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The Effects of Hemispheric Asymmetries and Depression on the Perception of Emotion

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The present study investigated hemispheric asymmetries in the perception of positive and negative emotion. The moderating effect of depression on hemispheric asymmetries was also examined. Forty undergraduates were presented with happy and sad faces using a bilateral visual half-field design. Subjects were classified as depressed or nondepressed based on scores on the Beck Depression Inventory. For nondepressed subjects, a right hemisphere advantage emerged for the speed of processing open and close-mouth sad expressions. For depressed subjects a right hemisphere advantage emerged for the speed of processing open-mouth sad expressions. In addition, a right hemisphere advantage for accuracy in identifying sad expressions was found for all subjects. No visual field differences were found for processing happy expressions.

There are currently two competing theories regarding hemispheric asymmetries in the perception of facial expressions. The dominant theory (right hemisphere theory) proposes that the right hemisphere is superior to the left hemisphere in the processing of all emotional expressions. The alternate theory, a valence-based theory, originated from studies of mood changes following unilateral brain damage (e.g., Gainotti, 1972) and predicts a right hemisphere advantage in the processing of negative expressions versus a left hemisphere advantage in the processing of positive expressions (Davidson,

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Mednick, Moss, Saron, & Schaffer, 1987; Reuter-Lorenz, Givis, & Moscovitch, 1983).

Support for the theory that there is a right hemisphere advantage in the processing of emotional information has been derived from a broad range of studies. Early studies simply examined hemispheric asymmetries in the processing of all facial expressions and generally found an overall right hemisphere advantage. This pattern of results was observed in studies with split-brain subjects (Gazzaniga, Risse, Springer, Clark, & Wilson, 1975; Benowitz et al., 1983) and brain-damaged individuals (Dekosky, Heilman, Bowers, & Valenstein, 1980; Kolb & Taylor, 1981), as well as in studies utilizing electrical stimulation and visual half-field techniques with non-clinical subjects (Buchtel, Campari, De Risio & Rota, 1978; Fried, Mateer, Ojemann, Wohns & Fedio, 1982; Landis, Assal, & Perret, 1979; Hansch & Pirozzolo, 1980; Safer, 1981). Thus support for the importance of the right hemisphere in facial expression perception has been produced from a diverse body of experiments using different populations and different experimental techniques. One limitation of the aforementioned studies, however, is that most of them (except Buchtel et al., 1978) did not investigate the alternate hypothesis that there may be differential strength of the left and right hemispheres for the processing of different types of the emotional expressions.

A small number of studies that examined hemispheric asymmetries for the processing of facial expressions with different types of emotional expression (e.g., happy versus sad; positive versus negative) have found results that support a right hemisphere advantage for the processing of all emotional expressions or valences tested. These include two visual half-field studies (Strauss & Moscovitch, 1981, Experiment 3; Suberi & Mckeever, 1977) and two studies using brain-damaged populations (Bowers, Bauer, Coslett, & Heilman, 1985; Bruyer, 1981). Other studies examining hemispheric asymmetries for different types of emotional expressions have only found qualified support for the right hemisphere theory. Specifically, the following patterns have been found with visual half-field experiments: an overall right hemisphere advantage for all expressions for females and a right hemisphere advantage only for surprise for males (Strauss & Moscovitch, 1981, Experiment 1); an overall right hemisphere advantage for all expressions for females but no visual differences for males (Ladavas, Umilta & Ricci-Bitti, 1980); a right hemisphere advantage for closed-mouth happy and sad expressions for all subjects, but no visual field differences for open-mouth happy expressions (Mclaren & Bryson, 1987); a right hemisphere advantage only for more extreme expressions (Ley & Bryden, 1979); and a right hemisphere advantage for happy expressions but no visual-field differences for sad expressions (Duda & Brown, 1984).

Qualified support for the right-hemisphere theory has also been found with a brain-damaged population. Weddell (1989) found that right brain-damaged subjects (RBDs) were less accurate than left brain-damaged subjects (LBDs) on a memory task, but only for happy and fearful expressions and not for disgusted, sad, surprised or angry expressions. Even though these studies often revealed the importance of moderating factors (e.g., gender, salience of expression, brain injury), the authors generally interpreted their results as supporting the right-hemisphere theory since when advantages emerged they were only for the right hemisphere.

