1982

Cerebral Laterality in the Perception of Facial Expression of Human Emotion

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CEREBRAL LATERALITY IN THE PERCEPTION OF FACIAL EXPRESSION OF HUMAN EMOTION

by

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A Thesis Submitted to the Faculty of the Graduate School of Loyola University of Chicago in Partial Fulfillment of the Requirements for the Degree of Master of Arts

November

1982

ACKNOWLEDGEMENTS

The author would like to thank Mark S. Mayzner, Ph.D., whose generous time and assistance as Thesis Director were extremely helpful in generating and integrating methodological possibilities into a viable research project. The author is indebted to J. Clifford Kaspar, Ph.D., whose ability to impart conceptual clarity and enthusiasm provided the motivation needed for this project to come to completion. The author would also like to thank Ira Appelman, Ph.D., who freely offered advice and constructive criticisms throughout this project and Arthur L. Benton who graciously encouraged the development of this project.

VITA

The author, Joseph Gerard Hermes, is the son of John Joseph Hermes and Loretta (Opatka) Hermes. He was born May 2, 1955, in Chicago, Illinois.

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REVIEW OF RELATED LITERATURE

The study of cerebral hemispheric laterality has become a complex, and often confusing, discipline in the past twenty years. Many insights have been gained regarding the cognitive and affective functioning of the brain through studies of split-brain patients, brain lesioned patients, and normals with intact brains. The human brain is organized so that two potentially independent mental systems coexist such that each hemisphere may act independently on specific information. The systems are asymmetrical in that each hemisphere utilizes either predominantly verbal-analytical or visual-spatial, affective associational strategies in the experience and analysis of information (Gazzaniga & LeDoux, 1978; Joseph, 1982). There is considerable overlap of function in that all input may be analyzed by each hemisphere but some types of information are dealt with more efficiently by one than the other hemisphere (Joseph, 1982). Hemispheric asymmetry is most often demonstrated by the recognition and processing of stimuli presented to the hemisphere reportedly specialized for these functions more readily than when these stimuli are presented contra-laterally to the non-specialized hemisphere (Wexler, 1980).

Based on such evidence, it has generally been accepted that the right hemisphere (RH) is primarily concerned with the reception and realization of non-linguistic, non-sequential, non-temporal sensory information (Gazzaniga, 1970; Gazzaniga & LeDoux, 1978, Joseph, 1982). It does not seem to label or perform differential analysis on the elements of stimuli but rather perceives things as a whole (Joseph, 1982; Sergent & Bindra, 1981). Wexler (1980) concludes that studies over the past 40 years which investigated differences between the hemispheres indicated that the right temporal lobe is essential for face recognition, maze learning, and appreciation of spatial relationships. The left hemisphere (LH) is widely accepted as being preeminent for mediation of analytical-mathematical and temporal processes including the linguistic labeling and categorization of experience (Gazzaniga & LeDoux, 1978; Joseph, 1982; Wexler, 1980). The left hemisphere is essential for verbal memory and word fluency. Evidence also exists which indicates that the hemispheres contribute differently to the experience and perception of emotion (Joseph, 1982; Tucker, 1981; Wexler, 1980) and that psychiatric illness is associated with various lateralized dysfunctions (Merrin, 1981; Sandel & Alcorn, 1980; Wexler, 1980). Thus, factors which appear important to the understanding of hemispheric specializations include the cognitive and affective nature of the incoming stimuli as well as the emotional state of the perceiving and processing subject.

Studies which have systematically investigated the cognitive and affective nature of stimuli presented to subjects make use of the fact that in man the temporal hemiretina in each eye projects directly to the ipsilateral visual cortex whereas the optic nerves from each nasal hemiretina cross at the chiasm to project to the contralateral visual cortex (Geffen, Bradshaw, & Wallace, 1971). This means that a stimulus in the left-visual field, i.e., left of fixation, is received by the right hemisphere (RH) whether that stimulus is viewed monocularly or binocularly. The converse is true for stimuli in the right-visual field (LH). Thus, while a subject is fixating a central point in a tachistoscope, stimuli may be presented exclusively to one visual field. Studies which have used this technique for unilateral and bilateral presentation of schematic faces (Geffen et al., 1971) and photos of familiar and unfamiliar faces (Hannay & Rogers, 1979; Hilliard, 1973; Jones, 1979a; Klein, Moskovitch, & Vigna, 1976; Leehy & Cahn, 1979) have found that males and females show a left-visual field (RH) superiority in recognition speed and accuracy. Right-handed males tend to demonstrate left-visual field (RH) superiority more strongly than any other sex/handedness group in facial recognition tasks (Jones, 1979b; Rizolatti & Buchtel, 1977;

