assembling performance
  B. Defective graphomotor performance

Physiological and behavioral studies of normal populations (see Bryden, 1982; Bradshaw and Nettleton, 1983) have verified right hemisphere superiority in spatial tasks. Partly perhaps because right hemisphere organization of spatial ability does not seem to conform to the relatively orderly pattern observed in the left hemisphere for language, a discussion of each of these processes with respect to their within hemisphere localization is too large a task to be accomplished here.

Nevertheless, a more detailed presentation of three abilities can be found in the Method section under "Cognitive Tasks: Right Hemisphere ."

Emotional Processing

While there seems to be general agreement on the interhemispheric organization of cognitive processes, the lateralization of emotion is one of the most debated issues in the field today. The two dominant views are essentially as follows:

(1) All emotional processes, irrespective of valence, are lateralized to the right hemisphere.

(2) Positive emotions are lateralized to one, negative emotions to the other hemisphere.

Both positions have received support from clinical and normal populations and it is not yet possible to state which of the two is the more accurate representation. Nevertheless, there is one factor which may prove to be important in discriminating between these alternative models. The studies supporting the first are typically based on the subject's ability to perceive or express an emotion. There is no measure of the subject's emotional state nor is any manipulation employed to create an emotion. The data bearing on the second theory more often come from subjects who are experiencing the emotion at the time of testing. Indeed, Hirchman and Safer (1982), Reuter-Lorenz et al (1983) and Davidson (1984a, 1984b) have questioned whether the perception of an emotion involves the same processes as does the experience of it (see also Silberman and Weingartner, 1986). Davidson et al (1987) asked subjects to rate how intensely a face appearing in the left or right visual field expressed an emotion and how intensely that facial expression evoked emotion in themselves. Visual field effects were found only for the second rating. Subjects rated themselves as happier in response to stimuli presented in the right visual field and sadder in response to that same stimuli appearing in the left visual field . The reports offered by Ross (Ross, 1983; Ross and Mesulan, 1979; Ross and Rush, 1981) suggest further that the expression of emotion is also distinct from the experience of it (see also Ladavas et al, 1984, p. 483). With this is mind, let us compare some of the literature relevant to these perspectives.

Model I: All affective processes are lateralized to the right hemisphere.

Clinical Populations

Borod et al examined the various ways in which left and right brain damaged subjects expressed emotion (1985) and their perception and expression of facial emotion (1986). In the earlier study, subjects were rated on the extent to which they used speech, facial expression, and intonation as well as on the appropriatness of their response to emotionally evocative slides. Analyses indicated that speech was the most frequently used channel of communication among all groups. In the left hemisphere group, all three modes of communication were equally used to convey emotion. The right brain damaged group on the other hand used speech significantly more than intonation or facial expression. As we will see shortly though the absence of intonation should not be taken to indicate a lack of affective experience.

In the second study (Borod et al, 1986) subjects were videotaped as they displayed spontaneous or posed positive and negative facial emotion.

Spontaneous expression was recorded as the subjects looked at the emotionally evocative slides. Posed expressions were produced by asking the subjects to express a particular emotion or to imitate the facial expression shown by a model. Perception of facial emotion was tested by having the subjects indicate what emotion the characters in the slides were experiencing.

Analysis of expression accuracy as rated by two judges revealed the right brain damaged subjects as significantly less accurate than left brain damaged subjects or controls in the spontaneous expression of negative and positive emotions. They were also less accurate than the other groups in posing positive emotion. Compared to controls, both clinical groups were equally impaired in their ability to pose a negative expression.

Although the right brain damaged subjects may have had special problems expressing positive emotions, they did not seem to have any difficulty in perceiving them. These patients however can neither express nor perceive negative emotion. Left brain damaged subjects showed somewhat of an opposite pattern. They received the lowest scores of the three groups on posed negative and performed slightly less accurately than the right brain damaged group on perceived positive.[3]

That the right brain damaged group demonstrated more "paramotias (i.e. a part of the total facial expression was inaccurate), unrecogniz-

[3]Correlations between expression and perception accuracy scores between groups and emotional valence did not reveal any significant patterns. That the perception of emotion is independent of the ability to express emotion receives further support from Ross (1983; Ross and Rush, 1981).

able facial expression, facial groping (i.e. a disorganized performance of multiple facial movements without production of any one specific or recognizable configuration) (p. 178)" suggests that a motor impairment may have contributed to their poor performance on the expression task. If we look at just the perception data, impairments are found among right brain damaged subjects for negative but not positive emotions and in the left brain damaged subjects somewhat for positive but not for negative emotions.

Another group of findings sometimes cited in support of right hemisphere lateralization of all affective processes (see for example Bryden, 1982; Levy, 1983) is the emotional aprosodia commonly seen in right brain damaged patients.

Prosody, or the "melody" of speech has been divided into four types (Monrad-Krohn, cited in Ross, 1983). Intrinsic prosody refers to the rising and falling inflections of voice that convey grammatical information such as the upward inflection at the end of a question. Intellectual prosody denotes variations in the stress put on one word or another which changes the implication of the statement, e.g. HE is clever versus He IS clever. Inarticulate prosody describes the sighs, grunts, etc. of speech. Emotional prosody represents the way in which feelings are conveyed in spoken language.

Interestingly, the investigators reporting on right brain damage and emotional aprosodia (Ross, 1983; Ross and Rush, 1981; Ross and Mesulam, 1979; Tucker et al, 1977) do not attribute the flat communiation of their subjects to deficits in emotional experience per se but rather to the patients' inability to express affect.

In describing two right brain damaged aprosodic patients, Ross and Mesulum (1979) stress "We strongly emphasize that neither of our patients' (outward) affective demeanor truly reflected (inward) emotional state (p. 148)." Both patients claimed that they were fully able to experience emotion and in at least one (no data was reported for the second), the ability to perceive emotions in others was likewise unimpaired.

In another report, Ross (1983) described several cases in which the expression of emotion was absent but the ability to comprehend and experience emotion remained intact. In fact, one of the patients "became suicidally depressed during his illness (even though) he never displayed a depressive affect (p. 502)."

It may also be pointed out that aprosodia generally accompanies damage to the more posterior brain regions (Heilman et al, 1975; Tucker, 1977; Ross, 1983). Ross (1983) has provided evidence that prosody is organized in the right hemisphere in much the same way that "content" abilities are distributed in the left. As already mentioned, emotional experience is believed to involve the more anterior frontal zones.[4]

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[4]It is interesting that the patient described by Ross (1983) as suicidally depressed had sustained damaged to the right frontal area whereas among the other patients, the damage was more posteriorly located. It might also be added that Robinson and Benson (1981) observed greater depression in aphasic subjects whose lesions were more anteriorly located even though their damage related problems were less severe than were those in patients whose lesions extended further back.

Lastly, were only the right hemisphere involved in emotion, left hemisphere damage might not be expected to produce any deficits in emotional perception or expression. In two studies involving emotional recognition (Cicone et al, 1980; DeKosky et al, 1980) left brain damaged subjects, while not quite as impaired as the right brain damaged group, were nevertheless significantly more impaired than controls.

Normal Populations

In an often cited study, Suberi and McKeever (1977) asked female subjects to memorize emotional (happy, sad or angry) or nonemotional faces and then to indicate whether each of the various faces tachistoscopically presented to the left or right visual field was a familiar face or a new one. Their results showed a significant right hemisphere superiority for all subjects and for all emotions particularly among those subjects who had initially memorized emotional faces.

Similar findings were reported by Ley and Bryden (1979). Twenty-five cartoon faces comprised of five different males each showing five different expressions (very positive, mildly positive, neutral, mildly negative and very negative) were tachistoscopically presented to the left or right visual field. Immediately following, a second face was presented centrally. The subject's task was to judge whether the first and second faces were expresssing the same emotion and whether the two faces were of the same character. A strong left visual field advantage for both positive and negative expression was observed but only when they were extreme. Mildly positive and mildly negative faces failed to produce a lateralized effect. Further statistical analyses revealed that recognition of facial identity, although also showing a left visual field advantage, was nevertheless independent of facial emotion recognition.[5]

In a series of experiments involving tachistoscopic recognition of facial emotion and identity, Strauss and Moscovitch (1981) replicated the earlier findings of Ley and Bryden (1979). Male and female subjects had to indicate whether a pair of photographed faces appearing in the left or right visual field were expressing the same emotion (exp. 1) or matched in emotion a target emotional expression studied prior to testing (exp. 3). Three emotions were used: happiness, sadness and surprise. Overall the results showed a general left visual field superiority for emotional expresssion regardless of the emotion presented; however, such factors as the sex of the subject, the sex of the model, the conditions underwhich the subject was to respond, etc. influenced the magnitude of the observed lateralized effect. Since the type of emotion did not enter into any of these comparisons, further discussion will be omitted.

Further support for the notion that all affective processes are served by the right hemisphere has been found in studies using other stimulus modalities. Safer and Leventhal (1977, exp 1) presented two 3 sentence passages monaurally to the left or right ears of male and female subjects. The two passages varied in the emotionality of the content and in the tone of voice with which the sentence was read. In some cases, the

[5]Similar findings on the independence of the perception of faces per se and the perception of emotional expression have been provided by Strauss and Moscovitch (1981, exp 2) using tachistoscopic recognition in normal subjects, from matching studies in brain damaged groups (Cicone et al, 1980) and from electrical stimulation mapping in brain surgery patients (Manteer, 1983b).

emotionality of the voice was appropriate to the content of the passage, e.g. "when the dark freighter left port, the captain was in a nasty mood... (p. 76)" delivered in an angry voice. In the remaining combinations, tone of voice and passage content were mismatched. The subjects' task was to indicate whether they thought the sentence was positive, negative or neutral.

As predicted by the investigators, subjects who heard the passage in the right ear offered judgements based on content while those subjects who heard passages in the left ear rated them on the basis of tone of voice. This left ear bias was observed for both positive and negative emotions. While these results may be interpreted as indicating right hemisphere involvement in all emotions, they could also be seen as reflecting right hemisphere superiority in the processing of emotional prosody.

Bryden et al (1982) prepared nine 12 note tonal sequences which varied in affective tone. The sequences were paired in all possible combinations for dichotic presentation. The subjects were asked to rate the sequence arriving at a specified ear on its affective valence and intensity. Accuracy, assessed by comparing the subjects' evaluations to those of an independent sample of judges, served as the dependent measure. Overall, a left ear advantage was observed; however, the magnitude of the effect varied as a function of the difference in affectivity between the target and competing tones. The strongest left ear advantage was seen when the ears received melodies opposite in affective value.

The left ear advantage was observed for both positive and negative patterns.

Bryden et al (1982) acknowledge that these results might be interpreted as a demonstration of the right hemsphere's superiority in processing musical stimuli. They argue though that were this the case, the left ear advantage should have been strongest in the more difficult comparison when the two tones were similar. As already noted, the opposite effect was found (reminiscent perhaps of the findings observed in the emotional expression recognition study [Ley and Bryden, 1979] in which only extreme expressions produced a lateralized effect). The implication then is that the left hemisphere does not participate in musical judgement tasks. Perhaps though the more demanding conditions of similar target and competing tones encouraged increased left hemisphere participation. This, of course, would minimize observed ear differences and be reflected in higher right ear accuracy scores as the tasks became more difficult. Although the authors do not present separate left and right ear data, inspection of the graph included in their report does suggest increased left hemisphere involvement in the more difficult trials. In other words, the Bryden et al (1982) data may indicate that when a task is simple, the hemisphere specialized for it can process the task alone. As the task becomes more demanding, bilateral participation is observed.[6] The authors state "Left ear effects were found for all

[6]It may be noteworthy that a similar explanation has been proposed for facial perception, also a right hemisphere task (see Sergent and Bindra, 1981). Similarly, deRenzi (1978) reported that when shape discrimination tasks are simple, only right hemisphere involvement is noted. As the problems become more difficult, increasing participation by the left hemisphere is observed.

classes of stimuli. There was very little evidence for left hemisphere involvement in the processing of positive stimuli (p. 86)." Interestingly, what "little evidence" there was is consistent with the second model of lateralized affect: "Among (those pairings in which target and competing stimuli matched in affective tone) by far the largest left ear advantage was observed with the negative stimuli while the positive stimuli produced a slight right ear advantage (p. 85)."

Thus, the data supporting right hemisphere involvement in emotional experience is at best tentative. There does seem to be good evidence that perhaps due to its gestalt-holistic approach to information processing, the right hemisphere is better suited for the <u>perception</u> or <u>expression</u> of emotion[7] (see Tucker, 1981) but there does not seem to be any direct support for the notion that the right hemisphere is exclusively responsible for the <u>experience</u> of emotion.

<u>Model 2: Positive and negative emotions are differentially lateralized</u>

According to the second model, affective processes are differentially lateralized with positive emotions served by one hemisphere and negative emotions by the other. Here too support can be found from both normal and clinical populations.

<u>Clinical Populations</u>

Terzian (1964) reported on the various behavioral changes observed when either hemisphere is barbiturized prior to surgery in order to ascertain language representation. To distinguish the dominant from

[7] Indeed, Silberman and Weingartner (1986) have extended this argument by suggesting that the right hemisphere superiority for processing emotional stimuli may actually represent a confound in studies of the lateralization of affect.

the nondominant hemisphere[8], he offers two criteria (p. 233): observed language disturbance and emotional response. Injection to the dominant hemisphere produces a depressive-catastrophic reaction:

> the patient especially when spoken to, despairs and expresses a sense of guilt, of nothingness, of indignity, and worries about his own future or that of his relatives without referring to language disturbances overcome and to the hemiplegia just resolved and ignored (p. 235).

Nondominant injection, on the other hand, produces

> an euphoric reaction that in some cases may reach the intensity of a maniacal reaction. The patient without apprehension, smiles and laughs and both with mimicry and words expresses considerable liveliness and a sense of well-being (p. 235).

Similar findings have been reported by several other investigators (see Silberman and Weingartner, 1986)

Gainotti (1972) analyzed the behavior of 160 right handed brain damaged subjects and reached similar conclusions. Of the eight behaviors categorized as "catastrophic, five were significantly more frequent in left-sided patients. Aggressive behavior, compensatory boasting and displacement were equally present with left- and right-sided damage. Of the four behaviors characterized as "indifference reactions," all were

[8]For right-handed individuals, who represent about 95% of the population, "dominant" refers to the left hemisphere, "nondominant" to the right. Therefore, in this paper dominant and nondominant will be used synonomously with left and right, respectively.

significantly more obvious in right-sided patients, particuarly "the tendency to joke in a fatuous, euphoric or ironical way (p. 44).[9]

[9] More recently however Gainotti (1983) has revised his interpretation in favor of right hemisphere dominance for all emotions. Based on more detailed analyses of the the emotional behavior of right- and left-brain damaged patients, Gainotti believes that the right hemisphere is primarily responsible for "the recognition and elaboration of affects (p. 188)" with the left controlling the degree or intensity of emotional expression. According to Gainotti, when the "catastropic reaction" associated with left hemisphere damage was subdivided into two more specific categories, it was only the behaviors characterizing the emotional storm ("anxiety reactions, bursts of tears, swearing and sharp refusals to go on with the examination [p. 178]") that were more frequent in left-brain damaged patients. The responses descriptive of the second subgrouping, anxiety and depressed mood, ("expressions of discouragement, anticipations and declarations of incapacity, rationalization, and glorifications of past abilities [p. 178]") were equally represented in both lesion groups. It may be noted, though, that it was only after some period of time that the right-brain damaged patients showed these negative mood characteristics. Preceeding their appearance, Gainotti (1983) often observed euphoric behavior. In fact, he says "the results for right-brain damaged patients generally confirmed our earlier (Gainotti, 1972) results (p. 180)." Perhaps the later development of these negative mood symptoms in the right-brain damaged group was a reflection of some recovery of right hemisphere functioning. Some support for this can be found in Lishman (1968) who reported that the extent of tissue damage is related to the type of emotional reaction observed: large lesions tend to produce positive or neutral emotional responses while smaller more localized lesions were associated with negative affect behaviors. This interpretation however depends on etiological factors since the nature of the causative agent, e.g. cerebrovascular infarction versus diffuse cerebral neoplasm determines, at least in part, whether recovery or further deterioration can be expected (see Meier and Thompson, 1983).

In 1982 Sackeim et al published the results of an extensive review on the relationship of pathological laughing or crying to the location and type of brain damage. In the cases of destructive lesions which render the affected area inactive, the investigators discovered pathological laughing more commonly associated with right-sided lesions while

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Since Gainotti's sample was "unselected (p. 177)" for type of brain damage, there is no way to determine the validity of this alternative hypothesis.

While the theoretical model now preferred by Gainotti (1983) can explain the presence of both positive and negative emotional behaviors in right-brain damaged patients, it is not clear how it would account for the absence of positive affect reactions in left-brain damaged subjects. In other words, if the left hemisphere is primarily responsible for modulating affective behavior, with the right hemisphere processing the emotion per se, it seems reasonable to expect both catastrophic and euphoric behaviors, albeit with variations in intensity, in patients with an intact right hemisphere. This does not seem to have been the case.

In addition to his own reaearch, Gainotti reviews the reports of other investigators, several of which were presented here, supporting right hemisphere lateralization of all emotional processes. As was discussed earlier in this proposal though (p. 11), it may be misleading to infer underlying affective experience from perceptual or expressive performance . Gainotti makes this very point. Referring to the review published by Sackeim et al (1982, see also p 26 here) he states:

> In our opinion, the data reported by Sackeim et al (1982) clearly suggests that a hemispheric asymmetry exists in the production of positive and negative emotional outbursts, but do not prove the existence of a lateral specialization in the experience of positive and negative emotions. As a matter of fact, pathological laughing and crying...may well be dissociated from the corresponding subjective mood since patients who present these symptoms often claim that their concurrent moods are unrelated to the displayed emotions (p. 189).

It can be asked why the behavior of Gainotti's brain-damaged subjects, or anyone else's, is accepted as a reflection of underlying emotional experience while the behavior of the Sackeim et al (1982) sample is not.

pathological crying more frequently accompanied left hemisphere damage. Hemispherectomy, in which an entire hemisphere is removed, was found to produce a similar pattern. Of the fourteen right hemispherectomy patients reviewed, twelve were reported as euphoric, one as normal and one as depresssed. There were too few left hemispherectomy cases found to allow any conclusions.