The initial support for the valence-based theory has come from two visual half-field studies. Reuter-Lorenz & Davidson (1981) found a marginal left visual-field (LVF) advantage for sad expressions and a significant right visual-field (RVF) advantage for happy expressions. In a subsequent study, Reuter-Lorenz et al. (1983) found a significant LVF advantage for sad expressions and a significant RVF advantage for both open- and closed-mouth happy expressions. A recent study by Hugdahl, Iversen, and Johnsen (1993) also found results consistent with a valence-based interpretation. Although the authors found a right hemisphere advantage overall, further analysis revealed a significant two-way interaction between emotional expression and visual-field with mean differences in the predicted direction. More recently, Gur, Skolnick, and Gur (1994), using an Xenon Inhalation measure for cerebral blood flow, reported greater left frontal activation for happy expressions and greater right parietal activation for sad expressions.

Wedding and Stalans (1985) also provided qualified support for a valence-based theory by finding a RVF advantage for positive emotions but no visual-field differences for negative emotions. Similarly, Burton and Levy (1989) found a RVF advantage for positive expressions and a LVF advantage for negative expressions for females but no visual-field differences for males. A recent study of children (Szelag & Wasilewski, 1992) found a LVF advantage for sad expressions and no visual-field differences for happy expressions. It should be noted however that these results are also partially consistent with the right hemisphere theory. In addition, Borod, Koff, Lorch & Nicholas (1986) found that RBDs were less accurate than LBDs in verbally labeling negative (sad, fear, anger, disgust, confusion) but not positive (happiness, surprise, sexual arousal) expressions (but see Cicone, Wapner, & Gardner, 1980).

Finally, there are several studies which have not found hemispheric differences in the processing of any of the facial expressions analyzed. Hirschmann and Safer (1982), in two separate experiments, and Thompson (1983), in two separate experiments, each failed to find a visual field by valence interaction or visual-field advantages for the processing of facial expressions. Similarly, Prigatano and Pribram (1982) failed to find either a hemisphere by expression interaction or a hemispheric advantage on the recall of or verbal labeling of emotional expressions in their study with brain-damaged subjects. Stalans and Wedding (1985) have also reported results which are generally inconsistent with either theory. Subjects categorized unilaterally presented expressions as either positive or negative faster when they were presented to the RVF rather than the LVF regardless of the valence of the expressions. They suggested that the RVF advantage may have been due to the analytical nature of their task.

METHODOLOGICAL CONSIDERATIONS

As noted earlier, the two Reuter-Lorenz studies have been the main source of support for the valence-based theory and as such, a considerable degree of controversy surrounds these studies. In the Reuter-Lorenz studies, pairs of Ekman faces (one neutral, one sad or happy) were simultaneously presented so that one face appeared in each visual field. Subjects selected the more emotional of the two presented faces. Several questions have been raised regarding the methodology employed in these studies and the effects that these procedures may have had on the results. One methodological issue concerns the use of a bilateral presentation technique in the Reuter-Lorenz studies. However, the work of Boles (1987, 1990) indicates that bilateral presentation techniques per se do not reverse or attenuate visual-field asymmetries, at least for his non-facial stimuli. Similarly, Corina (1989) found LVF advantages and no RVF advantages for processing facial expressions using a bilateral paradigm similar to those of Boles. In addition, recent work (Butler, 1989) explicitly testing visual field differences in processing facial expressions with bilateral and unilateral presentations, has found no evidence that presentation type accounts for the RVF effects with happy expressions found by Reuter-Lorenz and her colleagues. Thus, current experimental evidence suggests that the use of a bilateral presentation paradigm per se is not a sufficient explanation for the results of the Reuter-Lorenz studies.