Rizolatti, Umilta, & Berlucchi, 1971) and on other visuo-spatial tasks such as dot location (Birkett & Wilson, 1979). The essential nature of the right hemisphere for the processing of facial stimuli is also supported by clinical evidence of a right hemisphere lesion for 16 of 20 patients with facial agnosia (Hecaen & Angelergues, 1962). Because facial agnosia is such a rare condition, procedures to assess facial perception and memory in patients with brain disease were developed. Benton (1980) concludes, from evidence gathered during a series of studies in which facial recognition tasks were presented to normal and brain lesioned groups, that the primary role of the right hemisphere in mediating the identification and discrimination of familiar and unfamiliar faces has been demonstrated. He cautions however that findings on normal subjects indicate that many factors affect the neural mediation of facial discrimination and, therefore, weaken the conclusion that facial discrimination is an exclusive property of the right hemisphere.

Studies which have investigated the lateralized processing of affectively charged material have employed various experimental stimuli and procedures. Sackheim, Gur, and Saucy (1978) and Schwartz, Davidson, and Maer (1975) presented right-handed subjects with affectively charged questions and found that subjects exhibited more left than right lateral eye movements. Results were interpreted as suggesting a right hemispheric specialization for the processing of emotion. Tucker (1981) however suggests that it is insufficient to attribute all emotional functions to the right hemisphere. He states that the two hemispheres seem to exist in a reciprocally balancing relationship wherein each hemisphere's affective tendency opposes and complements that of the other. Several studies support the notion that both hemispheres are involved in the processing of affective material. Dimond and Farrington (1977) and Dimond, Farrington, and Johnson (1976) used heart rate as a measure of emotional response to unilaterally presented films. They found that, for 18-24 year old right-handed students, response was greater when affectively negative films were presented to the left-visual field (RH) and when affectively positive films were presented to the right-visual field (LH). Harman and Ray (1977) found that left hemisphere EEG amplitudes showed larger increases with positive emotional experiences than did right hemisphere EEG amplitudes. Davidson, Schwartz, Saron, Bennett, and Goleman (1979) reported differential activation of the anterior regions of the two hemispheres for positive versus negative emotions in terms of relative left versus right hemisphere activation respectively. Ahern and Schwartz (1979) recorded lateral eye movements for right-handed college students and found that positive emotion questions evoked relative left hemisphere involvement and that negative emotion questions evoked relative right hemisphere involvement. Schwartz, Ahern, and Brown (1979) recorded EMG readings from right and left facial muscles in subjects responses to reflective questions and found that these muscles exhibited differential responsitivity to positive and negative emotion respectively. They interpreted their results as being consistent with the growing body of evidence that the right hemisphere is specialized for the mediation of negative emotion and that the left hemisphere is specialized for the mediation of positive emotion.