Irritative lesions on the other hand, such as those corresponding to epileptic foci, result in neural overactivation. Thus, an opposite pattern might be expected: left-sided foci associated with pathological laughter, right-sided with pathological crying. Only six cases of epilepsy associated crying were discovered and in one of them the location of the focus had not been recorded. Among the remaining five cases in which foci sites were known, four were right-sided. Of the ninety-one instances of pathological laughing associated with epilepsy, the ratio of left- to right-sided foci was 2 : 1.

Normal Populations

Dimond and his associates (Dimond and Farrington, 1977; Dimond et al, 1976) devised a special contact lens by which prolonged visual stimuli could be preferentially projected to the left or right hemisphere. While wearing the lenses, normal subjects viewed three films: a neutral travel strip, a humorous cartoon, and an unpleasant surgical procedure movie. Half of the subjects saw the films in the left visual field while the other half watched in the right. The ratings of the subjects as to the affective intensity of the stimuli revealed that the cartoon was thought funnier and the surgical film more horrific when they were received by the left and right hemispheres, respectively. Both the cartoon and the surgical film were experienced as more unpleasant when viewed by the right hemisphere. These results compare well with the findings of Davidson (1984b) discussed earlier in which faces presented to the left and right hemisphere evoked positive and negative feelings, respectively, regardless of the expression on the face.

Using a set of standardized photographs depicting various emotions, Reuter-Lorenz and Davidson (1979) prepared slides for tachistoscopic presentation. Each slide had two poses of the same person: one pictured a neutral expression while the other showed an emotion. The subject's task was to indicate on which side of the central fixation point the emotional expression appeared. Reaction-time and accuracy were the dependent measures. While left visual field presentation of sad faces and right visual field presentation of happy faces were more correctly identified than the reverse, an emotion x visual field comparison failed to reach significance. Reaction-time data however was significant. Happy faces were recognized significantly more quickly in the right visual field than in the left. Sad faces were identified somewhat more rapidly in the left visual field than in the right ($p < .076$). Comparing reaction time to happy versus sad faces within visual fields, the same pattern emerged: happy faster than sad in the right visual field; sad faster than happy in the left visual field. These findings were replicated and extended in a second study (Reuter-Lorenz et al, 1983) which included two groups of left-handed subjects in the sample.

There is some evidence (see Reuter-Lorenz et al, 1983) that among left-handed subjects, writing posture may be indicative of hemispheric asymmetry. The pattern of cerebral organization in left-handed individuals who hold the pen in an inverted position (the hand is curved so that the tip of the pen points downward toward the bottom of the paper) is presumed to be similar to that of right-handed subjects: left hemisphere dominance for language; right hemisphere dominance for spatial abilities. Reversed cerebral asymmetry (right hemisphere dominance for language; left hemisphere dominance for spatial skills) is suspected among left-handed people who write in an upright, non-inverted position.

Using the same experimental design as the earlier study (Reuter-Lorenz and Davidson, 1979) Reuter-Lorenz et al (1983) confirmed that right-handed subjects more rapidly identified happy faces in the right visual field and sad faces in the left visual field. Inverted left-handed subjects performed like the right handed subjects. As predicted by the authors, the non-inverted left-handed subjects showed reversed visual field effects.

In light of the above facial emotion perception studies, the findings of Sirota and Schwartz (1982) are interesting. The zygomatic muscle draws the angle of the mouth backward and upward in the generation of a smile. Remembering that each side of the face is controlled by the contralateral hemisphere, the investigators found that among right-handers, right zygomatic activity is stronger for positive emotions on the right side of the face.

Davidson et al (1979b) compared EEG activity in the left and right hemispheres as subjects judged how much they liked or dislike portions of a television show which varied in emotional content. Two EEG epochs, one recorded during the most liked segment of the program, the other when the show was rated as most disliked were examined. Analyses revealed increased left hemisphere activity during the positive affect segment and increased right hemisphere activity during the negative portion of the show.

Model 2: An Alternative Formulation

Based on the same evidence as that cited in support of the left hemisphere - positive emotions/right hemisphere - negative emotions model, Tucker (1981) has advanced a differential lateralization theory which he and others (for example Levy, 1983) feel is "diametrically opposite" (Tucker, 1981, p. 20). That is, the right hemisphere is responsible for positive experience, the left, negative. In actuality, though, these two differential approaches may not be incompatible at all.

According to Tucker (1981), the two hemispheres are reciprocally balanced with each hemisphere's affective tendencies opposite and complementary to the other's. Throughout the paper however, Tucker emphasizes two points not really stressed by supporters of the other differential view:

(1) the cortex is essentially inhibitory over ipsilateral subcortical brain regions (see Nauta, 1971); and

(2) subcortical areas, especially possibly lateralized catecholamine dependent ones (see Tucker and Williamson, 1984), are of primary importance in emotional behavior.

As Tucker (1981) explains, when there is damage to the cortex of one hemisphere, the resulting loss of that region's inhibitory influence over the lower brain centers within that hemisphere allow those lower centers greater expression of their affective inclinations leading to an exaggerated emotional response. Thus, damage to the left hemisphere is associated with depression not because the patient is then left with only right hemisphere activity, as the alternative view holds (see for example Sackheim et al, 1982, p. 215), but because the left hemisphere's subcortical regions, which tend towards negative affect, are no longer inhibited. A further implication in that since the damaged cortex can no longer oppose the activity of the contralateral cortex, that intact cortex can exert an even stronger inhibitory influence over its subcortex. As in the above example, with left hemisphere damage, the "freed" right cortex could exert greater inhibition on its subcortical areas suppressing the expression of positive affect.

The apparent discrepancy between the two positions may be in how one conceptualizes "hemisphere." A hemisphere is composed of both cortical and subcortical regions. Tucker's model (1981) seems to place greater emphasis on subcortical processes minimizing the importance of cortical events in emotional behavior. A more balanced conclusion seems to be that the tendency of a hemisphere's <u>subcortex</u> is toward one affect while the tendency of that hemisphere's <u>cortex</u> is essentially in the opposite direction (via suppression of ipsilateral subcortical and contralateral cortical activity). Thus, left cortical damage results in increased negative affect, right cortical damage in increased positive affect.

While it may be theoretically important to establish the "natural tendency" (Tucker, 1981) of a hemisphere, behaviorally, both models lead to the same predicitions.

Contrary to the literature on the between hemisphere representation of affective processing, the data on intrahemispheric localization is fairly consistent. Studies of normal and clinical populations have strongly implicated the frontal cortical regions as integral to emotional behavior (see Damasio, 1985; Davidson, 1984b; Flor-Henry, 1979; Hecaen and Albert, 1978; 1978; Stuss and Benson, 1983 but see also Tucker and Dawson, 1984).

Robinson et al (1984) administered a battery of tests to right and left brain-damaged patients who had been further subdivided into anterior and posterior groups based on computer tomography identification of lesion site. Included among the measures were two depression inventories and a semi-structured interview designed to assess mood. In addition to providing support for the differential lateralization of positive and negative affect (depression was observed in fourteen of the twenty-two left hemisphere patients compared to only two of the fourteen right lesioned group and while none of the left hemisphere subjects were found "inappropriately cheerful [hypomania] (p. 86)", six of the fourteen right hemisphere were so observed) the investigators demonstrated that the anterior-posterior location of the lesion was correlated to the severity of depression. In the left hemispehre group, the closer the damage was to the frontal area, the more severe the depression, replicating earlier studies (Robinson and Benson, 1981). For the right lesioned group, the further the damage from the frontal pole, the more severe the depression with anterior lesions more frequently associated with hypomania.

Recalling the Davidson et al (1979b) study in which EEG was recorded while the subjects watched a television show, the investigators found differential activity for positive and negative emotion only at frontal recording sites. For both liked and disliked portions, right parietal activity was greater than left.

In two similarly designed studies with different groups of ten month old babies, Davidson and Fox (1982) had females born of right-handed parents watch a videotape which included segments of Sesame Street interspersed with a female actress exhibiting a neutral facial expression which then became either happy or sad. EEG was recorded bilaterally from frontal and parietal sites. Of the twenty-four subjects who provided artifact free records, twenty showed increased left frontal activity during the happy segment.[9] No lateralized differences were observed for the sad segments.[10] Like the earlier study (Davidson et al, 1979b) parietal activity was greater in the right hemisphere for both emotions. Fox and Davidson (1986) correlated bilateral frontal and parietal EEG to facial expressions in response to different tastes in newborns. Both water and citric acid generated facial expressions of disgust and greater right hemisphere activation[11]. The sucrose solution was associated with greater left frontal activity. More recent experiments (Fox and Davidson, 1987, 1988) examined the physiological and behavioral reactions of 10-month old babies to maternal approach, maternal separation and stranger approach with and without the mother present. The results indicated that increased left frontal activity, apparent in the mother approach condition, was related to increased vocalization and genuine[12] smiling. Crying during mother separation was accompanied by greater right frontal activity.

Schaffer et al (1983) compared frontal and parietal EEG in high and low scorers on the Beck Depression Inventory. In the eyes opened resting period, no differences were found between the groups for either brain

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[10]Davidson and Fox (1982) do not address the failure of the sad segment to produce a lateralized effect. Perhaps only the happy expression was effective because it was compatible with the pleasant mood the babies may have been experiencing just from sitting on mother's lap watching Sesame Street. The negative affect stimulus may not have been strong enough to overcome the enjoyment derived from the experimental conditions.

[11]The authors suggest that the negative response associated with the water may have been a reaction to the introduction of the solution-containing pipette in the infants' mouth. The water was always presented first.

[12]Some research suggests that genuine smiles involve different neural and muscular systems than do posed or social smiles (see Davidson and Fox, 1988).

region. During the eyes closed period, however, depressed subjects showed greater right frontal, but not parietal activation than did nondepressed subjects.

These findings are further supported by a recent study conducted by Ahern and Schwartz (1985) who suggested that researchers exploring stimulus related EEG effects not limit their investigation to the alpha and/or beta frequency ranges, as is usually done, but instead expand their analyses to include all frequencies particularly when emotional stimuli are used. Thus, in their study of EEG changes to questions which varied in both cognitive and emotional content,[13] Ahern and Schwartz (1985) examined delta, theta, alpha, beta and total EEG power recorded bilaterally from frontal and parietal sites in normal females.

Lateralization ratios, which indicate the amount of activation at one recording cite relative to the activiation of the homologous area in the other hemisphere, were calculated for each frequency band in response to each of the ten question types.

Similar to Davidson's observations (Davidson et al, 1979b; Davidson and Fox, 1982), the effect of emotional valence, i.e. positive versus negative, was seen only at frontal sites while the cognitive component, i.e. verbal versus spatial, influenced only parietal activity. More specifically, more right frontal than left frontal alpha[14] was observed in response to the happiness questions than to the fear questions

[13]Ten question types, each with six exemplar were used in a 2 (verbal/spatial) x 5 (happy/sad/excited/neutral/fear) design.
[14]Decreasing alpha is interpreted as indicative of increasing activation.

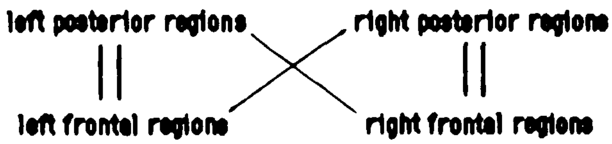
irrespective of their verbal/spatial content. Fear questions elicited the opposite pattern: less right relative to left frontal alpha.

Curiously, sadness questions produced an EEG alpha pattern more similar to the happiness than to the fear questions replicating an earlier study in which more rightward LEMs, indicating greater left hemisphere activation than leftward LEMs (right hemisphere activation) were seen for both happy and sad questions (Ahern and Schwartz, 1979; see also Harman and Ray, 1977).

Delta and total band power moved in the opposite direction. As alpha increased, delta and total band power decreased. For these frequencies, however, sadness questions produced the same pattern as did the fear questions: greater right than left activity. The positive affect items (happiness and excitement) were reflected in greater left than right activity.

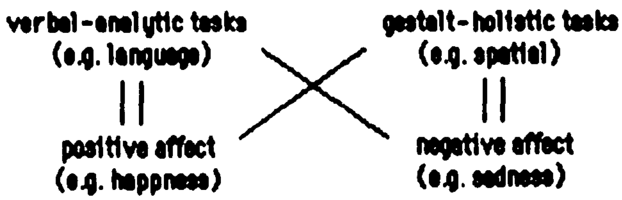
The alpha lateralization at parietal sites, observed only for the cognitive aspect of the question, was in the predicted direction (greater left parietal activation for verbal questions; greater right parietal activation for spatial items).

In addition to emphazing the inhibitory influence exerted by the frontal cortex over lower brain regions, Tucker (1981) reiterated Nauta's (1971) summary of anatomical findings which indicate that cortical inhibition extends in a posterior direction as well. Thus, increased frontal activation would produce decreased temporal, parietal and/or occipital activation. Davidson (1984a) has confirmed and extended this relationship by showing that frontal and parietal EEG asymmetries are negatively correlated; that is, frontal activation is accompanied not only by ipsilateral posterior deactivation, but by contralateral posterior activation as well. The following diagram may help to clarify this complex arrangement:



(single lines indicate excitatory influence:
double lines indicate inhibitory influence)

Numerous electrophysiological studies (see Bryden, 1982; Bradshaw and Nettleton, 1983) have indicated that when a subject is involved in performing a task, neural activity is increased in the brain region representing that task. Recalling that emotional processes occupy the more anterior regions while cognitive activity is accomplished posteriorly, certain behavioral implications of this neural arrangement become evident. Let us translate the above anatomical-physiological scheme into a behavioral one:



Thus, as suggested by Davidson (1984a) negative affect should disrupt the performance of a spatial task, but facilitate the performance of a verbal one. Positive affect should result in the opposite pattern: improved spatial but impaired verbal performance. Some support for these predictions is available.

The Interaction of Lateralized Emotional Processes and Lateralized Cognitive Processes

Clinical Populations

In 1976 Flor-Henry reported to the New York Academy of Sciences the results of studies which compared the cognitive performance of different diagnostic groups. In one (Flor-Henry and Yeudall, 1976 cited in Flor-Henry, 1976) it was found that on the Neuropsychological Test Battery, consisting of twenty-five indicators of localized brain function, depressives showed poor performance on those items sensitive to nondominant functions. Comparably low scores on the performance but not verbal subscales of the WAIS confirmed the data obtained from the test battery. In a later study (Flor-Henry, 1976), the performance of schizophrenic, unipolar depressed, manic, and bipolar depressed subjects on the Neuropsychological Test Battery were compared. Although the patients with affective disorders did reveal some dysfunction on tests of the left hemisphere, the majority of impairments were found on tests of the right .[15]

The same pattern of relatively poor right hemisphere test performance in depressed patients was reported by Taylor et al (1979). Using the Aphasia Screening Test, an instrument designed to reflect

[15] Apparently Flor-Henry (1976) collapsed the depressed, manic and manic-depressive subjects into one "affective disorder" group for statistical comparison. It would have been interesting to see if there were any performance differences between the unipolar depressed and the unipolar manic subgroups. Unfortunatey, no subgroup data was provided in the report.

lateralized and localized brain dysfunction, these investigators compared the number of depressed subjects who made errors on the various region-specific items to the number of controls who erred. Although the authors report that more depressives than controls made mistakes on tests of the dominant parietal area (p. 1032), it is apparent from the graph included in their article that the difference between the groups was not that great. As best as can be determined by visual inspection alone, only 8% of the depressives made errors on tests of the left parietal area versus about 3% of the controls. On tests of the nondominant hemisphere however a comparison between the number of depressed versus normal subjects making mistakes yielded a highly significant difference. While no control subject made any errors on right parietal items, over one-third of the depressed group did. These findings were confirmed in a later study (Taylor et al, 1981) which found that depressed patients performed poorly only on those items of the Smith Test Battery sensitive to nondominant functioning.

Kronfol et al (1978) administered four tests of left and four tests of right hemisphere function to eighteen depressed patients before and after unilateral ECT treatment. Prior to treatment, half the patients demonstrated poor performance only on tests of the right hemisphere. Two patients were defective on tests of both hemispheres. There were no patients who showed impairments only on left hemisphere tasks. Based on these observations, the authors included in their concluding remarks "depression itself interferes with cognitive functions, mainly those served by the non-dominant hemisphere (p. 565)."

In a recent study, Correll (1985) examined the association between anxiety, depression and WAIS subscale scores in patients referred for psychiatric evaluation. While a few (7.3%) of all the possible correlations did reach significance, the pattern of results did not indicate any systematic relationship between these three variables with one exception: WAIS block design which accounted for almost half of the significant correlations found between the measures.

As part of an experiment examining the relationship between depression and right hemisphere dysfunction, Johnson and Crockett (1982) administered two tests of cognitive functioning to depressed patients upon admission to psychiatric treatment. The Flags test required the subject to view a picture of a flag on the left side of a page and then to indicate the orientation of each of six flags pictured on the right side of the page by circling the "S" (same orientation) or the "O" (opposite orientation) under each illustration. The Word Fluency test allowed the subject one minute to generate as many words as possible beginning with a particular letter.

Compared to normal controls, the depressed subjects performed significantly worse on the Flags test. On the other hand, their performance on the Word Fluency Test was slightly, though not significantly, better than normal.

This pattern of impaired spatial performance possibly accompanied by superior verbal ability among depressed individuals has been noted by others. As part of a study on attributional styles in depressed children, Blumberg and Izard (1985) administered the Peabody Picture Vocabulary Test and the WISC Block Design test to forty-five boys and girls who were divided into three groups based on their scores on the Children's Depression Inventory. There were no differences between high, medium, or low scoring males for either cognitive test. Low depression females performed better than medium and high depression females on both tests. High depression females were impaired only on the block design test. In fact, their scores on the vocabulary test were somewhat better than those of the moderately depresssed girls. This low spatial - high verbal ability test profile had earlier led Kestenbaum (1979) to advise that it, along with other signs, may be suggestive of future affective disorder.

Normal Populations

Barden et al (1985) exposed second-grade children to situations intended to produce a positive or negative mood. Performance on a block design task served as one of several measures used to determine the affects of the emotion inducing manipulations. Compared to the children who had received a positive affect induction as well as to the controls who had not experienced any affect treatment, the negative affect group showed significantly poorer block design performance in terms of number of correct responses and amount of time needed for completion.

After recalling events that would induce a positive, negative or neutral mood, nursery school children were presented with several concept attainment problems involving shape discrimination (Masters et al, 1979). As predicted by the authors, the positive mood decreased and the negative mood increased the number of trials needed for successful completion as well as the rate at which each problem was solved. Measures of interest, involvement and arousal obtained afterwards proved to be only weakly related to success especially when viewed against the substantial influence of the induced moods.