Bryden (1988) and Ley and Strauss (1986) have also suggested that the RVF superiority for happy expressions found in the bilateral studies of Reuter-Lorenz and her colleagues may be due in part on the use of long exposure durations (i.e., 250–350 msec). This hypothesis is based on the results of some studies that have found RVF effects with longer exposure durations (Sergent & Hellige, 1986; Sergent, 1986). However, recent experiments on the processing of facial expressions at exposure durations of 20 msec versus 200 msec (Hellige & Jonsson, 1985); 40 msec versus 120 msec (Diehl & Mckeever, 1987); 50 msec versus 150 msec (Safer, 1981); 30 msec versus 200 msec (Thompson, 1984); and 30 msec versus 50 msec (Hirschman & Safer, 1982) have not found that exposure duration interacts with visual-field advantages. In addition, exclusively LVF advantages have been found with long exposure durations (300 msec+, Duda & Brown, 1984; 800 msec, Strauss & Moscovitch, 1981) and RVF advantages have been found with relatively moderate exposure durations (100 msec, Stalans & Wedding, 1985). Thus, current empirical evidence does not support the hypothesis that exposure durations interact with visual-field advantages in processing facial expressions and that this accounts for the Reuter-Lorenz findings.

There are also questions regarding the reliability of the Reuter-Lorenz findings. Duda and Brown (1984) used an almost identical procedure to Reuter-Lorenz and Davidson (1981) and did not replicate their results (i.e., the RVF advantage for happy expressions). However, one of the few methodological changes made by Duda and Brown (1984) was to use a fixation digit task to control the visual fixation of the subjects and there is theoretical and empirical evidence that this can confound visual asymmetries. For example, McKeever and Van Eys (1986) have found that the use of a fixation digit task increased the RVF superiority on a verbal task and theorized that the fixation digit task did so by affecting left hemisphere performance. Sergent and Hellige (1986) also point out that the use of a fixation digit task with bilateral presentations is problematic since the bilateral presentations are already similar to a dual task situation and the addition of a fixation digit task inextricably confounds the results. Thus, the failure of Duda and Brown (1984) to find a RVF advantage for processing happy expressions may have been because their fixation digit task interfered with left hemisphere processing.

The most recent attempt to replicate the valence-based results of Reuter-Lorenz and her colleagues was completed by McLaren and Bryson (1987). These authors also failed to replicate the RVF advantages for happy expressions found in the earlier studies. Instead they found a LVF advantage for both sad expressions and closed-mouth happy expressions and no visual-field advantage for open-mouth happy expressions. McLaren and Bryson (1987), however, also made an important task modification to the Reuter-Lorenz design: rather than picking the more emotional targets, subjects picked targets which made them feel better or worse. In addition, depressive subjects were screened out and poser expression asymmetries were controlled by using normal and mirror-image stimuli. Thus, it is not clear whether the results of Reuter-Lorenz were not replicated because of these substantial methodological changes.

In summary, even though the Reuter-Lorenz studies are a central source of support for the hypothesis that the right hemisphere is superior in the processing of positive emotions while the left hemisphere is superior in the processing of negative emotions, these results have been questioned by many researchers and they have not been independently replicated by researchers utilizing the same procedures as Reuter-Lorenz and her colleagues. The primary purpose of the present study was to conduct this replication.

The need to control for depression is another important methodological consideration in studies examining facial expression recognition. A growing body of literature suggests that depression is associated with a right hemisphere deficit (see Coffey 1987, for a review) and mood induction studies have found that induced moods influence the degree and direction of hemispheric function for various types of task performance (Gage & Safer, 1985; Ladavas, Nicoletti, Umilta, & Rizzolatti, 1984; Tucker, Stenslie, Roth, &

Shearer, 1981 but see David, 1989). More pertinent to the present investigation, recent studies have explored the effects of depression on hemispheric asymmetries in the perception of facial expressions. Davidson, Schaffer, and Saron (1985) found that depressed college subjects rated happy, sad and neutral expressions presented to the LVF for 8 sec as producing more happiness than identical RVF presentations. Nondepressed subjects showed the opposite pattern. Concomitant electrophysiological recordings also showed differing lateralization patterns between the two groups. Jaeger, Borod, and Peselow (1987) also found that clinically depressed subjects had a significantly lower left hemispace bias than nondepressed subjects on ratings of freely viewed happy chimeric faces. This implies that the right hemisphere had less of an advantage on the chimeric face task in the clinically depressed than nondepressed subjects. The second purpose of the present study is to examine the effect of mild depression on hemispheric asymmetries in the processing of facial expressions of emotion. If as discussed earlier, depression is associated with a right hemisphere deficit, then in the current experiment depressives should have a decreased LVF advantage for sad expressions.