Tucker (1981) suggested that the lateralization of emotional processes might be intrinsic to the differential forms of conceptualization of the two hemispheres. Unfortunately, the face recognition studies mentioned above did not control for the emotional tone of the stimuli presented to the subjects. Other studies have attempted to investigate the perception and cognitive processing of facial emotion more adequately. Suberi and McKeever (1977) had female subjects memorize either emotional or neutral (non-emotional) faces and then had subjects discriminate target and non-target faces in a tachistoscopic presentation. The authors hypothesized that the magnitude of left-visual field (RH) superiority for face recognition would be augmented by affective cues. Results indicated that subjects discriminated both emotional <u>and</u> neutral faces more quickly in the left- than right-visual field and had significantly faster discriminations of emotional versus neutral faces in the left-visual field (RH). The authors interpreted these findings as indicating that emotional expression augmented the right hemisphere's superiority over the left. The authors reported that differences in left-visual field (RH) superiorities for happy, sad, and angry faces occurred though the small number of subjects in each specific affect condition and the considerable variability precluded statistical significance of these differences. Given the growing evidence cited earlier regarding the differential hemispheric processing of positive and negative emotionality, it was unfortunate that the authors did not report reaction time data for happy, sad, and angry faces in the right-visual field (LH) also. While an overall left-visual field (RH) superiority was obtained, it may have been that this superiority of the left- versus right-visual field varied as per type of facial affect. This issue could not be addressed given the data reported by the authors. Hansch and Pirozzolo (1980) tachistoscopically presented right-handed subjects with photos of emotional (happy, angry, and surprised) and neutral faces to test the notion of independence of affective processing from facial recognition in producing a right hemisphere superiority effect. Results indicated that <u>both</u> emotional and neutral faces were recognized more quickly in the left-visual field (RH) than in the right-visual field (LH). However, a direct comparison of emotional and neutral face reaction times in the left-visual field (RH) failed to reveal a significant difference which contradicts the findings of Suberi and McKeever (1977). It would seem that the supposed left-visual field (RH) superiority for processing emotional facial stimuli is far from absolute.

Evidence for the possible role of type of emotion in the expression and processing of facial affect comes from diverse non-tachistoscopic studies. Sackheim and Gur (1978) had subjects rate the intensity of emotional expressiveness of left-side, right-side, and original orientation composite human faces expressing seven distinct emotions. The emotion categories sad, disgust, fear, and anger were grouped as instances of negative affect and the emotions happiness and surprise were grouped as positive affects. For all emotions except happiness, the left-side composite was judged as being more intense in its degree of emotional expression than the right-side composite. In happiness, the right-side composite was seen as being more intense than the left-side composite. The authors interpreted these findings as suggesting that, as in the case of the processing of emotional information, hemispheric response to emotional expression may be determined by the type of emotion being expressed. Graves and Natale (1979) investigated the relationship between hemispheric preference and communication accuracy of facial affect. Right-handed subjects' hemispheric preference was determined by conjugate lateral eye movements. The authors hypothesized that left-movers (RH preference) would demonstrate superior nonverbal expressive abilities for negative emotion and right-movers (LH preference) would demonstrate superior facial expression of positive emotions. Subjects were shown slides portraying various emotions and subjects' evoked facial expressions were videotaped and independently rated for accuracy. Results indicated that left-movers (RH) were significantly better than right-movers (LH) at non-verbally communicating negative affect but that hemispheric preference was not related to the expression of positive affect. Though stimuli in each of these studies were not directly presented to each hemisphere unilaterally, results from the studies do suggest that each hemisphere may differ in its processing of positive and negative emotional facial stimuli.

The results of previous studies provide considerable evidence indicating that the hemispheres are specialized for the processing of either positive or negative affect. To date, no study has systematically investigated the differential hemispheric processing of faces which differ only with respect to type of emotional expression. By focusing on the categorization of facial emotion and minimizing extraneous facial differences, the present study attempted to assess more adequately the influence of of the affective nature of facial stimuli on the cognitive processes of each hemisphere. By simultaneously presenting affective (happy and sad) facial stimuli to each visual field, hemispheric superiorities would be demonstrated in the following manner: (1) When presented with happy-sad photo pairs of the same face (Contrast condition), subjects (a) would identify the happy face more quickly than the sad face in the right-visual field (LH) and (b) would identify the sad face more quickly than the happy face in the left-visual field (RH). (2) When presented with happy-happy or sad-sad photo pairs of the same face (Identical condition), subjects would (a) more often respond to happy faces in the right-visual field (LH) than in the left-visual field (RH) and (b) more often respond to sad faces in the left- than the right-visual field.