When a hemisphere is involved in a task, reaction time to a simple stimulus presented to that hemisphere will be longer than when that hemisphere is not specifically engaged and longer than that of the other unoccupied hemisphere (Rizzolatti, 1979 cited in Ladavas et al, 1984). Ladavas et al (1984) made use of this phenomenon to examine the lateralization of negative affect. After obtaining baseline reaction time measures to a light stimulus presented in the left and right visual fields, Ladavas et al (1984) asked one group of subjects to "feel sad." Despite the simplicity of the manipulation, the authors claim that the instruction was sufficient to produce the desired affect. A second group of subjects was asked to visualize emotionally neutral everyday activities, like getting dressed.

The results showed that in the first testing session, with no prior instructions, there were no differences in reaction time between the groups nor between the two visual fields. In the second session, when the additional task had been introduced, reaction time to the light stimulus increased in both groups; however, for the neutral imagery group, the increase was equivalent for both visual field presentations. Among the sad subjects, the increased reaction time was greater with left visual field presentation.

Thus, there is a fair amount of data supporting one of the predictions generated by Davidson's (1984a) model: negative affect interrupts the performance of right hemisphere tasks. The results of

Masters et al (1979) support a second prediction: positive affect facilitates right hemisphere functioning. The results of Ehrlichman (1984) are also in accord with this second prediction.

After obtaining baseline measures on two verbal and two spatial tasks, Ehrlichman (1984) exposed one group of subjects to a pleasant odor and one group of subjects to an unpleasant odor as they completed parallel versions of the four cognitive tasks. Overall, the presence of an odor interfered with test performance; however, on one of the spatial tasks, the Form Board Test, the presence of an odor, particularly a positive one, resulted in significantly higher scores.

A third prediction which has received some confirmation is impaired left hemisphere functioning in the presence of a positive mood. Stern and Brown (1957) described a patient suffering from pathological laughing who also showed disrupted calculation ability and defective reasoning.

Isen et al (1982) have provided some very provocative data on the influence of positive affect. In timer tape problems, a paper tapes moves past a timer at a certain speed. The timer marks the paper tape with a dot at fixed intervals. As the speed at which the tape passes the timer varies, the number of dots produced varies proportionately. The subjects' task is to indicate which of several distractor tapes would have been produced by a given speed. This particular task was selected (see Isen et al, 1982) because it could be approached in either of two ways: intuitively or analytically. Earlier research (Means, 1980 cited in Isen et al, 1982) showed that for some unexplained reason, those subjects who employed an intuitive approach tended to equate speed with number: the faster the tape moved, the more dots produced. It is however the more cognitively demanding logical- analytical approach that leads to the correct conclusion that tape speed and dot frequency vary inversely. Isen et al (1982) reported that compared to controls, subjects in whom a positive mood had been produced by offering refreshments employed the incorrect intuitive approach.

All of the evidence reviewed, while certainly supportive of Davidson's model, is nevertheless retrospective. With the possible exception of Ehrlichman's study (1984), there has been no direct test of the interaction of positive and negative affect on left and right hemisphere cognitive functioning.[16] The proposed study will address the question of emotion-cognition interaction by comparing right and left hemisphere cognitive performance in the presence of an induced negative mood, an induced positive mood, an induced neutral mood and a no mood induction condition.

Following Davidson's (1984a) model, the following predictions are offered: Compared to no mood induction or a neutral mood induction,

(1) the performance of a right hemisphere task will be impaired in a negative mood, enhanced in a positive mood.

(2) the performance of a left hemisphere task will be enhanced in a negative mood, impaired in a positive mood.

(3) the performance of right or left hemisphere tasks will not be differentially affected by the neutral mood induction nor will the

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[16] Indeed, even Ehrlichman's (1984) study was not strictly based on emotional experience per se but rather on the assumption that affect may be a manifestation of more fundamental approach-avoidance tendencies differentially lateralized to the left and right hemispheres, respectively.

neutral mood induction produce scores different from the no mood induction condition.

As indicated in the beginning of this proposal though there is another theory of brain-behavior organization which might encourage opposite predictions.

The Interaction of Lateralized Brain Processes: An Alternative Formulation

While not directly concerned with the interaction between anterior/emotional and posterior/cognitive brain regions, Kinsbourne (Kinsbourne and Hicks, 1978; Kinsbourne and Hiscock, 1983)) has advanced a model which may nevertheless have bearing on emotion-cognition interactions.

According to Kinsbourne's "functional cerebral space" theory, performing a task activates not only the particular brain region specific for that task but, due to the spread of neural activation from that site, a large amount of adjacent cerebral area as well. In addition to the numerous behavioral studies cited by Kinsboure and Hiscock (1983) in support of the model are the physiological findings of Lassen and Roland (1983) who reported that increases in cerebral activation as measured by blood flow are found in entire cortical systems following exposure to even mild stimuli. The touch of a hair on the finger tip was found to increase neural activity in an area as large as that activated when the entire hand was moved. This spreading activation is presumed to be graded, that is, the closer (further) the adjoining regions are to the task specific cite, the greater (lesser) they will be activated. Thus, sites within a hemisphere are functionally closer to one another than they are to sites in the other hemisphere with one important exception. The right and left areas representing limb control are functionally closer to each other than they are to other control areas within their hemisphere. In other words, the control centers for the two hands are functionally closer to each other than they are to the control centers for their ipsilateral feet.

Thus, if two tasks whose performances are dependent on the functioning of closely situated brain regions are executed simultaneously, facilitation or impairment will be observed depending on the nature of the two tasks. Enhancement can be expected if one of the tasks is easy or if the two tasks are not incompatible. Enhancement can also be observed in a single task design if the hemisphere mediating that task has been primed (see Kinsbourne and Hiscock, 1983, p. 257) for example by prior exposure to other hemisphere-specific stimuli. Indeed, the performance of a hemisphere on a tachistoscopic task may be so improved as to actually reverse typical visual field asymmetries. By varying the nature of the stimulus appearing immediately before the target stimulus, a right visual field/left hemisphere advantage for shapes (Hellige, 1978) and a left visual field/right hemisphere advantage for digit recognition (Kershner et al, 1977) have been found. This "priming" effect receives further support, albeit indirect, from another observation of Lassen and Roland (1983). Increased cortical activation was noted even when the subjects were waiting for the stimulus to be presented suggesting "a specific mechanism...a state of depolarization with enhanced readiness for firing - amplifying so to speak - any sensory input to a maximum (p. 149)."

impairment will be seen when the two tasks are complex and/or require incompatible responses since the overflow activity from each task-specific brain region will spread, interfering with the task-specific activity of its neighbor. The more difficult the task, the more cerebral space involved and the greater the interference.

The literature seems to suggest that whether enhancement or impairment is observed in a particular dual-task experiment seems to depend on the complexity of the response(s) the subject must simultaneously execute. Assuming that the processes required by the two tasks occupy the same hemisphere, enhancement can be expected if only one overt response is required, the competing task is not complex, and/or the simultaneous performance of the two tasks increases general arousal and therefore available resources beyond that produced by either task alone (Kinsbourne and Hiscock, 1983, p. 320). If both tasks require simultaneous overt responses, or if both tasks are cognitively demanding even if only one overt response is called for, interference will be recorded.

Kinsbourne (1970) asked subjects to determine whether a tachistoscopically presented square, one of whose sides was in the central visual field with the other three to the left, right, top or bottom of fixation, had a gap in it and if so, on which of the square's sides the gap appeared. Performance on the task alone was compared to performance during a concurrent verbal memory load. Prior to stimulus exposure, the subjects heard and were asked to remember a list of six words. If the gap in the square appeared on its left side, the subject was to repeat the first three words of the list. If the gap was on the right, the last three were to be reported. If there was no gap in the square, the subject was to remain silent. A comparison of left versus right gap detection accuracy in the two conditions revealed a facilitation effect. Whereas performance was equivalent for left and right sided gap detection in the first, no concurrent task condition, for the second in which subjects had the additional verbal memory load, detection of gaps appearing in the right visual field (left hemisphere) was significantly better than detection of left-sided gaps. Indeed, right-sided gap detection in the verbal condition was better than right-sided gap detection in the silent condition[17]

Enhancement effects have also been reported for motor activity. Kimura (1973) found greater spontaneous movements in the right hand during speaking than during silence. Left hand movement did not discriminate between speaking and silent conditions nor were there any differences between the two hands during humming.

In a more recent study, Hamson and Kimura (1984) videotaped spontaneous movements of the left and right hands of subjects as they performed verbal and spatial tasks. All tasks were performed by manipulating blocks. For the spatial tasks, the subjects used blocks painted with various line patterns. For the verbal tasks, blocks with letters drawn on were used. Analysis of the videotapes allowed the researchers to classify nineteen identifiable movements into five categories, three of which were task related. The remaining two non-task

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[17]The only statistics included in the report are the means for left and right side performance so there is no way to determine if this difference was significant.

related categories were self touch (e.g. scratching)/rest (e.g. leaning head on arm) and miscellaneous (e.g. tapping finger on table top).

The authors found that compared to baseline performance on a nonlateralized task, spontaneous movements were greater in the right hand during verbal problems and greater in the left during the spatial problems for two of the three task-related and the miscellaneous non-task related movement categories. Auxiliary movements (e.g. widening the space between two blocks to permit insertion of a third) showed reversed asymmetry during the spatial task (greater right hand movement) compared to baseline. Lateralized shifts were not observed for auxiliary movements in the verbal condition. Self-touch movements were initiated as much by the left as the right hand in both verbal and spatial conditions.

Based on the observation that only task-related movements showed a lateralized increase consistent with the hemisphere specialized for the task, the authors rejected Kinsbourne's overflow theory:

> This selectivity in effects would appear to rule out one potential explanation of our findings, namely that the observed shifts are the result of a general motor overflow, or 'spillover' effects within the problem solving hemisphere. Presumably, this type of explanation would predict nonspecific facilitation of all manual activity generated by a particular half of the brain, which is obviously not the case in the present study (p. 120).

We can question though whether the same results would have been observed if the subjects were not permitted to actively manipulate the blocks. That is, perhaps the "spillover" is being exhausted by the necessary task-related movements so that there is no further need for additional movements. This hypothesis is supported by the findings of Kee et al (1984) who compared key-tapping performance of the left and right hands while the subjects solved spatial problems mentally versus physically. Compared to baseline performance, left hand key tapping was facilitated when the subjects had to complete the block design problems mentally - without handling the blocks. When the subjects actually positioned the blocks with one hand while key-tapping with the other, interference reflected in poorer left hand key-tapping performance was observed.

Other reports of lateralized interference effects in which speaking selectively interfered with right hand performance have been found for dowel balancing (Kinsbourne and Cook, 1971; Lomas and Kimura, 1976), finger tapping (Kee et al, 1984), sequential finger tapping (Lomas and Kimura, 1976) and arm movements (Lomas and Kimura, 1976). A thorough review can be found in Kinsbourne an Hiscock (1983).

Additional support for the relationship linking facilitation or interference with the nature of the required response(s) is provided by the results of a series of studies in which the complexity of the stimulus or the complexity of the response was varied. Green (1984) reported that the reaction time of the hand responding to a tachistoscopically presented stimulus is slower when the hemisphere controlling that hand is also the one specialized for processing the incoming stimulus. Thus, it might be predicted that by making the stimulus or response simpler thereby reducing the demands on the target hemisphere, reaction time by the ipsilaterally controlled hand would be reduced. In fact, varying the complexity of the stimulus had no effect on reaction time. Creating a simpler response requirement, though, eliminated interference effects regardless of the complexity of the stimulus.

The strongest support for Kinsbourne's spreading activation model (Kinsbourne and Hicks, 1978; Kinsbourne and Hiscock, 1983) is based on motor behavior. Indeed, all of the dual-task literature bearing on the theory can be classified into two categories (Kinsbourne and Hiscock, 1983). For the first group, both tasks are motor. In the second, one of the tasks is motor, the other cognitive. The studies representing the second, cognitive-motor grouping have revealed that interference effects occur in only one direction: cognitive to motor. That is, processing hemisphere specific cognitive tasks disrupts simultaneously performed motor behavior, especially in the ipsilaterally controlled limb, but motor activity does not impair concurrent cognitive processing. To date, there have not been any tests of Kinsbourne's theory using two cognitive tasks and certainly none in which one of the two concurrent activities of a hemisphere involves emotional processing. The data that have been reported however do invite certain predictions on the influence of emotion on cognition. Based on the assumption that the anterior activation associated with emotion spreads to the ipsilateral posterior regions involved in cognition, and on the findings that

(a) when one of the two tasks is not cognitively demanding (easy, well practiced, "automatic") and/or does not require a complex overt response, the performance of the second tasks will be improved;

(b) "priming" a hemisphere facilitates the performance of tasks mediated by that hemispere;

(c) increases in arousal may increase the resources available for task performance; and

(d) the presence of an emotion is associated with increased arousal (see pages 23-37 here; see also Tucker and Williamson, 1984),

the following predictions are offered: Compared to no mood induction,

(1) the presence of a negative mood will improve performance of right hemisphere tasks to a greater degree than will the positive and neutral mood inductions; due to the relatively great functional distance between contralateral anterior and posterior regions, the presence of a negative mood is not expected to influence the performance of left hemisphere cognitive tasks.

(2) the presence of a positive mood will improve the performance of left hemisphere tasks to a greater degree than will a negative or neutral mood induction. Once again, the relatively great functional distance between the left anterior and right posterior regions will inhibit any mood facilitating effects.

(3) the neutral mood induction may improve the performance of left hemisphere tasks as exposure to the mood manipulation per se may activate certain cerebral regions.

As will be recalled, according to Davidson (1984a), anterior activation is accompanied by ipsilateral posterior <u>de</u>activation and contralateral activation which is hypothesized to result in impaired performance on spatial tasks and improved performance on verbal tasks in a negative mood with better performance on spatial tasks and worse performance on verbal tasks in a positive mood. Perhaps the following table can help to clarify the different predictions made by these two models of brain-behavior organization:

	LEFT HEMISPHERE TASK PERFORMANCE		RIGHT HEMISPHERE TASK PERFORMANCE	
	Davidson	Kinsbourne	Davidson	Kinsbourne
positive affect	impaired	improved	improved	no change
negative affect	improved	no change improved?*	impaired	improved

(*as a consequence of the mood manipulation technique - see prediction [3] above.)

Thus, both of these theories predict treatment induced changes in task performance in specific (albeit opposite) directions. There is reason to believe that certain personality variables may modify the influence of induced mood on cognitive performance which would be reflected in the magnitude of mood induced changes.

COGNITIVE STYLE

Cognitive style refers to the characteristic ways in which individuals process information. Among the several that have been identified, Field Independence - Field Dependence has enjoyed the greatest research attention. The manifestations of this dimension are numerous and pervasive, extending into perceptual, cognitive, emotional and social domains (Witkin and Goodenough, 1978; Witkin et al, 1979). Field independence-dependence is defined by the extent to which an individual relies on the self or external referents in psychological functioning and is assumed to reflect differences in the broader category of psychological differentiation (Witkin et al, 1979). Field independence represents that end of the dimension marked by increased differentiation while field dependence is placed at the opposite pole. The better differentiated system shows clearer separation of constituent parts and can better segregate discrete elements and recognize boundaries between parts, and the whole they comprise. In the less differentiated system, components are less cleanly separated and there is a tendency towards overlap or blurring. Thus, we might expect that the cognitive performance of field dependents would be relatively more affected in the presence of a positive or negative mood than would be the performance of field independents who tend to maintain stricter boundaries between affective and cognitive systems.

Several authors have noted that males are more field independent than are females (Reighard and Johnson, 1973; Sabatelli et al, 1983; Witkin et al, 1962; 1967). It is interesting that Blumberg and Izard found a relationship been the severity of depression and task performance only for the females and that Clark and Teasdale (1985) reported differential mood effects on memory only among the female subjects. Indeed, mood induction techniques are ineffective for a considerable percentage of subjects who are exposed to them (see Clark, 1981 and Sutherland et al, 1982). We can question though whether the absence of mood effects in these "invulnerable" subjects was due to the ineffectiveness of the technique per se, i.e. the subject did not experience the suggested emotion or did experience the emotion but was able to segregate it from other on-going processes and thus show no change in behavior as a result of the procedure. Perhaps this possibility could be addressed by asking the subjects how they feel, as many researchers do; however, the obvious demand characteristics present in such a situation would caution against any conclusions based on the subjects' testimony. If, on the other hand, it was discovered that the effectiveness of the mood induction procedure was related to the subject's ability to maintain separateness betweeen psychological processes, i.e. degree of field independence, some support would be found for the hypothesis that the lack of mood effects are not necessarily due to the effectiveness of the procedure per se but possibly to the subject's cognitive style. To this writer's knowledge, the present study will be the first to explore this issue by comparing scores on a measure of field independence (the Group Embedded Figures Test) to scores on tests of cognitive functioning and a self-report mood questionnaire.

More specifically, the following prediction regarding the influence of induced mood on cognitive performance is offered: irrespective of the direction of change (see page 37), the magnitude of the change from first to second testing will be greater among field dependents receiving a positive or negative, but not a neutral, mood induction.

As for the relationship between cognitive style and self-reported mood, it is tempting to predict that field dependents will more likely report mood states consistent with the induction procedures; however, since field dependents more readily disclose their feelings than do field independents (Goodenough, 1977; Gruenfeld and Lin, 1984) we would have no way of knowing whether the reports of field independents truly reflected their mood state or their reluctance to reveal it.

THEORETICAL IMPLICATIONS

Before lateralized differences in mental functioning can be accepted as a reflection of anatomical and/or physiological differences in hemispheric organization, it is important to determine whether the observed pattern of results could also be interpreted from alternative viewpoints. Some investigators (see Harcum, 1978 and Bryden, 1982) have questioned whether information processing theory can account for reported findings. For example, does the right visual field advantage for verbal material occur because the left hemisphere, which receives the stimulus directly, is structurally superior for processing verbal material or because the English speaking subjects from whom this data was gathered read from left to right thus biasing attention to the right visual field? Likewise, perhaps the right ear superiority for verbal material in dichotic listenting studies is due to subjects' tendency to report right ear stimuli first (see Bryden, 1982). These stimuli would be more accurately recalled than those received by the left since some or all of the left ear material may have been lost due to decay or displacement.