Finally, the impact of cue saliency on hemispheric asymmetries in the processing of emotional expressions is not well understood. Cue saliency refers to the intensity of emotional expression and is often related to whether a facial expression has an open or closed mouth. Only a few studies have examined the role of cue saliency on hemispheric asymmetries. Reuter-Lorenz et al. (1983) found that cue saliency did not affect the RVF advantage for happy expressions. Yet in another study (Buchtel, Campari, De Risio, & Rota, 1978), the presence of teeth in happy expressions significantly increased accuracy in the RVF but not in the LVF. These results support the hypothesis that a left hemisphere processing strategy may emerge on tasks with high cue saliency. The third purpose of the present study is to investigate the role of cue saliency on hemispheric asymmetries in the processing of emotional expressions.

METHOD

Subjects

Subjects were 40 undergraduate volunteers who were classified as right handed according to the shortened version of Annett's handedness questionnaire (Briggs & Nebbes, 1975). Subjects also completed the Beck Depression Inventory (BDI; Beck, Rush, Shaw, & Emery, 1979) which has been shown to be a reliable and valid measure of depression in university populations (e.g., Bumberry, Oliver & McClure, 1978). Subjects with scores equal to or greater than 10 were classified as depressed (9 males; 9 females) while those with scores of less than 10 were classified as nondepressed (12 males; 10 females). This cutoff score was recommended by Kendall, Hollon, Beck, Hammen, and Ingram (1987) in a recent review of the BDI. The mean BDI scores for the depressed and nondepressed groups were 14.1 ($SD = 3.3$) and 3.2 ($SD = 2.6$) respectively. A total of 53 subjects actually completed screening measures for the experiment before data of 18 depressed and 22 nondepressed were available. All of the volunteers were paid a nominal fee for their participation.

Stimuli

Two sets of 26 stimulus cards (10 × 15 cm) were created using reproductions (2.3 × 3.4 cm) of the Ekman and Friesen (1976) photographs of facial expression. These facial expressions were posed by trained models and have been found to be reliable and valid representations (Ekman & Friesen, 1976). Each card presented two pictures: one picture of the target displaying a neutral expression and one of the target displaying an emotional expression (happy or sad). The pictures were mounted on the left and right halves of the card 2 degrees from the center. Side of presentation of the emotional face on each card in the first stimulus set was determined randomly and then reversed in the second stimulus set. Posers appeared once in each set of 26 cards, 13 cards displayed neutral/happy combinations (9 neutral/happy open-mouth; 4 neutral/happy closed mouth) and 13 cards displayed neutral/sad combinations (4 neutral/sad open mouth; 9 neutral/sad closed mouth). For preexperimental practice, 9 additional trial cards were created from the remaining pictures of the same posers.

Procedure

Each session began with subjects reading an information sheet detailing the nature of their participation in the experiment and completing an appropriate consent form. Subjects were then screened for depression by having them complete the BDI on the basis of their current and recent feelings during the past week. Once the subjects had completed the preliminary measures they were seated in front of a two field tachistoscope (Cambridge Tachistoscope, Behavioral Research and Development, portable model) which was adjusted in height to ensure proper viewing. Following the procedure utilized by Reuter-Lorenz and her colleagues (Reuter-Lorenz & Davidson, 1981; Reuter-Lorenz et al., 1983), subjects were instructed to identify the more ‘‘emotional’’ face of the two presented in the photographs by pressing one of two (left or right) response keys. The subjects used their right hand for this task.