As mentioned previously, the cognitive and affective nature of the stimuli as well as the emotional state of the perceiving subject can affect the lateralized functioning of the hemispheres. Kronfol, Hamsher, Digre, and Waziri (1978) administered neuropsychological tests, which included a facial recognition task (Levin, Hamsher, & Benton, 1975), to depressed patients and found that the right hemisphere functions were more frequently abnormal as compared to left hemisphere functions. The pattern of performance for a group of depressed patients on the Halstead Reitan neuropsychological test battery also suggested poor right hemisphere functioning (Goldstein, Filskov, Weavers, & Ives, 1977). Donnelly, Waldman, Murphy, Wyatt, and Goodwin (1980) administered the Category Test, a non-verbal abstractive task of discriminating visuo-spatial patterns for which the right hemisphere is specialized, to depressed patients and normals and found that the depressed group had significantly more errors than the control group. A study by Taylor, Greenspan, and Abrams (1979), which included 105 affective disordered patients, showed that a greater percentage of these patients committed more right hemisphere errors on an aphasia screening test than the percentage of patients who committed left hemisphere errors. Sandel and Alcorn (1980) utilized the conjugate lateral eye movement index to classify psychiatric patients and prison inmates, and their results indicated that depression was associated with right hemisphericity. In his review of the literature regarding cerebral laterality and psychiatry, Wexler (1980) comments that despite methodological differences, studies offered evidence of a right hemisphere dysfunction in depression. Using college students, Tucker (1981) used a mood induction procedure and found that a mild and transient depressive mood in normal subjects may be associated with a decrement in the right hemisphere's processing capacity similar to that observed with depressed patients. Given the right hemisphere's reported superiority for the processing of facial stimuli and negative emotional stimuli and the evidence for right hemisphere dysfunction in depression, it was hypothesized that scores on a depression inventory (Berndt, Petzel, & Berndt, 1980) would be related to reaction times for identification of sad faces in the left-visual field (RH).

METHOD

Subjects

Twenty-one undergraduate males participated in this study. All subjects indicated that they most often used their right hand to eat, write, and throw a ball with. Each subject received credit toward a course requirement for their participation in this study.

Stimuli Material

Stimuli material were full-face achromatic photographs of six unfamiliar females who had been instructed to express happiness and sadness. Four photographs for each type of emotional expression (happy and sad) for each of the six females were obtained which yielded 48 photos altogether. One sad or happy photograph for each face was placed on the right side and another happy or sad photo of the same face on the left side of a 5" x 8" white background. Four stimulus cards were thus generated for each of the six female faces: (1) sad-happy, (2) happy-sad, (3) happy-happy, and (4) sad-sad. The Contrast Conditions consisted of all sad-happy and happy-sad pairs, and the Identical Conditions consisted of all happy-happy and sad-sad pairs. The photographed faces measured approximately 4.45 centimeters in length and 3.97 centimeters in width. The center of each face appeared 2.86 centimeters to the left or right of the center of the stimulus card.

Procedure

Subjects freely viewed a display of the happy-sad or sad-happy face pairs for each of the six females and rated each of the 12 photographs (1) for whether the person looked happy or sad and (2) for how happy or sad the person seemed on a scale of 1-4.

Subjects were then seated in front of a tachistoscope (Scientific Prototype, Model N-1000) fitted with a viewing hood which minimized head movement. The subjects viewed the stimulus field with both eyes at a distance of approximately 129 centimeters. A trial consisted of the initial presentation of a black visual field with a red light at its center upon which the subject fixated for about one second followed by the presentation of a stimulus card for 175 milliseconds. This procedure allowed for the simultaneous unilateral presentation of one face from each pair to the left and right visual field. Trials were seperated by an average of three seconds. Stimuli were presented in randomized blocks of six stimulus cards. Each block contained one stimulus card from each of the six sets of stimulus cards such that no block had more than one stimulus card of the same face. Type of card (Contrast or Identical) and order of presentation were block randomized. Before presentation of each block of stimulus cards, the experimenter instructed the subject to fixate on the red fixation point and then to indicate, as quickly as possible after the presentation of the stimulus card, in which field he first recognized a happy face (or sad face depending on the instructional set for that particular block of stimulus cards). Instructional set for each block was randomized such that equal numbers of requests for sad and happy faces was made. The subject indicated his response by depressing a response key in his right hand with his forefinger for the right-visual field or the response key in his left hand for the left-visual field. Reaction time was automatically recorded by an electronic timer. A red or yellow light, right and left visual field respectively, flashed when the subject depressed a response key and the experimenter recorded which visual field the subject indicated for each trial.

