Evidence of Schizophrenia Patients’ Reduced Perceptual Biases in Response to Emotion Chimera

by Diane C. Gooding, Karen E. Luh, and Kathleen A. Tallent

Abstract

The goal of the study was to determine whether dextral individuals with schizophrenia display atypical perceptual biases in response to faces in general, or whether they display atypical perceptual biases in response to emotional facial cues. To this end, we assessed perceptual processing in schizophrenia patients with four types of free-vision chimeric stimuli. Perceptual biases were evaluated in 45 schizophrenia patients and in 46 controls using two face (emotion, gender) tasks and two nonface (dots, gradients) tasks. In response to the emotion chimera, the patients with schizophrenia displayed a reduced left perceptual bias. The two groups did not differ significantly in their response to the gender chimera or to the two nonface chimeras. These findings are consistent with the assertion that schizophrenia patients have impaired emotional perception. In the discussion we consider possible reasons for schizophrenia patients’ difficulty comprehending emotional facial stimuli. We suggest that schizophrenia patients’ reduced perceptual bias in response to the emotion chimera reflects a hypothesized affective information-processing deficit.

Keywords: Emotion, chimeric stimuli, schizophrenia, perceptual bias.


Since the writings of Bleuler (1911), schizophrenia has been associated with affective disturbances. Compared to controls, schizophrenia patients show deficits in facial affect discrimination (Walker et al. 1984; Heimberg et al. 1992; Kerr and Neale 1993; Salem et al. 1996), facial affect identification (Walker et al. 1980; Novic et al. 1984; Walker et al. 1984; Feinberg et al. 1986; Borod et al. 1993; Kerr and Neale 1993; Salem et al. 1996), and facial affect labeling (Walker et al. 1984; Feinberg et al. 1986). Theories of right hemispheric dysfunction in schizophrenia (c.f. Rotenberg 1994) would predict that schizophrenia patients would have difficulty comprehending facial cues in general, regardless of whether the facial cues had an affective component. Indeed, such a view would be consistent with others’ (c.f. Gessler et al. 1989; Kerr and Neale 1993; Salem et al. 1996) assertions that schizophrenia patients’ emotional impairments reflect generalized cognitive impairment. In contrast, other investigators (e.g., Feinberg et al. 1986; Mandal et al. 1998) postulate that schizophrenia patients have an emotion-specific deficit.

Chimeric stimuli are stimuli in which different or discrepant information is presented; chimeric faces are therefore composed of differing expressions to the left and right of the vertical midline (i.e., half the face has a smiling expression, and the other half has a neutral expression). The right hemisphere is particularly important in the processing of facial and visuospatial stimuli (c.f. Natale et al. 1983; Borod et al. 1993). Thus, when presented with chimeric face stimuli composed of happy and neutral half-faces, most normal right-handed individuals are biased to perceive the composite face with the smiling half-face to the left and a neutral half-face to the right as happier than its mirror image (Levy et al. 1983). Previous work (Levy et al. 1983; Luh et al. 1991, 1994) has shown that these biases reflect differential engagement of right hemisphere mechanisms for processing faces and other complex visuospatial stimuli. The chimeric faces task is an interesting way to explore potential sources of schizophrenia patients’ emotional impairments because the task yields reliable individual differences in terms of the way that the stimuli are processed. Moreover, Luh and colleagues (1991) demonstrated that although both face and nonface chimeric tasks share a large proportion of variance, they also have reliable sources of variance that are independent of each other. On the basis of functional magnetic resonance imaging (Sprengelmeyer et al. 1998) and magnetoencephalography (Streit et al. 1999), healthy controls...
display differential brain activity while performing facial emotion recognition tasks. Specifically, regions in the frontal cortex, right temporal cortex, and basal ganglia are preferentially responsive during facial affect recognition. Thus, comparing schizophrenia patients' responses to emotion face chimera and nonemotion face chimera can provide clues regarding schizophrenia patients' ability to process affective and nonaffective facial information.

We were intrigued by the question of how people with schizophrenia would perform on tasks that typically yield left spatial field biases in normal controls, and whether people with schizophrenia would display patterns of perceptual processing that are similar to those of controls. To our knowledge, there have been few prior studies of perceptual processing among schizophrenia patients using chimeric stimuli. David and Cutting (1990) reported that schizophrenia patients (n = 20) failed to display the typical left-sided perceptual bias in response to happy/sad chimeric stimuli. Federman and colleagues (1998) observed a trend suggesting that schizophrenia patients were less likely to show left perceptual biases in response to facial stimuli compared to controls. However, Federman and colleagues (1998) included left-handed and ambidextrous individuals, and previous work has demonstrated that left-handers and right-handers perform differently on these tasks (Levy et al. 1983; Luh et al. 1994). Moreover, the investigators failed to screen their comparison subjects for any psychopathology, thereby rendering their findings somewhat ambiguous.

In the present study, we investigated whether dextral schizophrenia patients would demonstrate atypical perceptual biases. We expected to replicate the finding of David and Cutting (1990), namely, that schizophrenia patients would show reduced bias for emotion chimera. However, we also sought to extend their previous work by administering other types of chimeric stimuli to schizophrenia patients. Although the results of Federman and colleagues (1998) suggest that schizophrenia patients display a decreased left spatial field bias relative to controls in response to face chimera, the results are unclear due to their inclusion of nondextral individuals. Therefore, we hypothesized that the schizophrenia patients would display a decreased left spatial field bias relative to the controls in response to emotion chimera, but we were unsure what to expect for nonaffective face chimera. We sought to improve on prior work by utilizing reliable tasks, a larger sample of schizophrenia patients (all of whom were right-handed), and a group of controls screened for psychopathology.