Prior to each trial subjects were reminded to fixate on a central point in the visual field. The onset of each trial was also preceded by the 750-msec illumination of a single red light (3 mm) which was centrally positioned in the visual field. The illumination of this central fixation point served both as an additional reminder for subjects to direct their attention to this central point and to indicate the onset of each trial. Termination of the fixation light triggered the presentation of the stimulus card at an exposure duration of 300 msec and the onset of the reaction time clock (Standard Electric Time Company, Type S-1). Pilot testing ($N = 5$) indicated that an overall accuracy of 74% was attained on the stimuli at this exposure duration. Depressing one of two response keys stopped the reaction time clock and illuminated one of two response lights that were visible only to the experimenter. A white visual field without the illumination of the fixation light appeared immediately followed the stimulus presentation. Each trial was separated by approximately 5 sec during which the experimenter recorded the subjects’ reaction time and response. After completing the nine practice trials, the subjects completed two blocks of 26 trials separated by a brief (approximately 3-min) rest period. Presentation of the stimulus cards within each set followed a fixed-random order. Following the experiment, all subjects were fully debriefed.

Dependent Variables

Two dependent variables were recorded: (1) response latency to target identification (reaction time) and (2) accuracy in the identification of the more emotional expression (i.e., happy or the sad) as opposed to the neutral expression in each stimulus card.

RESULTS

Descriptive Analyses

Logarthmic transforms were applied to normalize the reaction time data and all reaction time analyses were completed on the transformed scores (LRTs) from correct trials. The LRT scores were normally or nearly normally distributed in all conditions. The accuracy data were less normally distributed. Most notably, there are ceiling effects in the open-mouth happy distributions. An arc sine transformation only slightly improved normality. All inferential analyses involving accuracy data were performed with and without the arc sine transformation. Transformed and untransformed data did not differ on any results and, consequently, only untransformed data analyses are reported.

The assumption of homogeneity of variance was also analyzed for the two dependent variables. The largest variance for the LRT data was 0.15 for closed-mouth sad expressions presented to the RVF of nondepressives and the smallest variance was 0.03 for open-mouth happy expressions presented to the LVF of nondepressives. The largest variance was 4.67 times larger than the smaller variance. For the accuracy data the largest variance (0.10) was 4.95 times greater than the smallest variance (0.02). Howell (1985) states that as long as the largest variance is not more than 4 or 5 times greater than the smaller variance then ANOVAs should be valid. Given that the other LRT variances were much more homogeneous, and that multiple comparisons were not performed between the extreme LRT variances, homogeneity of variance did not present a problem in this experiment.

In order to explore the relationship between reaction time (RT) and accuracy in this experiment (see Babkoff & Faust, 1988), RT-accuracy correlations were calculated separately for depressed and nondepressed subjects in each visual field condition. In most of the conditions, RT was not linearly related to accuracy. This was true for both depressives and nondepressives and suggests that depressives are not using different processing strategies than nondepressives. Only one correlation was significant: for happy closed-mouth expressions presented to the RVF of nondepressives, increases in accuracy were positively correlated with increases in RT ($r(20) = .48$, $p < .05$). In all other conditions, the correlations were not significant. Also, the overall RT-accuracy correlation across all conditions was not significant. Since there was little or no linear relationship between the two dependent variables, and both dependent variables satisfy the assumptions of analysis of variance procedures, both dependent variables were analyzed and reported separately.

Inferential Analyses

Four-way ANOVAs with visual field (RVF versus LVF), saliency (open versus closed mouth) and emotion type (happy versus sad) as within-subject factors, and group (depressed versus nondepressed) as a between-subject factor were completed for both dependent variables. The results of these analyses, and subsequent ANOVAs and comparisons are reported below for each dependent variable. Preliminary analyses with sex as a between subject factor revealed no significant interactions, therefore this variable was excluded from the following analyses.