The experimenter read the instructions to the subject and the subject then completed 12 practice trials. Instructions stressed both speed and accuracy. Subjects then completed 72 trials. After completion of the tachistoscopic presentations, each subject completed a copy of the Multiscore Depression Inventory; a 118 True-False self-report measure designed specifically for use with non-clinical populations (Berndt, 1981; Berndt et al., 1980).

RESULTS

Error Data

As in other reaction time studies of face recognition (Geffen et al., 1971; Moskovitch et al., 1976; Sergent, 1982) only correct responses whose latencies were below 900 milliseconds were included in calculating the means and analyzing the data. Number of trials with response latencies greater than 900 milliseconds was not related to visual field or type of emotional expression, $\chi^2(1)=0.15$, $p>.05$. Errors occurred on 5.7% of the trials. Equal numbers of errors occurred on happy and sad face trials with 53% of errors occurring in the left-visual field (RH) and 47% of errors in the right-visual field (LH). The number of errors was not related to visual field or type of emotional expression, $\chi^2(1)=0.62$, $p>.05$.

Contrast Condition

A two-way repeated measures analysis of variance of mean reaction times for type of emotional expression and visual field (see Table 1) showed that overall (a) the main effect for type of emotion was significant, $F(1,20)=40.71$, $p<.001$, (b) the main effect for visual field was significant, $F(1,20)=6.88$, $p<.05$, and (c) type of emotional expression and visual field did not interact significantly, $F(1,20)=2.66$, $p>.05$.

Table 1

Analysis of Variance of Mean Reaction Times for Type of Emotional Expression and Visual Field

Source	df	MS	F
Emotional Expression	1	58,672.0	40.71**
Error	20	1,441.1	
Visual Field	1	8,316.3	6.88*
Error	20	1,208.0	
Emot Express x Vis Field	1	7,606.7	2.66
Error	20	2,861.5	

* $p < .05$
**$p < .001$

Mean reaction times for sad and happy faces in each hemisphere are given in Table 2. Hypothesis 1a was supported by the data; happy faces were identified more quickly than sad faces in the right-visual field (LH), $\underline{t}(20)=5.0$, $p<.05$. Hypothesis 1b was not supported by the data, in fact happy faces were identified more quickly than sad faces in the left-visual field (RH) also, $\underline{t}(20)=4.69$, $p<.05$. Analysis of individual subject data revealed that 90% and 71% of the subjects recognized the happy faces more quickly than the sad faces in the right and left visual fields respectively. These data were consistent with the results of the two-way ANOVA that happy faces were identified more quickly than sad faces. The results regarding an apparent overall right-visual field (LH) superiority were less consistent. Whereas 67% of the subjects demonstrated quicker right-visual field (LH) response than left-visual field (RH) response for happy faces, only 48% of the subjects demonstrated this pattern of responding for sad faces. Indeed, mean sad face reaction times in the right and left visual fields were virtually the same; 560 milliseconds and 561 milliseconds respectively.

In general, the Contrast condition results indicated that each visual field identified happy faces more quickly than sad faces and that the right-visual field (LH) was quicker at doing so than the left-visual field (RH). Sad

Table 2

Contrast Condition Mean Reaction Times (msec)

	Happy	Sad
Right Visual Field (LH)	488	560
Left Visual Field (RH)	527	561

faces were apparently identified equally well in each visual field. These results suggest that the hemispheres do not differ in their processing of negative facial emotion and that the left hemisphere is particularly adept at processing positive facial emotion.

Identical Condition

In order to test hypothesis 2a that subjects would respond more often to happy faces in the right-visual field (LH) than in the left-visual field (RH) and hypothesis 2b that subjects would respond more often to sad faces in the left than in the right visual field, a Wilcoxon matched pairs signed-ranks test (Siegel, 1956; p. 75) was carried out on the Identical condition face pairs. Results indicated that subjects did not more often choose one visual field or the other for either happy faces ($T(17)=71$, $p>.05$) or sad faces ($T(21)=85.5$, $p>.05$). These findings suggest that the hemispheres do not differ in their capacities to recognize happy or sad faces under these conditions.