Included in his recent Triarchic Theory of Human Intelligence, Sternberg (1984) proposed that the basic information processing activities underlying cognitive performance, called "components," be classified into three groups. Metacomponents include those higher-order "executive" activities such as decision making, planning, strategy selection, etc. that are involved in identifying what the problem is, selecting the lower-order performance components that will be used to solve the problem, allocating attention to the various aspects of the problem, and evaluating progress in solving the problem. Performance components refer to those specific processes, selected by the metacomponents, that are actually used in solving the problem. The third group, knowledge acquisition components are those information processing activities used to gain new knowledge including those that allow the problem solver to discriminate task relevant from task irrelevant information (selective encoding), those that integrate the relevant information selected (selective combination) and those that relate the newly acquired information to information acquired earlier (selective comparison). Thus, the widely acknowledged relationship between anxiety and impaired test performance (see Sarason, 1980) could be explained as the result of neural over-activation in certain left cortical regions (Tucker et al, 1978) which disrupts the optimal level of neural excitation in other brain areas or, alternatively, because anxiety produced stimuli compete with task-relevant stimuli for the limited attentional resources available to the individual (see, for example, Dunn, 1968).

Theoretically, an information processing approach such as that advanced by Sternberg (1984) could account for the hypotheses made in this proposal (assuming they are verified); however, at this early stage of its development, validating that interpretation experimentally may be more difficult. While a processing model can account for the effects of emotion on task performance generally (see for example Dobson and

Dobson, 1981; Ellis et al, 1984) in order to explain the differential effects predicted here (positive [negative] emotion affects one type of task differently than it does another) it would need to demonstrate firstly that the two kinds of tasks involve different processes (components) and secondly that these processes are affected in different ways by an emotion. Following Sternberg's (1984) model, since metacomponents and knowledge acquisition components are probably uniform across tasks, it would be upon the performance components, which do vary depending upon the nature of the task, that the interpretation would rest. Even though there is reason to believe that verbal-analytic and gestalt-holistic tasks do involve different processes (performance on the two are not highly correlated), identifying what those specific processes are and then how they differ in tasks sensitive to left hemisphere functioning and tasks sensitive to right hemisphere functioning must await the results of future research. Nevertheless, there is a method by which the influence of information processing variables on lateralized behaviors can be contrasted to the influence of neuropsychological ones: the performance of left-handed subjects can be compared to the performance of right-handed subjects. Since left-handed subjects are much more variable with respect to cerebral asymmetry, if the pattern of results observed in right-handed subejcts was due to asymmetric neural organization, then the proposed relationship between affect and cognitive performance should be attentuated in left-handed individuals. If, on the other hand, the results were a manifestation of different processing strategies, then there would be no reason to expect performance differences between the two handedness groups.

METHOD

Overview: Female subjects were given three timed tests of right and three timed tests of left hemisphere functioning as well as the Group Embedded Figures Test (GEFT) in an initial session. At a later date, the subjects were exposed to the positive, negative or neutral Velten Mood Induction Procedure (1968). They were then retested with parallel versions of the six timed cognitive tests administered initially.

Subjects: Right-handed females served as subjects. They were recruited from a large metropolitan college campus and paid for their participation. The decision to restrict the sample to females was based on the possibility that mood manipulations may be more effective in females (see Clark, 1981), that the majority of studies using the Velten procedure have used only females (see Pignatiello et al, 1986) and a better sampling of field dependent individuals would be secured.[1]

Materials:

1. The Velten Mood Induction Procedure (VIP) (Velten, 1968) consists of 60 increasingly potent self-referent statements designed to create an elated or depressed mood. For example, in the elation treatment, the subject reads statements such as "If your attitude is good, then things are good, and my attitude is good," or "Life is so full and interesting it's great to be alive." Examples of depression

[1] It might be argued that a heterogenous sample of males and females would provide a better distribution of field independence-field dependence; however, since males tend to be field independent (indeed, finding right handed field dependent males is apparently quite difficult [Pizzamiglio and Zoccolotti, 1981]), and females, field dependent, any behavioral differences found between field independents and field dependents would be confounded with sex.

inducing statement are "Things aren't quite like I would like them to be" or "I feel downhearted and miserable." Also included in the procedure is a set of 60 emotionally neutral statements such as "Utah is the beehive state" designed to control for any effects that might be caused the by treatment per se. The complete VIP can be found in Appendix I.

To test the effectiveness of this technique, researchers have compared the behaviors of normal subjects in the two affect conditions or, in the case of induced depression, to the behaviors characteristic of clinical depression. Overall, the technique fairs well. Similarities in the behaviors found in clinical depression and those consequent to the induced depression statements have been reported. Significant differences between induced elation and induced depression in normal subjects have also been found for a wide variety of behaviors (see Clark, 1981 for a review).

Strickland et al (1975) asked VIP elated and depressed subjects about the kinds of activities they would prefer to engage in at the moment. Elated subjects chose social, active endeavors while induced depressed subjects, like clinically depressed individuals, preferred more solitary, passive activities.

Natale examined the effects of induced mood on speech characteristics (1977a) and gaze behaviors (1977b). Compared to subjects in an induced neutral state, elated subjects responded sooner, spoke more rapidly and spent less time pausing.[2] While depressed subjects did tend to speak more slowly, only the amount of time pausing reached significance. The second study (1977b) found that compared to the neutral group, elated subjects spent more time, depressed subjects less time, looking at the confederate with whom they were having a discussion.

Teasdale and his associates have used the VIP in a number of studies (Teasdale and Fogarty, 1979; Teasdale and Taylor, 1981; Teasdale et al, 1980) investigating the effects of induced mood on memory retrieval. The research shows that subjects in an elated mood are more likely to recall positive than negative memories and will retrieve them more quickly. Sad memories are more commonly and quickly remembered in a depressed mood than are happy ones. More recently, Teasdale and Russell (1983) reported that subjects who had learned a list of positive, negative and neutral words before the mood induction, recalled after the induction those words that were compatible with the mood. Thus, negative words like "spiteful," "ungrateful," etc. were more frequent in the recall list of depressed subjects while positive terms like "sincere" and "pleasant" were recalled more in the elated condition. Similar results with the VIP have been reported by Madigan and Bollenbach (1982).

[2] At first glance, these findings may seem to contradict Davidson's (1984a) model; however, as was discussed earlier, speech production is the most anteriorly located aspect of language.

Bollenbach and Madigan (1982) asked three independent judges to evaluate the TAT stories given by subjects in an induced elated or induced depressed mood. The judges found the elated subjects' stories significantly more pleasant than the stories offered by the depressed subjects.

Sirota and Schwartz (1982) recorded zygomatic and corrugator[3] EMG after subjects had been administered the VIP elation, depression or neutral statements. Zygomatic activity was significantly greater in the elation treatment than in the depression or neutral conditions with no difference between the latter two. Corrugator activity was significantly stronger in the depression condition than in the elated or neutral conditions; again, with no differences between the latter two.

Studies contrasting induced depression to clinical depression may present problems in interpretation common to many comparative designs. It is often the case that only one of the populations is measured directly with the data bearing on the other group collected second-hand from the available literature. An exception to this is a very interesting experiment conducted by Raps et al (1980) using the VIP.

Three groups of subjects participated in the Raps et al (1980) study. One group was comprised of clinically depressed subjects,

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[3]As will be recalled, the zygomatic muscle is involved in the production of a smile. The corrugator muscle draws the eyebrows downward and inward and wrinkles the forehead when we frown.

a second group was made up of normal subjects who were exposed to inescapable noise in a learned helplessness paradigm. The third group of subjects were not depressed nor had they been subject to inescapable noise.

Prior to treatment, the two nonclinical groups were comparable on a depression questionnaire. A second questionnaire administered after the noise treatment revealed increased depression in that group. The three groups were then divided. Half of the subjects in each were given the 60 mood elevating statements while the remaining half read the neutral statements. The subjects were administered a third depression questionnaire and then asked to perform an anagrams task.

Analysis of the third questionnaire showed that the elation statements were effective in significantly reducing depression in all three groups. Anagram performance followed a similar pattern. The learned helplessness and clinically depressed subjects who read the elation statements performed significantly better than the two groups who read the neutral statements.

The proposed study will not use the full 60 statement VIP but rather a shortened version. Several studies have found shortened versions to be effective (Sutherland et al, 1982: 12 statements; Teasdale and Fogarty, 1979: 30 statements; Teasdale and Taylor, 1981: 12 statements; Teasdale and Russell, 1982: 12 statements; Teasdale et al, 1980: 30 statements).

2. Cognitive Tasks: Parallel versions of the following timed tests were used. Samples of each can be found in Appendix II.

A. Left Hemisphere

(1) Finding the Letter Test: In this test the subject must draw a line through any word in a list of words that has a particular letter in it. Studies of normal (Varney, 1981) and brain damaged subjects (Faglioni et al, 1969; Marshall et al, 1978; see also Levy, 1974 and Friedman and Albert, 1985) implicate the posterior regions of the left hemisphere as critical to recognizing letters. To insure that the task was being processed linguistically rather than on the basis of physical matching (Geffen et al, 1972), the words comprising each list were presented in different type faces and different cases (see also Varney, 1981).

Time Limit: 2 minutes

(2) Arithmetic Test: In this test the subject had to find the sum of 3 one- and two-digit numbers. As reviewed on page 9, arithmetical processing is a left hemispheric task engaging the posterior regions.

Time Limit: 2 minutes

(3) Word Endings (Rhyming) Test: This test asked the subject to list as many words as possible that rhyme with the syllable presented. That the ability to appreciate phonemic similarity is lateralized to the left hemisphere is supported by studies of brain-damaged (Benton et al, 1983; Dennis, 1980, cited in Bradshaw and Nettleton, 1983; Tallal and Newcombe, 1978), split-brain (Levy and

Trevarthan, 1977; Zaidel, 1978; both cited in Bradshaw and Nettleton, 1983) and normal (Klatsky and Atkinson, 1971) populations (see also Bradshaw and Nettleton, 1981 and Levy, 1974).

Time limit: 2 minutes

B. Right Hemisphere

(1) Test of Facial Recognition (Benton et al, 1983): This test, which was modified from the original Benton et al (1983) version, asked the subject to select which of 4 distractor faces matched a target face appearing to the left of the distractor faces. All of the faces were photographed in black and white with additional features, e.g. hair, blackened out. Within any one test item, all of the models were of the same sex with some items picturing males and others females. The target face was always presented as a full face view. The distractor faces, however, varied in shadowing or orientation.

Each version of this test included 10 faces from the shadowed category and 10 from the angled category for a total of 20 items. Benton et al (1983) do not specify any time limit although they do report that in the neurology clinic a shortened version of their test (13 items) is administered in about 7 minutes (R = 5-15). In order to make the test more demanding, the subjects were given about 10.5 sec/face.

Time Limit: 2 minutes

It is important to distinguish two processes subsumed under the general heading facial recognition: the recognition of familiar faces and the recognition of unfamiliar faces. Studies of neurologically impaired (Manteer, 1983a; Milner, 1968 cited in Alexander and Albert, 1983; Warrington and James, 1967) and neurologically intact (Ley and Bryden, 1979; Suberi and McKeever, 1977; see also Sergent and Bindra, 1981) populations indicate that these two processes are anatomically and functionally independent. While the ability to recognize familiar faces can be accomplished by either hemisphere (Damasio and Damasio, 1983; see also Sergent and Bindra, 1981), the ability to recognize unfamiliar faces is lateralized to the right hemisphere (see Bryden, 1982; Bradshaw and Nettleton, 1983) and localized to the posterior regions.

Warrington and James (1967) administered two tests of facial recognition to patients representing several different lesion groups. The test of familiar faces asked the patient to identify by name or by any distinguishing characteristic ten public figures. Naming accuracy and recognition accuracy were scored separately. Recognition of unfamiliar faces was measured by asking the subjects to select which face in a series of faces was the one they had just looked at immediately before.

The results showed that the left hemisphere group, particularly those with temporal lesions made more naming errors on the familiar face task than did the right hemisphere subjects. Neither lesion group was significantly different from controls in accuracy. On the test of unknown faces, the right hemisphere group was significantly more impaired than the left hemisphere group with the greatest number of errors made by the right parietal subjects. The performance of the left hemisphere group was comparble to controls.

Using the electrical stimulation mapping technique described earlier Manteer (1983b) examined recognition and short-term memory of unknown faces. A slide depicting a target face and three distractor faces was presented to the subject who had to indicate which of the three distractor faces matched the target. After a short interpolated task, the subject was shown another slide of three faces and had to choose which one was the previously shown target face. The results showed that facial recognition was most disrupted by stimulation near the parietal-occipital junction while short-term memory impairments accompanied stimulation to sites located slightly more anterior in the superior temporal gyrus. Ornstein et al (1980) confirmed right parietal involvement in facial recognition by analyzing the EEG records provided by normal subjects as they performed a facial recognition test that is very similar to the one that was be used here. Additional support can be found in Benton (1985), Bradshaw and Nettleton (1983) and Bryden (1982).

(2) Judgement of Line Orientation: In this task, also a modified version of a Benton et al (1983) test, the subject was shown a display of lines numbered 1 through 11. The middle line, #6, was vertical with the remaining lines fanning out to the left (#1-5) and right (#7-11) at 18^{0} intervals. Directly above the 11 line display were 2 lines each representing a segment of one of the display

lines. The subject was asked to indicate which of the display lines matched the test lines in orientation by circling the number that corresponded to the appropriate display line. There are two comparable 30 item versions of this test with the items presented in order of increasing difficulty. A time limit of 30 sec is recommended for patients groups.The present study used 20 items selected from easy, moderate and difficult levels and allowed about 6 sec per item.

Time Limit: 2 minutes

The localization data on judgement of line orientation is very consistent. In an early study, Warrington and Rabin (1970) administered several spatial ability tests to right and left brain damaged subjects. In one, the matching slope of line task, the subject had to indicate whether a pair of oblique lines were drawn at similar or different angles.

The results showed that compared to the left brain damaged group and controls who performed equivalently, the right brain damaged group, especially those with damage in the parietal region, performed significantly more poorly. Using tachistoscopic presentation of a different test of line orientation, Benton et al (1975) confirmed the results of Warrington and Rabin (1970). A comparison of right to left brain lesioned subjects revealed the right sided group as significantly more impaired than the left. There were no differences between left lesioned subjects and controls. An analysis of test performance with respect to lesion site, identified by radiographic techniques, revealed that the inferior performance of the right brain damaged group as a whole was entirely due to those subjects with posterior lesions.

Manteer (1983b) included two tests of line orientation in the stimulation mapping study of right brain surgery patients. The subjects were shown a slide on which a slanted target line and three distractor lines appeared. Then a facial emotion recognition test was administered. Finally, a slide showing three new oblique lines was presented. The subject's task was to indicate which of these three lines was drawn at the same angle as the original target line.

The results of this test were similar to those found for facial emotion recognition. If stimulation at any one site produced impairments on one of the tasks, it also disrupted performance on the other as well. The areas found to be most sensitive to stimulation were located in the parietal-occipital junction.

Kim et al (1984) examined the performance of left brain damaged, right brain damaged and normal controls on several spatial ability tests. The patient samples had been further subdivided into anterior and posterior groups. For the angles test the subject was shown a card on which a series of oblique lines were arranged in a semicircle. Below this display, a second card with one oblique line was presented. The subject had to indicate which of the lines forming the semicircle was at the same angle as the test line.

The error scores between all groups were significantly different with the normal controls receiving the highest scores and the right lesioned group the lowest. Further, right posterior lesioned patients performed much more poorly than did the right anterior lesioned subjects.

3. Size Discrimination: Circle-to-Circle Matching: For this test, the subject had to select which of five distractor circles was the same size as a target circle. The circles were displayed horizontally with the target circle to the left of a vertical line and the five choices to the right.

While this particular right hemisphere task has not been employed as frequently as some others, there is nevertheless some evidence that encouraged its use here.

Ornstein et al (1980) recorded bilateral central and parietal EEG in normal right-handed adults as they performed various tasks including Nebes's (1971a) arc-to-circle and circle-to-circle matching. Following Nebes (1971b) who observed performance asymmetries only for arc-to-circle matching, Ornstein et al (1980) hypothesized that this task would show stronger right hemisphere lateralization than would the circle-to-circle matching task as the former requires a "part-whole" synthesis. Contrary to the prediction however it was the circle-to-circle matching task which was lateralized to the right hemisphere with arc-to-circle matching producing greater activation in the left hemisphere.[4] For both tasks, asymmetries were observed only at the parietal leads.

Hatta (1977) presented a 120°, 180° or 240° arc in the central visual field followed immediately (Exp. 1) or five seconds later (Exp. 2) by a circle in the left or right visual field. The subject's task was to indicate whether or not the target arc belonged to the comparison circle.

According to Hatta (1977), while an overall left visual field advantage was observed, the factor of degrees of completeness of circle (size of the arc)...was not significant" (p. 148). An examination of Hatta's results however suggests that the 240° arc contributed more to the left visual field advantage than did the 120° or the 180° arcs.

In order to test the hypothesis that perceptual deficits in brain damaged patients are due to response biases (Kimura, 1963 in Bisiach et al, 1976), Bisiach et al (1976) examined the performance of left and right brain damaged subjects on 7 perceptual tests according to Signal Detection Theory. Included in the battery was an area discrimination task for which the subject had to indicate whether two circles were the same or different in diameter.

While statistical analyses allowed the authors to rule out a response bias interpretation for only 1 of the 7 tests (line length

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[4] It may be noted that the Nebes (1971b) subjects did not view both target and distractor stimuli as did the Ornstein et al (1980) sample but rather felt the target arc or circle which was hidden behind a screen.

discrimination), the results of an analysis of covariance encouraged to authors to conclude

> ...we feel sufficiently confident to generalize to all classes of stimuli the conclusion that the selective loss of ability in making fairly accurate discriminations, which has been repeatedly shown to ensue from right posterior brain damage, cannot be reasonably attributed to chance factors nor to response biases...
> While still speculative, we would chance...the conclusion that after injury to its right posterior regions the brain is left a coarser, though steady, measuring tool to cope with linear length discrimination and, in general, with discrimination between slightly different stimuli (p. 341).

Since the Facial Recognition and Judgement of Line Orientation tasks were used in a different way[5] than that described by Benton et al (1983), both forms of these two tests along with both forms of the other four were administered to an independent sample of college men and women to determine their reliability. Some of the subjects began with Form A, the remainder with Form B. At least three weeks intervened between the two test administrations.