Reaction time. The four-way ANOVA produced the following significant main effects: targets were identified more quickly in the LVF than in the RVF ($M = 6.76$ versus $M = 6.82$; $F(1, 33) = 6.35$, $p < .02$); happy expressions were identified more quickly than were sad expressions ($M = 6.75$ versus $M = 6.84$; $F(1, 33) = 8.87$, $p < .0005$); and open-mouth expressions were identified more quickly than were than closed-mouth expressions ($M = 6.73$ versus $M = 6.86$; $F(1, 33) = 51.98$, $p < .0001$). In addition, there was a significant visual field by emotion type interaction ($F(1, 33) = 5.13$, $p < .03$), a significant emotion type by saliency interaction ($F(1, 33) = 23.02$, $p < .0001$), and a significant emotion type by saliency by group interaction ($F(1, 33) = 7.07$, $p < .01$). These interaction effects were qualified by a significant four-way interaction ($F(1, 33) = 5.55$, $p < .03$). In order to break down the four-way interaction, three-way ANOVAs with visual field, saliency and emotion type as within-subject factors were performed separately for depressed and nondepressed subjects with LRT as the dependent variable.

Several main effects were significant in the LRT-analyses for nondepressed subjects: targets were identified more quickly in the LVF than in the RVF ($M = 6.68$ versus $M = 6.76$; $F(1, 21) = 6.35$, $p < .02$); happy expressions were identified more quickly than were sad expressions ($M = 6.64$ versus $M = 6.79$; $F(1, 21) = 20.29$, $p < .0002$); and open-mouth expressions were identified more quickly than were closed-mouth expressions ($M = 6.66$ versus $M = 6.78$; $F(1, 21) = 17.54$, $p < .0004$). As illustrated in Fig. 1, for nondepressed subjects the visual field by emotion type interaction was significant ($F(1, 21) = 6.37$, $p < .04$). Two tailed t-tests revealed that happy expressions were processed with equal speed in both visual hemifields. The LRT distributions indicate that this lack of a visual-field advantage was not due to ceiling effects. In contrast, sad expressions were processed faster in the LVF than in the RVF ($t(21) = 3.25$, $p < .01$). No other interactions were significant.

For the depressed subjects, a main effect for cue saliency was significant ($F(1, 17) = 22.62$, $p < .0002$). As with nondepressed subjects, depressed individuals identified open-mouth expressions more quickly than closed-mouth expressions ($M = 6.74$ versus $M = 6.85$). In addition, a cue saliency by emotion interaction was observed ($F(1, 17) = 25.20$, $p < .01$). These effects were qualified by a significant three-way interaction between cue saliency, visual field and emotion type ($F(1, 15) = 6.56$, $p < .02$). As Fig. 2 illustrates, depressed subjects identified open-mouth happy expressions

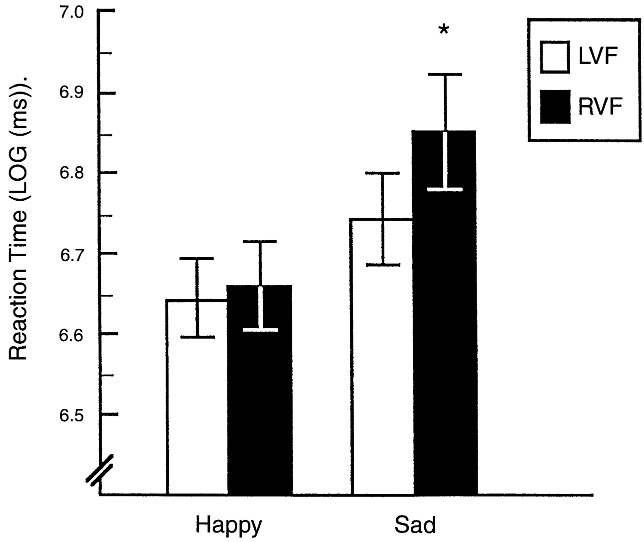

FIG. 1. Log reaction time means of nondepressed subjects for happy and sad expressions in each visual hemifield, collapsed across saliency ($n = 22$). Error bars are ±1 SEM.