Mean reaction times for each of the expression type-visual field conditions are presented in Table 3. Both happy and sad faces were recognized more quickly in the left-visual field (RH) than in the right-visual field (LH). However, post hoc analysis of this apparent left-visual field (RH) advantage revealed that differences between the two visual fields for happy and sad faces were not significant, $t(19)=1.14$, $p>.05$ and $t(19)=0.79$, $p>.05$ respectively.

Table 3

Identical Condition Mean Reaction Times (msec)

	Happy	Sad
Right Visual Field (LH)	561	604
Left Visual Field (RH)	543	586

Though the experimental design did not permit post hoc analysis of happy versus sad faces in each visual field, direct comparison of mean reaction times in the Identical condition supports the Contrast condition findings that happy faces were recognized more quickly than sad faces in each visual field.

Comparison of mean reaction times for Identical condition emotion x visual field combinations (Table 3) with Contrast condition combinations (Table 2) showed that reaction times for each emotion x visual field combination were longer in the Identical condition. Though this study was not designed to assess these differences, the data suggest that subjects found the task requirements of the Identical condition more difficult than those of the Contrast condition.

The only consistent finding from the Contrast and Identical conditions was that happy faces were recognized more quickly than sad faces in each visual field. Ratings by the 21 subjects for emotional "intensity" of the six pairs of faces revealed that happy faces were significantly more expressive of happiness ($\overline{X}$=3.22) than the sad faces were of sadness ($\overline{X}$=2.45), $\underline{t}(125)=4.14$, $p<.05$. All subjects agreed as to type of emotional expression for each face. Results could therefore be interpreted as indicating that the more emotionally intense faces were more quickly recognized in each hemisphere. In order to address this possible confound of emotional intensity with type of emotion, post hoc analyses of mean reaction times for face pairs whose happy and sad poses were both judged as emotionally "intense" (mean ratings of 3.0 or greater) were carried out. Results showed that, among these emotionally "intense" faces, happy faces were recognized more quickly than sad faces in the right-visual field (LH) but not in the left-visual field (RH), $t(19)=2.84$, $p<.05$ and $t(19)=0.32$, $p>.05$ respectively (see Table 4). These findings were not consistent with the previous findings of a happy face advantage in each visual field. The happy face advantage over sad faces in the right-visual field (LH) was maintained regardless of emotional intensity, whereas this advantage was not maintained in the left-visual field (RH) when faces were equated for emotional intensity. Of interest was the finding that mean reaction times for sad faces in the left-visual field (RH) were quicker than those in the right-visual field (LH); 539 and 569 milliseconds respectively. However, this difference between the visual fields for sad faces was not significant, $t(19)=1.54$, $p>.05$.

Some subjects commented spontaneously that they had focused only on whether or not the faces had teeth showing in order to discriminate happy from sad faces. Results could therefore be interpreted as showing that subjects merely responded more quickly when teeth were showing (happy faces) than when teeth were absent (sad faces)

Table 4

Mean Reaction Times (msec) for Faces with Comparable Emotional Intensities

	Happy	Sad
Right Visual Field (LH)	500	569
Left Visual Field (RH)	535	539

rather than responding to the emotional nature of the faces per se. In order to address this possible confound, post hoc analysis of a face pair with teeth showing in each emotional pose was carried out. Results were consistent with the findings on emotional intensity: happy faces were recognized more quickly than sad faces in the right-visual field (LH) but not in the left-visual field (RH); $\underline{t}(17)=2.54$, $p<.05$ and $\underline{t}(14)=0.17$, $p>.05$ respectively. Of particular interest was the finding that sad faces were recognized more quickly in the left- than right-visual field, $\underline{t}(15)=2.3$, $p<.05$. These findings suggest that, when presented with emotional facial stimuli not confounded by the presence or absence of teeth, the left hemisphere processes happy faces more quickly than sad faces while the right hemisphere shows the reverse pattern.

Depression and Laterality

It was hypothesized that depression would be related to reaction times for sad faces in the left-visual field (RH). Pearson-Product Moment correlations revealed that full-scale scores on the Multiscore Depression Inventory (MDI) were not related to left-visual field (RH) reaction times for sad ($\underline{t}(19)=0.05$, $p>.05$) or happy faces ($\underline{t}(19)=1.21$ $p>.05$). Given the previous finding of the two-way ANOVA for a right-visual field (LH) advantage for identification of faces, a post hoc analysis of MDI full-scale scores and right-visual field (LH) reaction times was carried out.