3. <u>Group Embedded Figures Test (GEFT)</u>:

The Group Embedded Figures Test (Oltman et al, 1971) is an easily used paper and pencil measure of field-independence which is suitable for individual or group administration. In this test, the subject is given a 2 color booklet with various simple geometric shapes printed on the outside

[5]Benton et al (1983) show the subjects one test item at a time in a one-on-one testing session. This study presented 4 items per page in a booklet suitable for group administration.

back cover. The booklet contains several more complex figures presented in order of increasing difficulty each of which contains one of the simpler shapes in the same orientation and size as on the back cover. The subject's task is to find and trace out the embedded simpler shape. The test is divided into 3 separately timed sections although only the second and third, which contain 9 items each, are used for scoring purposes. The time limits for the sections are 2, 5, and 5 minutes.

4. Mood Manipulation Check:

In order to determine the effectiveness of the mood manipulation as well as the subjects' mood as they performed the cognitive tasks, they were asked place a mark on a Likert-type mood scale ranging from -10, very depressed to +10, very happy to indicate how they were feeling at that moment. An initial measurement was taken before the the induction procedure and then immediately before each test.

Procedure: At the first testing session (no mood induction), the subject was told that this study is concerned with how our feelings and behavior interact. It was also be explained that in order to explore this question, we need to obtain two sets of measures so, if she chose to continue, she would need to return for a second testing session at a later date. The subject was asked to sign a consent form describing the experimental procedures but worded in such a way as to disguise the hypotheses being tested (see Appendix III-A). Before administering the six cognitive tests, the experimenter explained that the tests were timed. The subject was given sample items from the tests to insure that she understood what each required. The order of right and left hemisphere tests was counterbalanced and arranged so that each of the six tests appeared with equal frequency in all positions. After the subject completed the cognitive tests, the GEFT was administered. An appointment for the second testing session (at least three weeks later) was made, and the subject thanked for her participation.

After the tests had been scored, the subjects were randomly assigned to one of three treatment conditions with the provisions that the initial no mood induction test scores and the field independent-field dependent distributions be approximately equivalent in the three samples.

When the subject returned for the second set of measurements, the experimenter restated the purpose of the study. The subject signed a second consent form (see Appendix III-B) explaining the mood induction and experimental procedures. Included in these directions were task motivational instructions taken from Barber (1979) which are designed to increase the subject's involvement in the task. The subject then reported her mood on the first mood measure. Again, she was given sample items from the six cognitive tests to refresh her memory.

In the second session, the subject was exposed to the mood induction procedure. Each subject was exposed to only one condition: either the elation, the depression or the neutral. Parallel versions of the three left hemisphere and three right hemisphere tasks were then administered.

Subjects were tested individually in a small room with no lateral distractions. The experimenter was seated in the outside corridor with the door to the experimental room slightly ajar. This permited her to continuously observe the subjects and be certain that all tests were completed within the time limit. After the testing was finished, handedness was assessed and for the subjects in the induced depression group, the elation inducing treatment was administered. Each subject then completed a post-experimental questionnaire (see Appendix IV) and was thoroughly debriefed. The subjects were thanked for their participation and invited to leave a mailing address so that a summary of the experiment could be sent after the results were analyzed.

RESULTS

The purpose of the present investigation was to determine whether performance on lateralized tasks would be differentially affected by the presence of a positive or negative emotion. There are two models of brain-behavior interaction relevant to this question. Following Davidson's reciprocal inhibition theory (1984a) a sad mood was hypothesized to improve left, but impair right hemisphere performance. Conversly, a happy mood was predicted to enhance right hemisphere functioning while interfering with left hemisphere activity. Kinsbourne's spreading activation theory (Kinsbourne and Hicks, 1978; Kinsbourne and Hiscock, 1983) would predict increased performance on right hemisphere tasks in a sad mood, on left hemisphere tasks in a happy mood. Although the theories generate opposite hypotheses, nevertheless they both predict an interaction between type of mood and type of task.

RESULTS OF THE RELIABILITY STUDY

As described earlier (see p. 73), the presentation of the Lines and Faces tests used in this study would be somewhat different than that described by the authors of the measures (Benton et al, 1983). Thus, both forms of these, as well as the other four tests were administered to an independent sample of college men and women. The means, standard deviations and correlations between Forms A and B of the six cognitive tests are presented in Table 1 (p. 95). The correlations indicated that all of the tests were reliable.

MOOD INDUCTION AND PERFORMANCE

The means and standard deviations of the six tests obtained from the sample used in the present study can be found in Table 2 (p. 96). Both pre- and post mood induction data are included. Table 3 (p. 97) shows the intercorrelations among these measures.

Based on a substantial literature linking the Lines, Circles and Faces tests to right hemisphere functions, and the Finding A's, Arithmetic and Rhyme tests to left hemisphere activity, statistical relationships among the 3 tests of each hemisphere were expected. While the present study did not require factorial coherence, if Finding A's, Arithmetic and Rhyme (and Lines, Circles and Faces) all depend, at least in part, on some common analytical-left hemisphere (gestalt-right hemiphere) process, significant correlations within each set of measures should emerge. As can be seen in Table 3 however, the 3 tests of each hemisphere do not seem to be reflections of a common underlying "hemisphere" factor. There were no significant correlations between any of the left hemisphere tests either before or after the induction. The relationships among the right hemisphere tests were somewhat stronger as moderate correlations between Lines and Circles and Lines and Faces were observed. It may be interesting to note that of the 4 significant correlations that emerged from the analysis of the total sample (n=72), 2 were "cross-hemispheric": Finding A's and Lines and Finding A's and Faces. It may be noteworthy that among the "left-hemisphere" tests, Finding A's relies most on perceptual-recognition processes and least on higher, more cognitive activity.

Since the pattern of intercorrelations showed little, if any, shared variance among the tests of each hemisphere and since there was no way of determining which test was the more valid measure of its hemisphere's functioning, it seemed most reasonable to statistically examine the effects of the mood induction procedure in separate analyses. Thus, a series of mood by task ANOVAs was carried out in which the performance difference on each right hemisphere test was contrasted with the performance difference on each left hemisphere test. For example, change on the Lines test (post-induction z-score minus pre-induction z-score) was analyzed against changes on the Findings A's, Arithmetic, and Word Endings tests. With 3 tests of each hemisphere, 9 comparisons result. A final ANOVA was computed in which a combined "verbal (left hemisphere) score," obtained by averaging the standard scores on the Finding A's, Arithmetic and Rhyme tests, was compared to a combined "spatial (right hemisphere) score" using Lines, Circles and Faces.

This set of 10 ANOVAs was used in 6 different types of data classification. The first set compared the effects of the elation, depression and neutral inductions for all 72 subjects. Table 4 (p. 98) presents the F values for the task x mood interactions for each of the 10 ANOVAs. Two of these interactions were significant: Arithmetic and Lines and Arithmetic and Circles. As shown in Table 5 (p. 99), however, these significant interactions were primarily due to the group differences on the Arithmetic test which did emerge as a significant main effect in the Lines by Arithmetic comparison ($F = 3.14$, $p < .05$).

The possibility that the weak relationships observed in the first analysis were due to the neutral group masking any differences between the two emotion groups was eliminated by a second set of mood x task ANOVAS. In this comparison the same left hemisphere test by right hemisphere test contrast was used except that the neutral group was omitted. There were no significant interactions, as indicated in Table 6 (p. 100), nor were any main effects observed.

The third set of 10 mood by task ANOVAs compared the induced mood, irrespective of valence, to the neutral mood induction. This analysis would represent a test of the alternative theory of lateralized affect - both positive and negative emotions are functions of the same (right) hemisphere - and was accomplished by placing the elation and depression induction subjects into one category (N=48) and comparing them to the neutral group (N=24). The significant interactions which were once again found between Lines and Arithmetic and Circles and Arithmetic (see Table 7, p. 101) seem primarily due to the neutral versus emotion group difference on the Arithmetic test as can been seen in Table 8 (p. 102). This analysis also revealed two significant main (group) effects: in the Lines by Arithmetic comparison ($F = 6.18$, $p < .01$) and the Faces by Arithmetic comparison, ($F = 9.22$, $p < .003$) the neutral group showed performance increases while the emotion group showed performance decreases.

The Velten procedure has been criticized (see Clark, 1983 and Sutherland et al, 1982) as wasteful of subjects; that is, the individual may be exposed to the mood statements but not experience the intended affect. As such, some investigators (Teasdale and Taylor, 1981; Teasdale et al, 1980) do not include the data collected from these unaffected subjects in their analysis. Therefore, 3 more sets of 10 mood by task ANOVAs were completed. These were similar to the ones just described but included only the scores of the 12 subjects in each induction group whose reported mood, averaged over the 6 post induction mood reports, most closely matched what was intended. Table 9 (p. 103) presents the interaction F-ratios using the 3 group (elation, depression and neutral) classification. Table 10 (p. 104) shows the 2 emotion group (elation versus depression) interaction and Table 13 (p. 107) presents the results of the emotion versus neutral analysis.

Of the 30 ANOVAs, 2 significant interactions and 2 significant main effects resulted. Table 10 shows a significant interaction between the Lines and Findings A's tests. In this case, as can be seen on Table 11 (p. 105) the change scores were in the direction predicted by Davidson's (1984a) theory: the depression subjects decreased on the Lines test but improved on Finding A's. The elation group performed better on Lines test, worse on Finding A's. A nearly significant interaction ($p < .06$) between Circles and Rhyme is also evident in Table 10 but here, the pattern of change was exactly opposite to what would be predicted by the same model (see Table 12, p. 106). The other significant interaction, as seen in Table 13, resulted from the Arithmetic by Circles contrast in the emotion group versus neutral group comparison. Table 14 (p. 108) presents the change scores.

The two main effects that were found seem to be reflecting performance differences on the Arithmetic test. In the 3 mood groups comparison, the neutral group improved on the Arithmetic and Faces tests while both the elation and depression subjects showed performance decrements on the former test and for the elation subjects, on the latter test as well ($F = 3.39$, $p < .05$). The Arithmetic by Lines analysis in the neutral group versus emotion group comparison once again found the neutral group showing increases, the emotion group, decreases on both tests ($F = 4.09$, $p < .01$).

Cognitive Style: Statistical analyses revealed no significant patterns for field independents or field dependents on any of the cognitive tests or on reported mood averaged over the 6 tests.

DISCUSSION

The results of the present investigation do not support Davidson's (1984a) reciprocal inhibition or Kinsbourne's (Kinsbourne and Hicks, 1978; Kinsbourne and Hiscock, 1983) spreading activation model. While some significant mood effects were revealed, their patterns do not suggest that the presence of an induced positive or negative mood differentially affects the performance of tasks sensitive to right or left hemisphere functioning.

The most consistent and apparently meaningful finding was the group differences on the Arithmetic test. Of the 60 mood by task ANOVAs that were computed, 6 significant interactions and 5 significant main (group) effects emerged. All of the main effects and 5 of the 6 interaction effects were primarily due to the neutral group's increased performance, and the depression and elations groups' decreased performance on Arithmetic. None of the theoretical models discussed can account for this finding. According to Davidson (1984a), the depression group should have improved on the left hemisphere-Arithmetic test. Kinsbourne's theory (Kinsbourne and Hicks, 1978; Kinsbourne and Hiscock, 1983) would predict the elation group to show enhanced performance. Assuming the positive correlations Davidson found between contralateral frontal and parietal neural activity (see Davidson, 1984a) are related to behavior, the alternative theory of lateralized affect, which places all emotion in the right frontal zones, would expect performance increases in both emotion groups on the Arithmetic test.

At this point, it seems that the most likely interpretation of the group differences on the Arithmetic test would emphasize psychological "software". Of the 6 cognitive tests used in this experiment, the Arithmetic test seems to make the greatest demand on short-term memory processes. The 3 right hemisphere tests, Lines, Circles and Faces, are recognition tests. Finding A's, a left hemisphere test, is also a recognition test. The Rhyme test probably relies more on long-term memory. While emotional arousal may affect all cognitive processes to some extent, Gilligan and Bower's (1984) network theory of affect seems to suggest that short-term memory may be somewhat more vulnerable:

> This differential flooding of short-term memory by emotion-related material has several implications. ...the filling of consciousness by emotionally related ideas results in the phenomenon described as the "narrowing of attention" to mood-related material (Easterbrook, 1959). In certain cases, if the internally generated scenario is sufficiently compelling, the emotional flooding of short-term memory can lead to a "lack of attention" to external stimuli (p. 565).

The only other significant interaction observed was in the direction predicted by Davidson's (1984a) reciprocal inhibition theory. That is, the ANOVA contrasting the Lines test and Finding A's test in the 12 most elated and 12 most depressed subjects comparison (Results: Tables 10 and 11) revealed that the elated subjects improved on Lines but decreased on Finding A's. The depressed group showed the reverse pattern. The importance of this result however is not clear. It may indeed be a genuine reflection of brain-behavior interaction or, alternatively, it may be nothing more than a pattern of results which might be expected to occur once or twice in 60 comparisons by chance alone.

There were two findings which may support the "chance" interpretation. The first concerns the Finding A's test. It is now questionable how sensitive this particular test was to left hemisphere functioning. The intercorrelations between all of the tests (see Results: Table 3) showed Finding A's significantly correlated with 2 of the 3 right hemisphere tests (Lines and Faces) but with none of the left hemisphere tests. As mentioned earlier, of the 3 left hemisphere tests, Finding A's appears to be the most dependent on perceptual processes and is, like the right hemisphere measures, a recognition test. The Rhyme test, on the other hand, which may be a better left hemisphere measure than Finding A's[1], was analyzed against the Circles test in the same most elated/most depressed comparison. An almost significant interaction ($F=3.76$, $p<.06$) but in a direction exactly opposite to that which Davidson's theory would predict emerged. Nevertheless, as the same interaction pattern between Lines and Finding A's was also observed using the full 24 subject elation and depression groups and that the mood by task interaction approached significance ($F=2.56$, $p<.11$), a replication with a larger sample does seem warranted.

As seen in the Results section, the mood induced changes in test performance were small. In fact, in some cases, the neutral group showed as much change as did the emotion groups. As such, it may be important to address the possibility that the subjects were not actually experiencing the mood but nevertheless reported that they did because of

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[1]Levy (1974, p. 149) states: "The right hemisphere may know...that 'cat' means a furry, small pet with claws, but it does not know that 'cat' rhymes with 'rat'."

demand characteristics. Velten's (1968) original study did include two "simulator" groups - subjects asked to respond as they thought actual induction subjects would. Differences between real and "simulating" subjects were found on both objective and subjective criteria. Velten's experimental design though has not been without its critics. The results of two independent studies (Polivy and Doyle, 1980; Buchwald et al, 1981) suggest that demand characteristics may be responsible, at least in part, for some of the behavioral differences reported between Velten induced ėlation and depression subjects. Alternatively, there are other researchers (Alloy et al, 1981; Ranieri and Zeiss, 1984; Ellis et al 1984) who have observed Velten induced changes in studies which appear to be free from such contamination.

It is not likely that demand characteristics were influencing the subjects' self-report in the present study. First, the subjects were given a very strongly worded honesty instruction. Second, after the experimental session was over, many subjects commented on how surprised they were that the statements actually "worked." Several subjects asked if the elation statements could be sent to them along with the experimental results. This is similar to Polivy and Doyle's observation: "During debriefing, close to half the subjects in the mood-induction groups reported actually feeling the mood implied by the statements" (1980, p. 289). Lastly, and most importantly, there were some, although not many, significant differences in test scores. It could be argued that just as experimental demand may pressure subjects into being less than completely truthful on their mood reports, it may likewise induce them to alter their test performance (see for example Zamansky et al, 1964). This possibility, however, seems unlikely. Virtually every subject indicated on the post-experimental inquiry forms that she knew the purpose of the study was to assess the influence of mood on task performance. Every subject indicated that mood would have some affect. If the subjects reported feeling the requested emotion because of experimental demand, and then changed their performance accordingly, there should be some relationship between belief and behavior. A comparison of how the subject felt mood would affect test performance and how their performance actually changed revealed no significant correspondence. This observation compares well to the findings of Gulian and Thomas (1986). Male and female subjects were asked to solve simple arithmetic problems in a quiet or noisy environment and with the instruction that the noise would or would not affect their performance. The results showed that female subjects, regardless of what they were led to believe about the influence of noise on behavior, performed more poorly in the noisy condition.

In many of the studies that reported significant effects using the Velten technique (Natale, 1977a, 1977b; Bollenbach and Madigan, 1982; Madigan and Bollenbach, 1982; Raps et al, 1980; Ellis et al, 1984) the subjects read the full 60 statement procedure whereas this experiment presented only 30. While shortened versions have been employed with success (see pg. 43 here), with the exception of Teasdale and Russell (1983) those studies did not detail which particular Velten statements were used.[2] Inspecting the elation and depression statements that were excluded here (see Appendix I), one sees the deliberate omission of those items referring to somatic condition. There is some research that suggests that the somatic statements may be more responsible for observed Velten MIP effects than are the self-evaluative ones (Frost et al, 1979; Kirschenbaum et al, 1985 but see Riskind et al, 1982). It is possible that we failed to find stronger Velten effects because we used the "wrong" statements; however, had we included somatic statements, we would have confounded affect per se with feelings of lethargy/energy, drowsiness/alertness, etc.

One might also ask whether limiting the study to females may have been responsible for the lack of significant findings. As will be recalled (see Methods, page 60), males were not sampled because of their reported (see Clark, 1981) difficulty in experiencing Velten induced moods and their tendency to be field independent (Witkin et al, 1962, 1967; Reighard and Johnson, 1973; Sabatelli et al, 1983). While females do seem to have greater success with the Velten procedure and provide a broader distribution of field independence, they are also less strongly lateralized (Bryden, 1982; Bradshaw and Nettleton, 1983; Robinson et al, 1983). Thus, the experiment may have failed to reveal significant lateralized effects because it did not measure lateralized individuals. The likelihood of this interpretaion, though, does not seem great.

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[2]Indeed, as noted by Clark (1983) it isn't even clear if it is the statements that are producing the mood. The subjects might "manipulate their mood by changing their facial expression...humming a tune...reliving a past experience...We have very little idea how (the Velten MIP) actually works (p. 40)."

Pizzamiglio and Zoccolotti (1981) have suggested that many of the reported behavioral differences between males and females rest not on the gender variance per se but on the sexes' difference in field independence. That is, when cognitive style is considered in a data analysis, otherwise noted sex differences often disappear. Other work, employing physiological (Oltman et al, 1979) and behavioral (Bryden, 1982; Pizzamiglio and Zoccolotti, 1981; Pizzamiglio et al, 1983; Rapaczynski and Ehrlichman, 1979; Zoccolotti and Oltman, 1978; Zoccolotti et al, 1979) criteria has shown that field independence is related to lateralization. Since this experiment did include a measure of field independence, it was possible to contrast performance changes in strongly lateralized-field independent subject to those of weakly lateralized-field dependent subjects. The computations revealed that the field independent subjects performed no differently than did the field dependent ones.