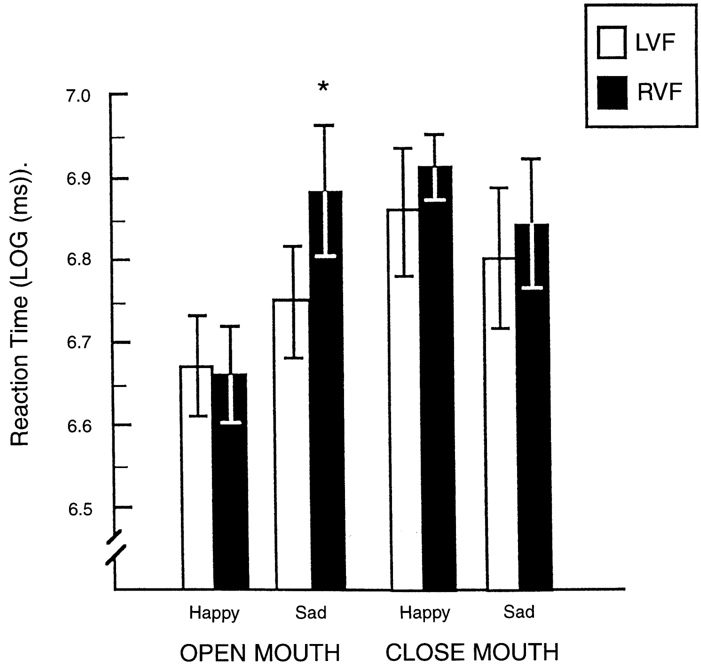

FIG. 2. Log reaction time means of depressed subjects for open- and close-mouth happy and sad expressions in each visual hemifield, ($n = 18$). Error bars are ±1 SEM.

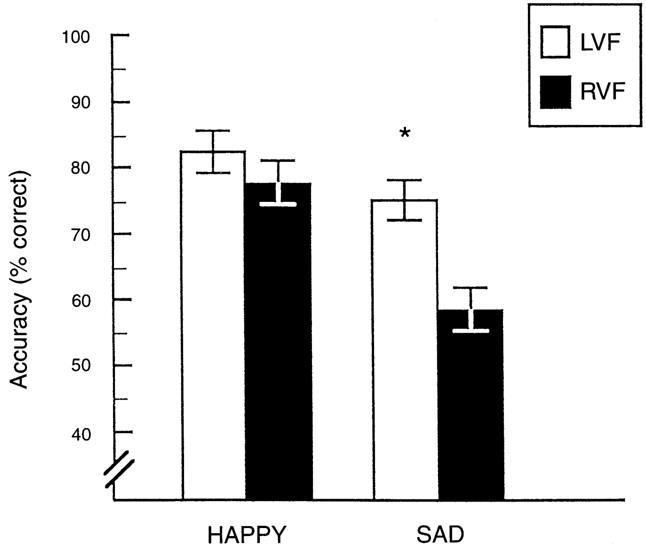

FIG. 3. Mean accuracy for happy and sad expressions for both visual hemifields, collapsed across group and saliency ($n = 40$). Error bars are ± 1 SEM.

equally well in either visual field and had a LVF advantage for open-mouth sad expressions ($t(15) = 3.99$, $p < .01$). For the closed mouth sad expressions, however, the LVF advantage disappeared. This finding appears to be caused by an increase in LVF LRTs and a decrease in RVF LRTs for the depressives in this condition.

Accuracy data. The four-way ANOVA produced the following significant main effects: targets were identified more accurately in the LVF than in the RVF ($M = 78.5\%$ versus $M = 68\%$; $F(1, 38) = 6.78$, $p < .01$); happy expressions were identified more accurately than were sad expressions ($M = 80\%$ versus $M = 67\%$; $F(1, 38) = 32.51$, $p < .0001$); and open-mouth expressions were identified more accurately than were closed-mouth expressions ($M = 81.5\%$ versus $M = 65.5\%$; $F(1, 38) = 61.23$, $p < .0001$). The only significant interaction produced from the analysis was a visual field by emotion type interaction ($F(1, 38) = 9.73$, $p < .004$). No visual-field differences were found for happy expressions. Unlike the LRT data, ceiling effects in some of the happy expression conditions may have contributed to the absence of a visual-field advantage here. Sad expressions were identified more accurately in the LVF than in the RVF by all subjects ($t(38) = 4.26$, $p < .001$) (Fig. 3).