MDI scores and right-visual field (LH) reaction times for happy and sad faces were not related, *t*(19)=0.25, $p>.05$ and *t*(19)=2.05, $p>.05$ respectively. These results indicated that depression, as measured in male undergraduates, was not related to recognition of sad or happy faces in either visual field.

DISCUSSION

In order to assess the lateralized cognitive processing of positive and negative emotionality, the present study recorded subjects' reaction times for tachistoscopic discriminations of affective facial stimuli. Whereas affect had previously been understood to be an interfering cue that could blur distinctions on a face recognition task (Suberi & McKeever, 1977), the present study employed categorized emotional expression as the discriminating feature between similar facial stimuli. It was hypothesized that the left hemisphere would demonstrate superiority for discriminating happy faces and that the right hemisphere would be superior for sad faces. It was also hypothesized that the emotional state of the perceiving subject would affect lateralized cerebral functioning; specifically that depression would be associated with the right hemisphere's processing of negative facial stimuli.

The results of the Identical condition that subjects did not more often respond with the left or right hemisphere for each type of emotion does not support the traditional notion that one hemisphere is specialized for the processing of facial stimuli while the other hemisphere does not process facial stimuli. Indeed, analysis of reaction times for the Identical and Contrast conditions suggests that each hemisphere may differ in the efficiency with which recognition takes place depending upon the cognitive and affective nature of the stimuli. Results which compared happy versus sad face reaction times within the same hemisphere revealed the one consistent finding of this study which supported the hypothesis that, within the left hemisphere, happy faces are recognized more quickly than sad faces. This finding is in agreement with previous studies which have found differential processing of positive and negative affect in the left hemisphere and was suggestive of an overall left hemisphere superiority for the processing of positive affect.

However, planned analyses indicated that happy faces were responded to more quickly than sad faces in <u>both</u> hemispheres. This finding argues against a left hemisphere superiority for positive affect since the right hemisphere also seemed to process happy faces more quickly than sad. Interestingly, it was seen that the hemispheres may have been responding to the emotional <u>intensity</u> rather than the type of emotion per se and may have accounted for this result. Post hoc analyses revealed that the left hemisphere's superiority for happy faces maintained regardless of emotional intensity, whereas the right hemisphere's processing of affect appeared to vary as a function of intensity. While these data do not support the hypothesis that the right hemisphere would recognize sad faces more quickly than happy faces, they do suggest that the right hemisphere is more sensitive than the left to the intensity of affective material. This finding is consistent with other studies which have found a right hemisphere advantage for the processing of emotional versus non-emotional stimuli.

The discussion above was based on analyses regarding happy verus sad faces in the same hemisphere. Analyses regarding the differential hemispheric processing of the same emotion were inconclusive. However, when the face pairs were of comparable emotional intensity (Table 4) there was a slight tendency for happy faces to be more quickly identified in the left than in the right hemisphere and for sad faces to show the reverse pattern. While these tendencies were not statistically significant, they are in the expected directions as found by studies which have investigated lateralized processing of positive and negative affect.

It was seen that subjects could have responded only to the presence or absence of teeth in the photos; in essence comparing the faces for only one highly salient feature. Such a strategy is similar to one investigated by Patterson and Bradshaw (1975) who found that when subjects were presented with comparisons for test and memorized schematic faces a right-visual field (LH) superiority for faces differing on only one feature and a left-visual field (RH) superiority for faces differing on three or more features emerged. In examining this and other lateralized face recognition experiments with normal subjects, Sergent and Bindra (1981) suggested that face recognition requiring analytic judgements (e.g., very similar faces such as with twins) would lead to a right-visual field (LH) superiority and face recognition requiring holistic processing (e.g., very dissimilar faces) would result in a left-visual field (RH) superiority. In a systematic study of hemispheric processing of schematic faces, Sergent (1982) found that an analytic mode of comparison was performed in right-visual field (LH) presentations.