Our inability to find support for Davidson's (1984; or Kinsbourne's[3]) theory should not be interpreted as evidence against either position. The design of this experiment rested on several assumptions, albeit ones that seemed to be amply justified by the literature. Nevertheless, we accepted the presence of certain conditions without direct, empirical verification. For example, we took for granted that the subjective state generated by the Velten MIP would be accompanied by parallel physio-

[3]As will be recalled, the two models predict changes in opposite directions.

logical, i.e. EEG changes in frontal brain areas[4]. There is reason to believe that the Velten MIP may not produce the same kind of affective state, and therefore neural activation, as do emotions resulting from other stimuli.[5]

The acceptance of the Velten MIP as a model of natural depression[6] is most enthusiastic among those assuming a cognitive-behavioral stance (compared to say, psychodynamic or neuropharmacological). Indeed, several researchers (Teasdale and Fogarty, 1979; Henderson and Lohr, 1982; Natale and Hantas, 1982; Raps et al, 1980; Bollenbach and Madigan, 1982; but see also Hasher et al, 1985) have noted the similarity between Velten's self-referent statements and the negative feelings about one's self, one's future, and one's ability to remedy their situation that are believed to lie at the root of depression (Kovacs and Beck, 1979). Thus, exposure to the Velten depression statements might be expected to create the same emotional condition with similar behavioral consequences.

Two aspects of the assumption that Velten MIP depression is analogous to natural depresion need to be explored. The first concern the proverbial "chicken or egg first" dilemma. Kovacs and Beck (1979) do not make clear how the depressed person's thinking became distorted to begin

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[4]For the purposes of the present discussion it does not matter which model of emotion is employed.

[5]Indeed, one might question how different affect inductions influence behavior and biology. Would listening to music (see Clark, 1983), for example, generate the same degree of altruism as receiving a free gift (Isen, 1984).

[6]Out of necessity, this discussion must focus on induced vs natural depression as there are no comparable studies on induced vs natural elation.

with. It is difficult to believe that the biased thoughts of depressives are reflections of a more general cognitive impairment as Kovacs and Beck suggest:

> Characteristic transformation processes, errors of thought, and the apparent impairment in evaluating the soundness or validity of the resultant conclusions produce the impression of some basic thinking disorder in depression (1979, p. 435)

since it seems to involve only the self; i.e., depressives' evaluations of other people appear to be relatively accurate (Kovacs and Beck, 1979). There are at least two other ways of interpreting the affect-cognition relationship. The more common[7] would put the negative mood before its behavioral consequences. The more likely, particularly in clinical cases is that both disordered cognition and dysphoric emotion are manifestations of some other underlying variable(s). This is not meant to imply that distorted self-referent thinking is not a characteristic of depression but only that the cognitive interpretation may be somewhat restrictive and does not seem to consider abundant neurochemical evidence suggesting that there are several different kinds of depression (Rosenzweig and Leiman, 1982). That the type of depression (or elation) created by the Velten MIP is qualitatively different from natural and/or clinical depression(s) receives some support from an experiment by Ehrlichman and Halpern (1988) in which the presence of a positive and negative odor was substituted for the elation and depression Velten procedures in an

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[7]judging by the majority of studies in which mood is the independent variable.

otherwise direct replication of the Teasdale memory studies (Teasdale et al 1980; Teasdale and Taylor, 1981). While it certainly can be argued that a sensory experience is not comparable to an affective one (but see Ehrichman, 1984 and Ehrlichman and Halpern, 1988), it is nevertheless very interesting to note, as do Ehrlichman and Halpern, that their results match those obtained by Clark and Teasdale (1982) in clinically depressed subjects as well as unpublished observations Ehrlichman (1985, see Ehrlichman and Halpern, 1988) collected from normal subjects in very positive or very negative moods. Furthermore, all three of the aforementioned studies (Clark and Teasdale, 1982; Ehrlichman and Halpern, 1987) yielded results that are different from Teasdale et al (1980) and Teasdale and Taylor (1981) using the Velten MIP.

In addressing the question of why some studies have not found mood-dependent memory effects, Isen (1985) concluded that "the findings of researchers working with mildly depressed or saddened college students might not speak directly to our understanding of severe or clinical depresssion (p. 391)." Likewise, perhaps the cognitive sequelae of pathological mood disorder(s) are not actually relevant to an appreciation of how emotion affects thinking in normal university women.

It is interesting that the Velten MIP is the most widely used affect manipulation in experimental studies investigating emotion-cognition interactions but may be less like naturally occuring moods than are other affect induction techniques (see Ehrlichman and Halpern, 1988). That is, unlike procedures to which the subject passively responds, e.g. receiving a gift or watching a film, the Velten MIP seems more deliberate or contrived. The more "natural/passive" inductions may result in a different affect situation, one which might be described, perhaps, as more of a diffuse or subtle emotional "background" to which the subject does not necessarily attend but which may nevertheless influence his or her behavior. The Velten, on the other hand, requiring the subjects' active participation may be creating a situation in which the mood is a "figure." In the present experiment, however, there were other "figures" to which the subject had to attend as well, resulting in a kind of psychological Necker cube: when the subject was working on the tasks, she may not have been experiencing the mood because her attention was focused elsewhere. When focusing on the mood, she did not concentrate on the tasks. The mood checks preceeding each test redirected the subject's attention to her emotional state and she responded accordingly but then when she returned to tasks, once again the mood took an experiential back seat to the more salient cognitive demands of the tests. Thus, the fundamental condition necessary for a fair test of either model - the presence of an affective state at the same time the subject is performing a task(s) - may not have been achieved.

What seems to be needed is some way to independently verify the subjects' emotional state while they are performing the task(s). In all likelihood this will prove very difficult. A separate behavioral measure, even if one unobtrusive enough could be found, would confound the data. Physiological measures, such as EEG may be better candidates as they appear to be less susceptible to demand characteristics and, since the subject doesn't have to "do" anything, may reduce the chance of confounding[8]. A comprehensive study including physiological measures obtained when the subject is experiencing a mood, when that same subject is performing a task and then when he or she is doing both, and an analysis of that data in conjunction with behavioral observations (self-reported mood and performance on the task)[9] might provide more insight into the relationships between feeling and thinking and brain and behavior.

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[8]This assumes that the subject is accustomed to and comfortable with whatever recording apparatus is used.

[9]It is possible that EEG changes like those described by Davidson (1984) do occur but are just not behaviorally significant in normal populations. Davidson presented stimuli designed to produce positive or negative emotion and recorded EEG. In only one study (Davidson et al, 1979b) were subjective reports on the most liked/disliked portions of the stimuli collected and then correlated to the EEG. The more recent studies of Fox and Davidson (1986, 1987, 1988; see also p. 34 here) do correlate behavioral data with EEG activity in different emotion inducing situations and while the results of these experiments generally support Davidson's model, their relevance to the present work is limited by the different populations involved.

TABLE 1

MEANS, STANDARD DEVIATIONS AND CORRELATIONS OF FORMS A AND B OF THE SIX COGNITIVE TESTS (INDEPENDENT SAMPLE)

	$\bar{X}$	SD	r
Finding A's (n=59)			
Form A	25.30	9.14	
Form B	25.29	8.32	.731[1]
Arithmetic (n=63)			
Form A	18.16	6.41	
Form B	15.83	5.72	.846[1]
Rhyme (n=63)			
Form A	5.05	2.45	
Form B	6.43	3.35	.460[1]
Line Orientation (n=64)			
Form A	11.44	4.93	
Form B	11.16	4.58	.843[1]
Circle Matching (n=64)			
Form A	12.35	2.98	
Form B	12.15	3.49	.462[1]
Face Matching (n=64)			
Form A	12.31	4.00	
Form B	10.46	3.73	.725[1]

[1]$p<.01$

TABLE 2

MEANS AND STANDARD DEVIATIONS OF THE THREE MOOD INDUCTION GROUPS ON THE SIX COGNITIVE TASKS

		LEFT HEMISPHERE						RIGHT HEMISPHERE					
		Finding A's		Arithmetic		Rhyme		Lines		Circles		Faces	
MOOD		pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
Depression (n=24)	$\bar{X}$	27.04	26.96	19.63	19.21	8.58	7.8	11.21	11.79	11.96	12.29	10.08	10.63
	SD	8.15	8.64	5.75	5.43	2.96	3.9	4.32	3.62	4.05	3.40	4.04	3.88
Elation (n=24)	$\bar{X}$	26.33	24.13	18.79	16.88	8.00	8.50	10.58	11.79	11.08	11.63	10.58	10.25
	SD	6.53	9.05	5.35	4.78	2.95	2.92	4.27	4.38	3.06	3.12	4.73	4.05
Neutral (n=24)	$\bar{X}$	25.04	24.50	18.29	20.58	7.50	7.13	10.29	11.25	11.29	11.17	9.92	11.42
	SD	5.86	7.38	5.39	5.79	2.69	3.06	3.90	3.97	3.57	3.29	3.92	4.09

TABLE 3

INTERCORRELATIONS BETWEEN THE SIX COGNITIVE TESTS

	CIRCLES pre	CIRCLES post	FACES pre	FACES post	FINDING A'S pre	FINDING A'S post	ARITHMETIC pre	ARITHMETIC post	RHYME pre	RHYME post
LINES (N=72)	.311		.351[3]		.252[1]		.066		.100	
depressed (N=24)	.507[1]	.111	.509[1]	.490[1]	.129	.114	-.308	.115	.272	-.030
elated (N=24)	338	.280	304	.234	.214	.266	620	.277	-.345	-.059
neutral (N=24)	.026	.023	.236	200	.466[1]	.303	-.122	.014	380	.248
CIRCLES			.200		.082		-.029		.028	
depressed			.436[1]	.081	-.088	-.110	.068	.131	.176	-.126
elated			.068	.197	.349	.177	.025	-.123	-.366	-.064
neutral			076	.059	.072	.064	-.222	-.067	.175	-.145
FACES					.291[2]		.054		-.020	
depressed					.164	-.041	.090	-.199	-.147	-.297
elated					.502[1]	.455[1]	.113	.240	.091	.088
neutral					.219	.052	-.050	307	-.021	-.147
FINDING A'S							.132		.017	
depressed							.245	.252	-.066	.263
elated							-030	.076	-.210	-.072
neutral							111	.363	.222	.059
ARITHMETIC									-.072	
depressed									-.081	.323
elated									-.222	-.023
neutral									.050	-.139

[1] $p < .05$
[2] $p < 02$
[3] $p < 01$

TABLE 4

TASK X MOOD INTERACTIONS:
ELATION VS DEPRESSION VS NEUTRAL GROUP COMPARISON (N=72)

	Lines	Circles	Faces	"Spatial"
Finding A's	1.14	1.17	.36	
Arithmetic	4.01[1]	3.98[1]	.63	
Rhyme	.29	.56	1.55	
"Verbal"				.789

[1]$p < .02$

TABLE 5

DIFFERENCE SCORES:
LINES, CIRCLES AND ARITHMETIC TESTS (N = 72)

	Lines (post - pre)	Circles (post-pre)	Arithmetic (post - pre)
Depression (N=24)	-.079	.038	-.074
Elation (N=24)	.073	.080	-.346
Neutral (N=24)	.006	-.119	.421

TABLE 6

TASK X MOOD INTERACTIONS:
ELATION (N=24) VS DEPRESSION GROUP COMPARISON (N=24)

	Lines	Circles	Faces	"Spatial"
Finding A's	2.56	.84	.004	
Arithmetic	2.46	.73	.04	
Rhyme	.48	.76	2.06	
"Verbal"				.027

TABLE 7

TASK X MOOD INTERACTIONS:
EMOTION (N=48) VS NEUTRAL (N=24) GROUP COMPARISON

	Lines	Circles	Faces	"Spatial"
Finding A's	.202	1.40	.73	
Arithmetic	5.85[1]	7.18[2]	1.24	
Rhyme	.023	.193	1.03	
"Verbal"				1.57

[1] $p < .02$
[2] $p < .01$

TABLE 8

DIFFERENCE SCORES: LINES, CIRCLES AND ARITHMETIC TESTS
EMOTION VS NEUTRAL COMPARISON (N=72)

	Lines (post - pre)	Circles (post-pre)	Arithmetic (post - pre)
Emotion (N=48)	-.003	.059	-.21
Neutral (N=24)	.006	-.119	.421

TABLE 9

TASK X MOOD INTERACTIONS:
ELATION (N=12) VS DEPRESSION (N=12) VS NEUTRAL (N=12) GROUP COMPARISON

	Lines	Circles	Faces	"Spatial"
Finding A's	1.47	.71	.12	
Arithmetic	2.65	2.39	.32	
Rhyme	.24	2.52	1.70	
"Verbal"				.577

TABLE 10
TASK X MOOD INTERACTIONS:
ELATION (N=12) VS DEPRESSION (N=12) GROUP COMPARISON

	Lines	Circles	Faces	"Spatial"
Finding A's	4.55[1]	.13	.02	
Arithmetic	2.49	.02	.14	
Rhyme	.41	3.76	2.18	
"Verbal"				.158

[1]p<.05

TABLE 11

DIFFERENCE SCORES. LINES AND FINDING A'S TESTS
DEPRESSION (N=12) VS ELATION (N=12) GROUP COMPARISON

	Lines (post - pre)	Finding A's (post - pre)
Depression	-.192	.158
Elation	.178	-.263

TABLE 12

DIFFERENCE SCORES: CIRCLES AND RHYME TESTS
DEPRESSION(N = 12) VS ELATION(N = 12) GROUP COMPARISON

	Circles (post - pre)	Rhyme (post - pre)
Depression	.218	-.318
Elation	-.045	.315

TABLE 13

TASK X MOOD INTERACTIONS.
EMOTION (N=24) VS NEUTRAL GROUP COMPARISON (N=12)

	Lines	Circles	Faces	"Spatial"
Finding A's	.11	1.31	.22	
Arithmetic	3.12	4.89[1]	.52	
Rhyme	.002	.54	.54	
"Verbal"				1.06

[1]p<.03

TABLE 14

DIFFERENCE SCORES: CIRCLES AND ARITHMETIC TESTS
EMOTION (N=24) VS NEUTRAL (N=12) COMPARISON

	Circles (post-pre)	Arithmetic (post - pre)
Emotion	.086	-.211
Neutral	-.173	.423

APPENDIX I

VELTEN INDUCTION PROCEDURE. DEPRESSION STATEMENTS

1. TODAY IS NEITHER BETTER NOR WORSE THAN ANY OTHER DAY
2. HOWEVER, I FEEL A LITTLE LOW TODAY
3. I FEEL RATHER SLUGGISH NOW*
4. SOMETIMES I WONDER WHETHER SCHOOL IS ALL THAT WORTHWHILE
5. EVERY NOW AND THEN I FEEL SO TIRED AND GLOOMY THAT I'D RATHER JUST SIT THAN D ANYTHING
6. I CAN REMEMBER TIMES WHEN EVERYBODY BUT ME SEEMED FULL OF ENERGY*
7. TOO OFTEN I HAVE FOUND MYSELF STARING LISTLESSLY INTO THE DISTANCE, MY MIND A BLANK WHEN I DEFINITELY SHOULD HAVE BEEN STUDYING*
8. IT HAS OCCURRED TO ME MORE THAN ONCE THAT STUDY IS BASICALLY USELESS, BECAUSE YOU FORGET ALMOST EVERYTHING YOU LEARN ANYWAY
9. PEOPLE ANNOY ME; I WISH I COULD BE BY MYSELF
10. I'VE HAD IMPORTANT DECISIONS TO MAKE IN THE PAST, AND I'VE SOMETIMES MADE THE WRONG ONES
11. I DO FEEL SOMEWHAT DISCOURAGED AND DROWSY -------------MAYBE I'LL TAKE A NAP WHEN I GET HOME.*
12. PERHAPS COLLEGE TAKES MORE TIME, EFFORT, AND MONEY THAN IT'S WORTH
13. I'M AFRAID THE WAR IN VIET NAM MAY GET A LOT WORSE (I'M AFRAID THAT THERE WILL EVENTUALLY BE A NUCLEAR WAR)
14. I JUST DON'T SEEM TO BE ABLE TO GET GOING AS FAST AS I USED TO*
15. THERE HAVE BEEN DAYS WHEN I FELT WEAK AND CONFUSED, AND EVERYTHING WENT MISERABLY WRONG*
16. JUST A LITTLE BIT OF EFFORT TIRES ME OUT*
17. I'VE HAD DAYDREAMS IN WHICH MY MISTAKES KEPT OCCURRING TO ME-------SOMETIMES I WISH I COULD START OVER AGAIN

*This statement was omitted in the shortened version used here.