DISCUSSION

The results of this study do not replicate the results of Reuter-Lorenz and her colleagues. Specifically, no visual field differences were found for happy expressions. When visual field effects emerged they indicated that sad expressions were processed more quickly and more accurately in the LVF (right hemisphere) than in the RVF (left hemisphere). The results are consistent with the findings of Szelag and Wasilewski (1992) who found similar effects with children. Our findings don't clearly distinguish between either theory since both theories predicted a right hemisphere advantage for negative expressions and neither theory predicted a lack of visual-field differences for positive expressions.

Our failure to replicate the left hemisphere advantage for the processing of happy expressions found by Reuter-Lorenz is particularly noteworthy given the fact that we employed a very similar methodology to that which was employed in the original studies. In comparing the procedures used in the present study with those that were used by Reuter-Lorenz the only difference that emerged was that of stimulus repetition. In the present study, a large number of different facial stimuli were presented only once each to each visual field. In contrast, Reuter-Lorenz and her colleagues used a smaller number of different facial stimuli and presented these repeatedly to each visual hemifield. Sullivan and McKeever (1985) have demonstrated that stimulus repetition may be necessary for RVF superiority to emerge under some conditions. In addition stimulus repetition may produce increased familiarity and decreased task complexity both of which have been associated with increased left hemisphere processing in other visuospatial tasks (Dee & Hannay, 1981; Fontenot, 1973; Mathieson, Sainsbury & Fitzgerald, 1990; Patterson & Bradshaw, 1975). It is unlikely, however, that stimulus repetition accounts for the failure of the current study to replicate the left hemisphere advantage for happy expressions found by Reuter-Lorenz given the fact that the present study replicated the right hemisphere advantage for sad expressions. If high stimulus repetition was responsible for the results of the Reuter-Lorenz studies and the failure of the current study to replicate these findings, their results should be viewed with some caution as evidence of a left hemisphere advantage for positive emotions.

Alternatively, Szelag and Wasilewski (1992) have suggested that the absence of visual-field differences for happy expressions is due to the interaction of two competing factors. They propose that the left hemisphere is specialized for positive emotions however these effects may be neutralized by the right hemispheres advantage at processing faces.

The results of the present study also suggest that depression and cue saliency are important factors that may influence the degree and direction of hemispheric asymmetries. Even though the results for depressed subjects resembled those for nondepressed subjects in most conditions, depressed subjects showed no overall LVF advantage on reaction time and no visual-field advantage for closed-mouth sad expressions. These results are consistent with previous research that suggests depression is associated with a right hemisphere deficit (Coffey, 1987). These deviations are quite significant in light of the fact that these subjects were only mildly depressed. Bumberry et al. (1978) report that in a random sample of students from four medium-sized universities, 23% of the students were at least mildly depressed as measured by the BDI. It may be important to screen for depression in future research in light of the fact that the incidence of mild depression is quite high in university populations and depression appears to have some effects on lateralized processing of emotional information. Indeed, some laterality researchers have already begun screening out depressives in studies of hemispheric asymmetries (Mclaren & Bryson, 1987).

No visual-field differences were observed for closed-mouth sad expressions for the depressed group. In fact, the closed-mouth sad expressions were identified the least accurately by both groups. These results are consistent with those of Ley and Bryden (1979) suggesting that asymmetries are less likely to be detectd with closed-mouth expressions. One possible explanation for this is that closed-mouth expressions may represent less extreme emotions and therefore be harder to detect.

In summary, the present study employed a highly similar methodology as was used in the Reuter-Lorenz studies and failed to replicate the finding of a left hemisphere advantage for positive emotions but did replicate a right hemisphere advantage for negative emotion. Results also indicated that depression and cue saliency are important factors that need to be examined in future studies of hemispheric asymmetries. These factors may obscure hemispheric asymmetries in the processing of emotional information and thus may be responsible for the wide diversity of findings in this area.

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