In order to better understand the absence of an overall left (analytic processing) or right (holistic processing) hemisphere superiority in the present study it would be helpful to examine how the task requirements of this study compare with those of previous tachistoscopic studies which have employed facial stimuli. Classification of various face recognition studies (Sergent & Bindra, 1981) include (a) perceptual discrimination tasks which require a discrimination between two faces and (b) response latency studies which are designed to determine which visual field yields faster facial recognition. Each of these tasks involve some memory function in that the subject typically compares a test face with a previously exposed target face or vice versa. Sergent and Bindra (1981) suggest that it is this memory function which has led to the right hemisphere advantage often found in these studies. The present study was a "memory free" task in that subjects compared faces simultaneously presented to each hemisphere. The lack of a consistent right or left hemisphere superiority in the present study may have been the result of the absence of a memory component. Such an interpretation would be consistent with the findings of Moskovitch, Scullion, and Christie (1976) that manual reaction times were consistently shorter to left-visual field (RH) presentation only when test faces were compared for identity to a memorized sample but not when compared directly to each other.

In addition to the delay interval between test and target faces (memory component), exposure duration and featural characteristics of stimuli have varied from study to study. Sergent and Bindra (1981) comment that long exposure duration (250-300 msec.) and similar faces may lead to a left hemisphere advantage whereas short exposure duration (180 msec.) and fairly dissimilar faces may lead to a right hemisphere advantage. The net result of employing a short exposure duration for similar faces might be that no clear left or right hemisphere advantage would emerge. Indeed, the present study employed similar faces (same face pairs) in order to isolate emotionality and short exposure duration (175 msec.) to minimize eye movement confoundings and found no clear cut left or right hemisphere advantage.

The consistently longer mean reaction times within the Identical condition as compared to the Contrast condition indicated that subjects found the Identical condition discriminations more difficult. This increase in difficulty may have lead to the slight tendency for a right hemisphere advantage within the Identical condition. This interpretation would be consistent with the notion that although both half brains have substantial capacities for visual recognition, the right excels mainly when upper perceptual limits are tested (Gazzaniga & LeDoux, 1978).

This study did not find evidence for a specific right hemisphere dysfunction nor any other laterality effects due to depression. Most studies which have reported right hemisphere dysfunction and/or other cognitive and perceptual deficits in depression have employed clinical populations. Though depression in college students, as measured by the MDI, has been found to be associated with deficits in initial perceptual processing (Berndt & Berndt, 1980), it is noteworthy that some studies which have employed patient populations indicate that even severe depression represents only minimal cognitive dysfunction (e.g., Friedman, 1964). This latter possibility, along with the generally less distinct lateral asymmetries in normals as compared to the often marked hemispheric differences of split-brain (Wexler, 1980) and other clinical populations (Benton, 1980), engender the uncertainty of determining a consistent lateralized effect of depression in college undergraduates.

The belief that brain and behavior are linked underlies the search for disorders of brain function which has the potential to clarify cerebral mechanisms involved in psychiatric disorder and to provide an objective basis for the differentiation of clinical subgroups. To this end, brain structure and function need be specified and investigations of cerebral lateralities bring brain structure and function closer together by evaluating brain components that are both anatomic and functional units (Wexler, 1980). In this manner, research on hemispheric specializations has begun to provide a clearer model of brain function that is relevant to higher order psychological processes (Tucker, 1981). However, the theory and methods of studying lateralized processing of emotion are just beginning to be articulated. In a theoretical sense, research on hemispheric specialization may allow delineation of particular forms of neuropsychological organization that are relevant to the conceptualization of an emotional experience and may provide opportunities to view information processing in the context of those emotional processes that contribute to real-world cognition (Tucker, 1981) and dysfunctions thereof.

More specifically, systematic investigation of the role of various affective and procedural variables in laterality studies are important for determining the exact nature of left and right cerebral functioning and for clarifying hemispheric specializations. The present study investigated lateralized processing of facial emotion and results suggested that the emotional valence and intensity of such stimuli may be factors contributing to the often contradictory results reported in hemifield comparisons of speed and accuracy of processing faces (Sergent & Bindra, 1981). Continued investigation of these factors is warranted because of their particular relevance for studies which employ face recognition tasks for investigating cognitive functioning in various psychiatric disorders.

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The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Arts.

Date

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