18. I'M ASHAMED THAT I'VE CAUSED MY PARENTS NEEDLESS WORRY

19. I FEEL TERRIBLY TIRED AND INDIFFERENT TO THINGS TODAY*

20. JUST TO STAND UP WOULD TAKE A BIG EFFORT*

21. I'M GETTING TIRED OUT; I CAN FEEL MY BODY GETTING EXHAUSTED AND HEAVY*

22. I'M BEGINNING TO FEEL SLEEPY; MY THOUGHTS ARE DRIFTING*

23. AT TIMES I'VE BEEN SO TIRED AND DISCOURAGED THAT I WENT TO SLEEP RATHER THAN FACE IMPORTANT PROBLEMS.*

24. MY LIFE IS SO TIRESOME-----THE SAME ONE THING DAY AFTER DAY DEPRESSES ME

25. I COULDN'T REMEMBER THINGS WELL RIGHT NOW IF I HAD TO*

26. I JUST CAN'T MAKE UP MY MIND; IT'S SO HARD TO MAKE SIMPLE DECISIONS*

27. I WANT TO GO TO SLEEP------I FEEL LIKE JUST CLOSING MY EYES AND GOING TO SLEEP RIGHT HERE*

28. (I'M NOT VERY ALERT,)* I FEEL KIND OF SAD

29. I'VE DOUBTED THAT I'M A WORTHWHILE PERSON

30. I FEEL WORN OUT
MY HEALTH MAY NOT BE AS GOOD AS IT'S SUPPOSED TO BE*

31. IT OFTEN SEEMS THAT NO MATTER HOW HARD I TRY, THINGS STILL GO WRONG

32. I'VE NOTICED THAT NO ONE SEEMS TO REALLY UNDERSTAND OR CARE WHEN I COMPLAIN OR FEEL UNHAPPY

33. I'M UNCERTAIN ABOUT MY FUTURE

34. I'M DISCOURAGED AND UNHAPPY ABOUT MYSELF

35. I'VE LAIN AWAKE AT NIGHT WORRYING SO LONG THAT I HATED MYSELF

36. THINGS ARE WORSE NOW THAN WHEN I WAS YOUNGER

37. THE WAY I FEEL NOW, THE FUTURE LOOKS BORING AND HOPELESS

38. MY PARENTS NEVER REALLY TRIED TO UNDERSTAND ME

39. SOME VERY IMPORTANT DECISIONS ARE ALMOST IMPOSSIBLE FOR ME TO MAKE*

40. I FEEL TIRED AND DEPRESSED; I DON'T FEEL LIKE WORKING ON THE THINGS I KNOW I MUST GET DONE *

41. I FEEL HORRIBLY GUILTY ABOUT HOW I'VE TREATED MY PARENTS AT TIMES

42. I HAVE THE FEELING THAT I JUST CAN'T REACH PEOPLE

43. THINGS ARE EASIER AND BETTER FOR OTHER PEOPLE THAN FOR ME
I FEEL LIKE THERE'S NO USE IN TRYING AGAIN

44. OFTEN PEOPLE MAKE MY VERY UPSET
I DON'T LIKE TO BE AROUND THEM

45. IT TAKES TOO MUCH EFFORT TO CONVINCE PEOPLE OF ANYTHING
THERE'S NO POINT IN TRYING*

46. I FAIL IN COMMUNICATING WITH PEOPLE ABOUT MY PROBLEMS

47. IT'S SO DISCOURAGING THE WAY PEOPLE DON'T REALLY LISTEN TO ME

48. I'VE FELT SO ALONE BEFORE, THAT I COULD HAVE CRIED

49. SOMETIMES I'VE WISHED I COULD DIE

50. MY THOUGHTS ARE SO SLOW AND DOWNCAST
I DON'T WANT TO THINK OR TALK*

51. I JUST DON'T CARE ABOUT ANYTHING
LIFE JUST ISN'T ANY FUN

52. LIFE SEEMS TOO MUCH FOR ME ANYHOW------MY EFFORTS ARE WASTED

53. I'M SO TIRED*

54. I DON'T CONCENTRATE OR MOVE
I JUST WANT TO FORGET ABOUT EVERYTHING*

55. I HAVE TOO MANY BAD THINGS IN MY LIFE

56. EVERYTHING SEEMS UTTERLY FUTILE AND EMPTY

57. I FEEL DIZZY AND FAINT
I NEED TO PUT MY HEAD DOWN AND NOT MOVE*

58. I DON'T WANT TO DO ANYTHING*

59. ALL OF THE UNHAPPINESS OF MY PAST LIFE (I'VE KNOWN IN MY LIFE) IS TAKING POSSESSION OF ME

60. I WANT TO GO TO SLEEP AND NEVER WAKE UP

VELTEN INDUCTION PROCEDURE: ELATION STATEMENTS

1. TODAY IS NEITHER BETTER NOR WORSE THAN ANY OTHER DAY
2. I DO FEEL PRETTY GOOD TODAY, THOUGH
3. I FEEL LIGHT-HEARTED*
4. THIS MIGHT TURN OUT TO HAVE BEEN ONE OF MY GOOD DAYS
5. IF YOUR ATTITUDE IS GOOD, THEN THINGS ARE GOOD, AND MY ATTITUDE IS GOOD
6. I'VE CERTAINLY GOT ENERGY AND SELF-CONFIDENCE TO SPARE*
7. I FEEL CHEERFUL AND LIVELY
8. ON THE WHOLE, I HAVE VERY LITTLE DIFFICULTY IN THINKING CLEARLY*
9. MY PARENTS ARE PRETTY PROUD OF ME MOST OF THE TIME
10. I'M GLAD I'M IN COLLEGE------IT'S THE KEY TO SUCCESS NOWADAYS
11. FOR THE REST OF THE DAY, I BET THINGS WILL GO REALLY WELL
12. I'M PLEASED THAT MOST PEOPLE ARE SO FRIENDLY TO ME
13. MY JUDGMENT ABOUT MOST THINGS IS SOUND*
14. IT'S ENCOURAGING THAT AS I GET FARTHER INTO MY MAJOR, IT'S GOING TO TAKE LESS STUDY TO GET GOOD GRADES
15. I'M FULL OF ENERGY AND AMBITION-----I FEEL LIKE I COULD GO A LONG TIME WITHOUT SLEEP*
16. THIS IS ONE OF THOSE DAYS WHEN I CAN GRIND OUT SCHOOLWORK WITH PRACTICALLY NO EFFORT AT ALL*
17. MY JUDGMENT IS KEEN AND PRECISE TODAY
JUST LET SOMEONE TRY TO PUT SOMETHING OVER ON ME*
18. WHEN I WANT TO, I CAN MAKE FRIENDS EXTREMELY EASILY
19. IF I SET MY MIND TO IT, I CAN MAKE THINGS TURN OUT FINE
20. I FEEL ENTHUSIASTIC AND CONFIDENT NOW
21. THERE SHOULD BE OPPORTUNITY FOR A LOT OF GOOD TIMES COMING ALONG
22. MY FAVORITE SONG KEEPS GOING THROUGH MY HEAD*
23. SOME OF MY FRIENDS ARE SO LIVELY AND OPTIMISTIC*

24. I FEEL TALKATIVE-------I FEEL LIKE TALKING TO ALMOST ANYBODY*

25. I'M FULL OF ENERGY, AND AM REALLY GETTING TO LIKE THE THINGS I'M DOING ON CAMPUS*

26. I'M ABLE TO DO THINGS ACCURATELY AND EFFICIENTLY*

27. I KNOW GOOD AND WELL THAT I CAN ACHIEVE THE GOALS I SET

28. NOW THAT IT OCCURS TO ME, MOST OF THE THNGS THAT HAVE DEPRESSED ME WOULDN'T HAVE IF I'D JUST HAD THE RIGHT ATTITUDE

29. I HAVE A SENSE OF POWER AND VIGOR*

30. I FEEL SO VIVACIOUS AND EFFICIENT TODAY------SITTING ON TOP OF THE WORLD

31. IT WOULD REALLY TAKE SOMETHING TO STOP ME NOW*

32. IN THE LONG RUN, IT'S OBVIOUS THAT THINGS HAVE GOTTEN BETTER AND BETTER DURING MY LIFE

33. I KNOW THAT IN THE FUTURE I WON'T OVER-EMPHASIZE SO CALLED "PROBLEMS"

34. I'M OPTIMISTIC THAT I CAN GET ALONG VERY WELL WITH MOST OF THE PEOPLE I MEET

35. I'M TOO ABSORBED IN THINGS TO HAVE TIME FOR WORRY

36. I'M FEELING AMAZINGLY GOOD TODAY!

37. I AM PARTICULARLY INVENTIVE AND RESOURCEFUL IN THIS MOOD

38. I FEEL SUPERB! I THINK I CAN WORK TO THE BEST OF MY ABILITY*

39. THINGS LOOK GOOD THINGS LOOK GREAT!

40. I FEEL THAT MANY OF MY FRIENDSHIPS WILL STICK WITH ME IN THE FUTURE

41. I CAN FIND THE GOOD IN ALMOST ANYTHING

42. I FEEL SO GAY (JOYOUS) AND PLAYFUL TODAY
I FEEL LIKE SURPRISING SOMEONE BY TELLING A SILLY JOKE

43. I FEEL AN EXHILARATING ANIMATION IN ALL I DO*

44. I FEEL HIGHLY PERCEPTIVE AND REFRESHED*

45. MY MEMORY IS IN RARE FORM TODAY*

46. IN A BOUYANT MOOD LIKE THIS ONE, I CAN WORK FAST AND DO IT RIGHT THE FIRST TIME*

47. I CAN CONCENTRATE HARD ON ANYTHING I DO*

48 MY THINKING IS CLEAR AND RAPID*

49. LIFE IS SO MUCH FUN, IT SEEMS TO OFFER SO MANY SOURCES OF FULFILLMENT

50. THINGS WILL BE BETTER AND BETTER TODAY

51. I CAN MAKE DECISIONS RAPIDLY AND CORRECTLY, AND I CAN DEFEND THEM AGAINST CRITICISM EASILY*

52. I FEEL INDUSTRIOUS AS HECK------I WANT SOMETHING TO DO!*

53. LIFE IS FIRMLY IN MY CONTROL

54. I WISH SOMEBODY WOULD PLAY SOME GOOD LOUD MUSIC!*

55. THIS IS GREAT-----I REALLY DO FEL GOOD
I AM ELATED ABOUT THINGS

56. I'M REALLY FEELING SHARP NOW*

57. THIS IS JUST ONE OF THOSE DAYS WHEN I'M READY TO GO!

58. I FEEL LIKE BURSTING WITH LAUGHTER (I WISH SOMEBODY WOULD TELL A JOKE AND GIVE ME AN EXCUSE!*)

59. I'M FULL OF ENERGY*

60. GOD, I FEEL GREAT!

VELTEN INDUCTION PROCEDURE: NEUTRAL STATEMENTS

1. OKLAHOMA CITY IS THE LARGEST CITY IN THE WORLD IN AREA, WITH 631.166 SQUARE MILES*

2. JAPAN WAS ELECTED TO THE UNITED NATIONS ALMOST FOURTEEN YEARS AFTTER PEARL HARBOR

3. AT THE END APPEARS A SECTION ENTITLED "BIBLIOGRAPHY NOTES."

4. WE HAVE TWO KINDS OF NOUNS DENOTING PHYSICAL THINGS: INDIVIDUAL AND MASS NOUNS.

5. THIS BOOK OR ANY PART THEREOF MUST NOT BE REPRODUCED IN ANY FORM.*

6. AGRICULTURAL PRODUCTS COMPRISED SEVENTY PER CENT OF THE INCOME.

7. SATURN IS SOMETIMES IN CONJUNCTION, BEYOND THE SUN FROM THE EARTH, AND IS NOT VISIBLE.*

8 SOME STREETS WERE STILL SAID TO BE LISTED UNDER THEIR OLD NAMES

9 THE SYSTEM IS SUPERVISED BY ITS BOARD OF REGENTS

10 THERE IS A LARGE ROSE-GROWING CENTER NEAR TYLER, TEXAS.*

11 MANY STATES SUPPLY MILK FOR GRAMMAR SCHOOL CHILDREN.

12 IT IS GOD'S WILL THAT THE FITTEST SURVIVE*

13 THE TYPOGRAPHY, PAPER, AND BIND WERE OF THE HIGHEST QUALITY.

14 THE MACHINE DOMINATED COUNTY POSTS FOR AS LONG AS ANYONE COULD REMEMBER*

15 THE DESK WAS OLD, AND SCRATCHED INTO ITS SURFACE WAS A PROFUSION OF DATES, INITIALS, AND PLEADING MESSAGES.

16. THE ORIENT EXPRESS TRAVELS BETWEEN PARIS AND ISTANBUL.

17. WHEN THE BANYAN BENT DOWN UNDER ITS OWN WEIGHT, ITS BRANCHES BEGAN TO TAKE ROOT

18. THERE ISN'T A SCIENTIFIC EXPLANATION FOR EVERY U.F.O. SIGHTING.*

19. THE HOPE DIAMOND WAS SHIPPED FROM SOUTH AFRICA TO LONDON THROUGH THE REGULAR MAIL SERVICE.

20 THE REVIEW IS CONCERNED WITH THE FIRST THREE VOLUMES.

21 THE SHIP WAS ANCIENT, AND WOULD SOON BE RETIRED FROM THE FLEET.

22 SLANG IS A CONSTANTLY CHANGING PART OF THE LANGUAGE

23. THERE IS A SMALL ARTICLE IN THE LOCAL NEWSPAPER WHICH INDICATES ACCEPTANCE OF THE OF THE KIDNAPPERS' TERMS.

24. THERE ARE SOME FORMS IN WHICH NO OATH IS REQUIRED.*

25. INTRAMATICS FINDS MATES FOR THE LONELY.*

26. 99.1% OF ALASKA IS OWNED BY THE FEDERAL GOVERNMENT.*

27. TWO MEN DRESSED AS REPAIRMEN WILL APPEAR SHORTLY AFTER THE VAN PULLS UP.

28. THE WOOD WAS DISCOLORED AS IF IT HAD BEEN HELD IN A FIRE.

29. A LIGHT WAS NOTICED IN THE DARK OUTSIDE, AND IT MOVED EERILY TOWARDS THE HOUSE.

30. PAINTING IN A FEW OTHER NON-EUROPEAN COUNTRIES IS TREATED IN A SEPARATE VOLUME.

31. A RECENT STUDY REVEALED THAT ONE HALF OF ALL COLLEGE STUDENTS WERE UNABLE TO FIND SUMMER JOBS.*

32 PROVOKED AROUSAL AND ORIENTATION ARE ACCOMPANIED BY STEEPER NEGATIVE SHIFTS.*

33 THE NAMES ON THE CHRISTMAS MAILING LIST ARE ALPHABETICALLY ORDERED.

34. SIGNIFICANTLY, THESE CHANGES OCCUR DURING THE FULL MOON.

35. WEST SAMOA GAINED ITS INDEPENDENCE IN 1965.

36. THE MAGAZINE'S REPORT WAS SLANTED, AS USUAL*

37. THE MAP WOULD PROVE USELESS AS A BEGINNING GUIDE.*

38. THE SPEAKER OUTLINED A PLAN WHEREBY THE CURRENT DEFICITS COULD BE ELIMINATED.

39. BLACK AND WHITE PICTURES ARE ARRANGED IN TEN SECTIONS

40. THE VOICES COME ONLY AT NIGHT, AND WHISPER WORDS, TERRIBLE WORDS.*

41. THE PAPERS HAD BEEN FRONT-PAGING IT FOR DAYS.*

42. THE NOTICE MADE IT CLEAR THAT COFFEE BREAKS WERE BEING LIMITED

43. NO MAN WORKED HARDER THAN HE.*

44. POTTER WROTE NUMEROUS SATIRES ON SOCIAL CYNICISM.

45. BOEING'S MAIN PLANT IN SEATTLE EMPLOYS 35,000 PEOPLE*

46. THE DOORKEEPER WAS DRESSED IN RED.

47. DURING THE NEXT TEN YEARS, THE GROUP PARTICIPATED IN POLITICS.*

48. THE ORGANIZATION DEPENDED ON THE PEOPLE FOR SUPPORT.

49. IN 1965, ELIZABETH MADE THE FIRST STATE VISIT BY A BRITISH MONARCH TO GERMANY IN 56 YEARS.

50. IT WAS THEIR SIXTH CONSECUTIVE BEST SELLER *

51 IT ALL FITTED IN WITH THE OFFICER'S STORY.

52. THE MERGER DID NOT CHANGE THE COMPANY'S POLICY*

53 THE MANSION WAS RENTED BY THE DELEGATION.*

54 NINETY OCCUPATIONS WERE LISTED AS ELIGIBLE FOR THE GRADS IN BUSINESS.*

55 UTAH IS THE BEEHIVE STATE.

56 CHANGES WERE MADE IN TRANSPORT OF LUMBER AFTER THE BORDER INCIDENT.*

57 THE CHINESE LANGUAGE HAS MANY DIALECTS, INCLUDING CANTONESE, MANDARIN, AND WU.

58 THINGS WERE BOOMING ONCE AGAIN IN THE LITTLE GOLD RUSH TOWN OF ANGEL.

59 AT LOW TIDE THE HULK OF THE OLD SHIP COULD BE SEEN.*

60. A FREE SAMPLE WILL BE GIVEN TO EACH PERSON WHO ENTERS THE STORE.*

Appendix II: Cognitive Tasks

FINDING A'S

MENTION	RUNNING	MORNING	neighbor
ladder	numerous	SETTING	strong
bench	promise	puzzle	DOOR
theory	funny	witty	MOON
shutter	skip	DRYLY	SOOTHE
further	BLOOM	switch	quarrel
PUBLISH	PERFUME	fellow	spelling
spread	monkey	blotter	wheel
deliver	eleven	melted	STEAM
REMIND	DISMAL	EXPENSE	SOBER
improved	SPONGE	ringing	night
forbid	history	durable	couch
pudding	NOBODY	mixture	SWELL
sunrise	biscuit	TOUCH	correct
REWARD	TEMPLE	PICNIC	hear
PROGRESS	consist	whistle	window
intense	indeed	lemon	BITTER
bridle	distant	WITHIN	lively
PRIZE	scenery	SHRIEK	engine
GOOSE	jesting	riddle	COMPEL
indoor	howl	politics	TWINKLE
WINDING	JUMP	leave	serene
temper	FIGURE	wintry	MODERN
message	depend	RELISH	revive
virtue	race	wonder	fifth
endure	sprout	BREAD	study
SIXTH	HONEY	SWEEP	boast
CHALK	clock	prince	juicy
MOTOR	duke	confide	scorn
route	cliff	socket	mood
syrup	four	fatigue	SEIZE
gold	SHAWL	monster	IVORY
spicy	lunch	EXPLODE	renew
LION	crowd	MILLION	COLONY
WOOL	EXTENT	EMPIRE	loudly
PINE	GUARD	regular	HORSE
sour	JOLLY	church	giant
cork	upper	BULGE	visit
PINT	noon	timid	ounce
SHEEP	dough	plum	STONE
DUSTY	expect	MOSS	BEING

GO ON TO THE NEXT PAGE

ARITHMETIC
(Reduced in size for duplication purposes)

8	44	26	61	3	9	68	9	8	15
5	36	[illegible]	78	86	58	64	28	42	93
6	34	19	34	11	48	17	36	39	92

14	39	75	93	67	33	99	59	74	99
38	34	31	27	35	41	37	19	23	17
44	18	56	43	12	32	67	33	32	22

17	86	6	69	99	31	25	56	15	91
61	68	48	96	86	98	78	26	3	35
46	79	27	59	16	66	69	44	19	33

38	29	92	14	24	31	56	96	55	42
89	77	97	32	13	49	26	95	97	57
68	4	45	37	15	24	44	33	39	65

92	31	13	63	67	98	62	7	23	74
86	84	87	52	3	10	95	64	59	58
71	72	53	1	52	38	74	13	82	41

7	45	58	16	7	38	91	42	66	47
94	5	29	94	17	53	85	73	21	23
65	47	14	29	49	84	36	37	54	76

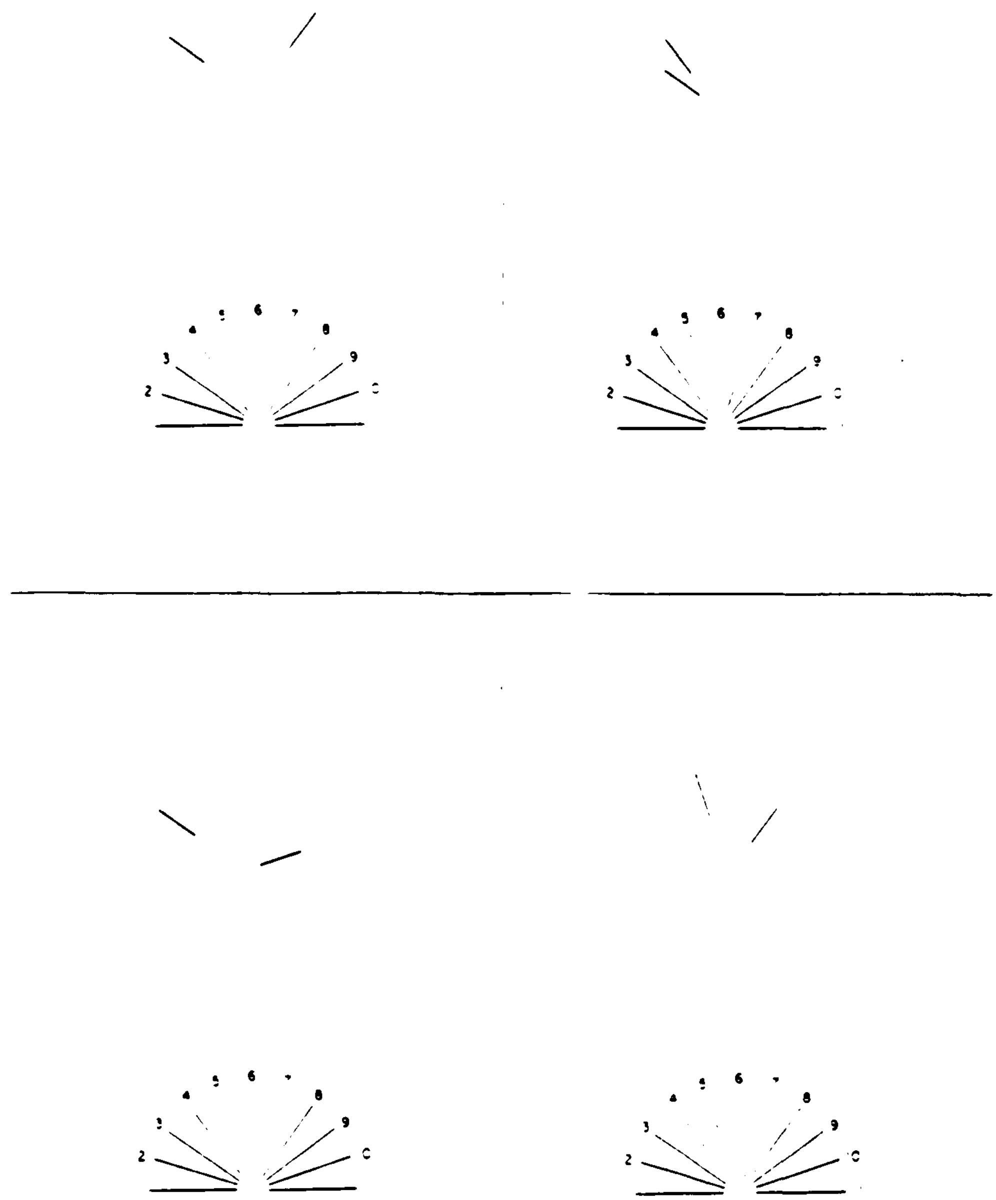
STOP!

WORD ENDINGS

Write as many words as you can that end with "ARE"

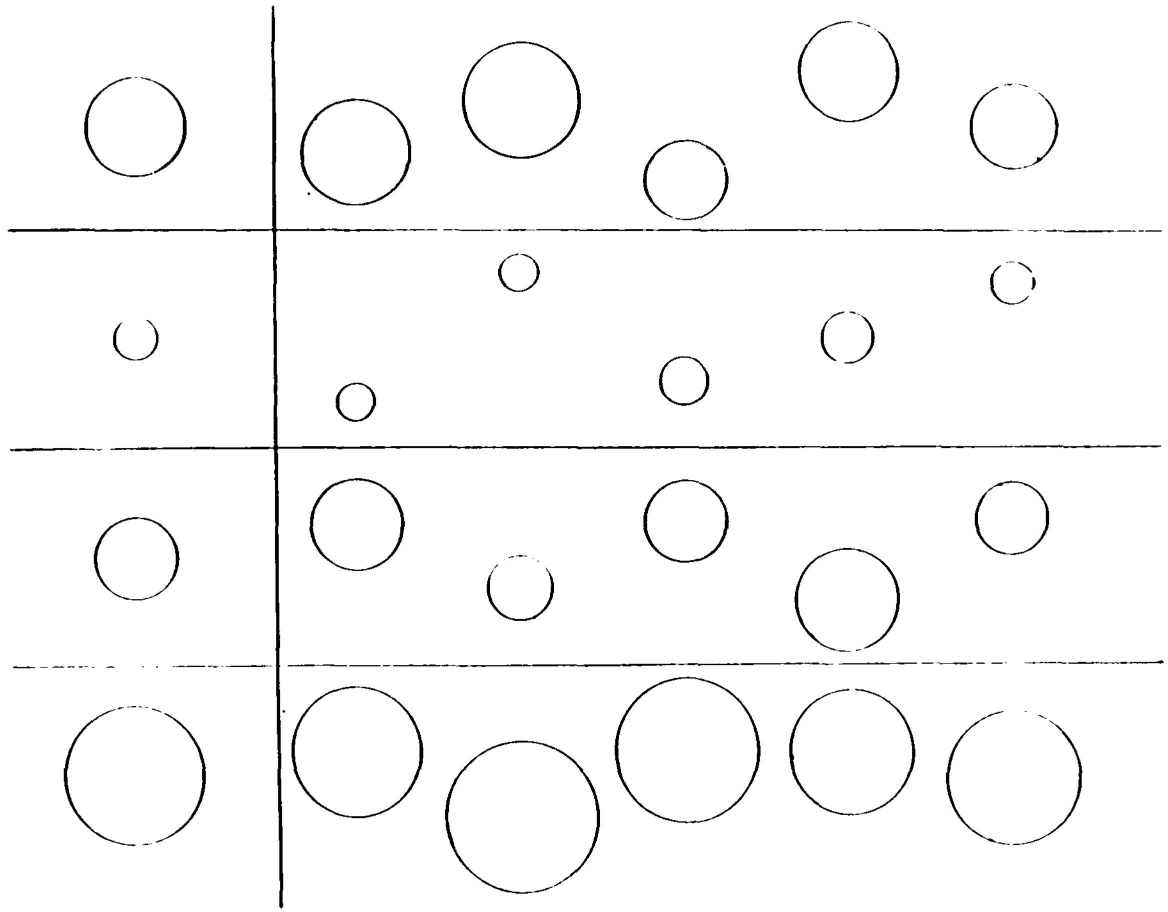
LINE ORIENTATION

(Reduced in size for duplication purposes)

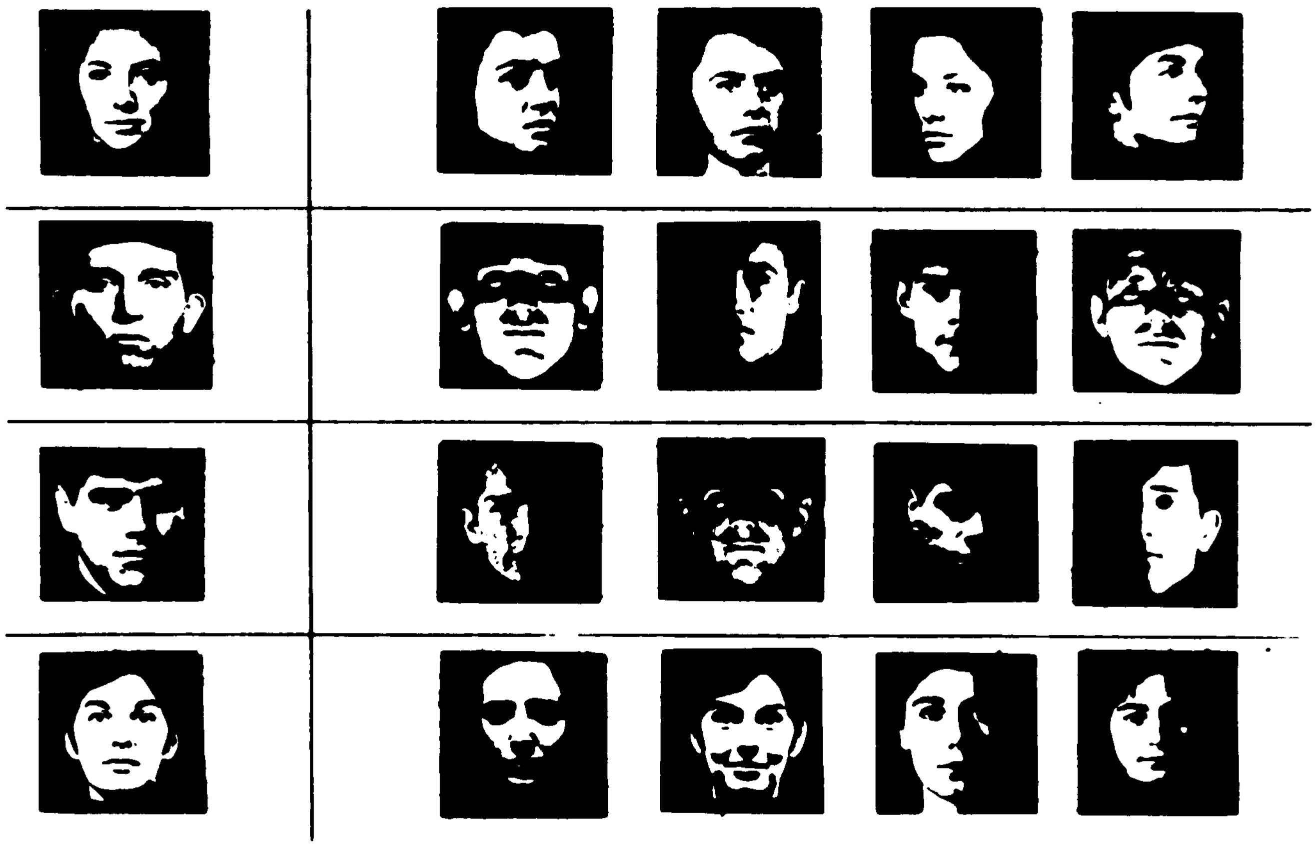


CIRCLES

(Reduced in size for duplication purposes)



FACES
(Reduced in size for duplication purposes)



Appendix III-A: Consent Form

You may have noticed that when you are feeling a certain way, doing something else can affect the way you feel. For example, if you are feeling happy, dancing may help you to stay happy or even make you happier. Or, if you are angry, doing some physical exercise may help you to get rid of that anger. The purpose of the present study is to find out how well people can stay in a mood while they are performing different kinds of tasks.

The group that you are in will be asked to perform some ____________________ tasks. We would like to know how these tasks influence your mood. Since we have no way of knowing how different tasks influence mood, it is very important that you give the task that your group has been assigned your utmost attention while you try your best to stay in the mood that you will be asked to experience.

There are two parts to this experiment. In the first part, I will ask you to complete seven (7) short, simple tasks. The purpose of this session is to familiarize you with the experimental procedure and to obtain some baseline information. In the second session, I may ask you to perform some _______________ tasks after you have gotten into a certain mood to see how well you can stay in the mood while you perform the tasks. In order to get into the mood, you will be asked to read a set of statements designed for this purpose. This procedure has been successfully used in many experiments.

Once again, I would like to stress that there is no way of knowing how different kinds of tasks will affect a person's mood. Therefore, it is very important that you try to the very best of your ability to do well on the tasks and to stay in the mood that I will ask you to feel.

The procedure of the experiment being conducted by D. Springer of the Graduate Center of the City University of New York has been explained to me. I understand what will be required of me and I agree to participate. I also understand that my responses will be held in the strictest of confidence and that I may withdraw from the experiment at any point without consequence or prejudice. I have received a copy of this consent form.

Print Name________________________ Sign Name_________________________

Social Security No.________________ Date ______________________________

Appendix III-B: Consent Form

As you know, the purpose of this study is to find out how our behavior may affect our feelings. In a few moments, I'm going to ask you to take a few tests - just like the ones you took the last time you were here. This time though, before you take the tests, I would like you to go through the cards in this envelope. Each card has a statement written on it designed to create a mood. Before you begin the tests, please read the statements and try to experience the mood that the statement expresses. Past research has shown that subjects who are willing to cooperate and concentrate on the statements to the fullest extent have no difficulty getting into the mood. Some people feel that this is an awkward or silly thing to do and do not try to experience the mood. If you don't try to the best of your ability, this experiment will be worthless and I'll tend to feel silly. On the other hand, if you try to the best of your ability to get into the mood suggested by the statements, you will be helping this experiment and not wasting any time.

Take aout 10 minutes to go through the cards, about 20 seconds per statement. You may find that some statements do not help you to experience the mood while others are more effective. Do not spend too much time concentrating on the statements that do not work for you. Instead, concentrate on the statements which help you to experience the mood. It is very important that you try to achieve the mood that the statements are trying to create.

Do not be concerned about the time. I will let you know when it is time to put the cards on the side and get ready to take the tests. As you probably remember, there is a time limit for the tests. I will tell you when the time is up and when it is time to begin the next test: just wait. Perhaps you could concentrate on the mood statements you just read. Once again, please do not go on to the next test until I have told you to begin.

On the first page of every test you will see a scale that ranges from 10, very depressed to +10 very happy. Right before you begin each test, (when I say "ready") indicate how you are feeling by placing a mark at that point on the line that best refelct your mood <u>at that moment</u>. As you remember, the purpose of this study is to learn how performing a task influences mood. Since we have no way of knowing what the outcome will be, IT IS VERY IMPORTANT THAT YOU BE <u>COMPLETELY</u> HONEST WHEN YOU INDICATE YOUR MOOD ON THE SCALE .

I understand that in the second part of the study being conducted by Dee Springer of the Graduate Center of the City University of New York I will be asked to experience and maintain a depressed mood while I try to perform the tasks to the best of my ability and to report my mood before each test honestly.

______________________________ ____________________

(sign name) (date)

Appendix IV: Post-Experimental Questionnaire

Sometimes people who participate in experiments can provide very valuable insights that help us in designing future experiments. I would be very interested in knowing about your experience of participating in this study. Please indicate in the space below what YOU thought this experiment was about. In other words, please tell me what questions YOU think I was interested in answering.

Listed below are 12 statements concerning the goals of this experiment. Some of the statments do reflect the goals of this experiment while others do not. Based on your experience in this experiment, I would like you to tell me which of these goals the experiment wants to achieve. In other words, please indicate what you thought the purpose of this experiment was by placing a check next to the choice that represents your opinion.

For example, if the statement is "To see if adults can maintain a mood better than children can" and you do not think that this was what the experiment is about, you would place a check next to the last choice: "not a purpose of the experiment." If you think that this statement may have been a purpose of this experiment, you would check "may have been a purpose of the experiment." If you think that this statement represents the main focus of the experiment, then you would check "definitely a purpose of this experiment." (By the way, to see if adults can maintain a mood better than children can was not a purpose of this experiment!)

1. To see if more intelligent people have greater difficulty or less difficulty in maintaining a mood than less intelligent people do.

    __________ definitely a purpose of the experiment

    __________ may have been a purpose of the experiment

    __________ not a purpose of the experiment

2. To see if you could get into the mood suggested by the mood induction

   __________ definitely a purpose of the experiment

   __________ may have been a purpose of the experiment

   __________ not a purpose of the experiment

3. To see if females are better, worse or no different than males in maintaining a mood while they are being distracted by another task.

   __________ definitely a purpose of the experiment

   __________ may have been a purpose of the experiment

   __________ not a purpose of the experiment

4. To see if you could maintain the mood while you performed the tasks.

   __________ definitely a purpose of the experiment

   __________ may have been a purpose of the experiment

   __________ not a purpose of the experiment

5. To see how well you could do on the tasks while you were in the mood.

   __________ definitely a purpose of the experiment

   __________ may have been a purpose of the experiment

   __________ not a purpose of the experiment

6. To see if concentrating on a task that involves thinking takes you mind off of how you feel.

   __________ definitely a purpose of the experiment

   __________ may have been a purpose of the experiment

   __________ not a purpose of the experiment

7. To see if a laboratory induction of a mood state is similar to naturally occuring mood states.

__________ definitely a purpose of the experiment

__________ may have been a purpose of the experiment

__________ not a purpose of the experiment

8. To see how long the mood can be maintained when you are not doing anything special compared to how long the mood can be maintained when you are doing something specific.

__________ definitely a purpose of the experiment

__________ may have been a purpose of the experiment

__________ not a purpose of the experiment

9. To see if being a mood influences how quickly you can complete the tests.

__________ definitely a purpose of the experiment

__________ may have been a purpose of the experiment

__________ not a purpose of the experiment

10. To see how well a person can perform when they are experiencing a mood compared to how well they can perform when they are not experiencing a mood.

__________ definitely a purpose of the experiment

__________ may have been a purpose of the experiment

__________ not a purpose of the experiment

11. To see if certain kinds of tasks are better than other kinds of tasks in taking your mind off of how you feel emotionally.

__________ definitely a purpose of the experiment

__________ may have been a purpose of the experiment

__________ not a purpose of the experiment

12. To see if being in a mood influenced how you performed on the tasks.

_________ definitely a purpose of the experiment

_________ may have been a purpose of the experiment

_________ not a purpose of the experiment

Generally speaking, how well do you think someone in a happy mood would do on these tests compared to when they weren't feeling happy? Do you think someone in a happy mood would perform better on all of the tests, worse on all of the tests, better on some of the tests, worse on other tests, or no differently than when they aren't feeling happy?

Please indicate by checking "BETTER", "WORSE" or "NO DIFFERENCE" how you think someone in a happy mood would do on these tests compared to when they are not in any special mood.

	BETTER	WORSE	NO DIFFERENCE
Finding the "As"	______	______	______
Word Endings (Rhyming)	______	______	______
Arithmetic	______	______	______
Circle Matching	______	______	______
Face Matching	______	______	______
Line Orientation	______	______	______

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