### Method

#### Sample Overview
There were 45 schizophrenia patients and 46 normal controls in this investigation. Inclusion crite-

### Schizophrenia Patients
The patient group consisted of 45 (34 male and 11 female) individuals with a mean age of 42.1 years (standard deviation [SD] = 9.8) who met DSM-IV criteria for schizophrenia (American Psychiatric Association 1994). The patients were recruited from Mendota Mental Health Institute (MMHI), a long-term psychiatric care facility, and area outpatient mental health facilities. The schizophrenia (20 paranoid, 13 undifferentiated, 7 residual, 5 disorganized) group included 16 inpatients and 29 outpatients. All of the patients were receiving neuroleptic medication (30 on atypical antipsychotics, 9 on typical neuroleptics, 6 on both types of antipsychotic medication). Overall, the patient group had a mean age of onset of 23.6 years (SD = 6.6) and an average duration of illness of 18 years (SD = 8). All of the patients were screened for other Axis I disorders; although some patients had a history of psychoactive substance use, all were in remission for at least 6 weeks prior to testing. All outpatients were clinically stabilized, and the MMHI patients were at their baseline level of functioning at the time of assessment.

#### Control Subjects
Forty-six subjects (33 males and 13 females with a mean age of 31.5 years, SD = 11.0) recruited from the community served as comparison subjects. All of the controls were screened for the presence of any lifetime Axis I diagnoses using the Structured Clinical Interview for DSM-IV Axis I Disorders—Nonpatient Edition (First et al. 1995). The control subjects denied any history of psychosis or treatment with antipsychotic medication in their first-degree relatives. After complete description of the study to the subjects, written informed consent was obtained.

Table 1 provides the demographic characteristics of the participants. The groups did not significantly differ in

<table>
<thead>
<tr>
<th>Table 1. Demographic characteristics of the subject groups</th>
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<tbody>
<tr>
<td>Schizophrenia (n = 45)</td>
</tr>
<tr>
<td>Control (n = 46)</td>
</tr>
<tr>
<td>Age (yrs, mean ± SD)</td>
</tr>
<tr>
<td>42.1 ± 9.8</td>
</tr>
<tr>
<td>31.5 ± 11</td>
</tr>
<tr>
<td>Education (yrs, mean ± SD)</td>
</tr>
<tr>
<td>12.7 ± 2.1</td>
</tr>
<tr>
<td>14.5 ± 1.5</td>
</tr>
<tr>
<td>IQ (mean ± SD)</td>
</tr>
<tr>
<td>101.76 ± 13.7</td>
</tr>
<tr>
<td>117.11 ± 8.2</td>
</tr>
<tr>
<td>Gender (male/female)</td>
</tr>
<tr>
<td>34/11</td>
</tr>
<tr>
<td>33/13</td>
</tr>
</tbody>
</table>

Note.—SD = standard deviation.
terms of their proportion of males and females, \( \chi^2(1) = 0.17, \text{ns} \). The schizophrenia patients were significantly older than the control subjects, \( t(43) = 4.84, p < 0.05 \). However, previous research (Levine and Levy 1986) has indicated that perceptual asymmetry for chimeric faces does not change across the lifetime span. As expected, the control group had significantly more years of education, \( t(78) = 4.57, p < 0.05 \), and higher estimated IQs, \( t(72) = 6.48, p < 0.05 \).

**Materials.** Stimuli were four free-vision tasks: two face tasks and two nonface tasks. A set of happy/neutral chimeras were made by joining a half-face of a smiling poser with the opposite half-face of the same poser with a neutral expression; this chimera was paired with its mirror image, once with the mirror image on the top of the page, and once with the mirror image on the bottom of the page. Subjects were asked to judge which face looked happier. Normal participants are biased to select the chimera with the smiling face on the left. A second set of chimeric faces was composed of male half-faces joined to female half-faces; subjects judged which face looked more feminine. Normal participants are biased to select the chimera with the female half-face on the left. For both emotion and gender tasks, images were derived from photographs.

Two nonface tasks that also yield left spatial field perceptual biases were included. For the dot chimera, pairs of rectangles were filled with asymmetric distributions of dots. Subjects judged which of each pair of rectangles seemed to contain more dots. Normal participants are biased to select the chimera with the greater dot density to the left. The second nonface task was composed of mirror-image pairs of rectangles filled with light-to-dark gradients of patterns, for which subjects judged which appeared darker (Mattingley et al. 1994). Normal participants are biased to select the chimera with the darker pattern on the left.

Four booklets, each containing all 12 pairs of images for each of the four tasks, were assembled. For all tasks, the queried trait (happier, more feminine, more dots, darker) appeared on the left half of the top image or half of the trials, and on the left half of the bottom image on half of the trials. Images were printed out in gray scale, and images within a task were assembled in a booklet in a pseudo-random order, with task order balanced in a Latin square design. Previous work (Luh et al. 1991) has revealed that order has no effect on performance on these tasks, and will not be discussed further.

**Procedure.** All subjects were tested individually. For each booklet, general instructions appeared on a cover page, and the specific question to be answered (e.g., “which face looks happier?”) appeared on a page before each task. Subjects recorded their choices on a separate answer sheet by circling a “T” or a “B” for each item, to indicate a top or bottom choice. They were instructed to form a general impression of each stimulus pair and forced to choose one of the items (no “can’t decide” answers allowed). Participants were free to work through the items as quickly or as slowly as they wished, and most completed the 48 items in 5 to 10 minutes.

**Scoring.** Tasks were scored for the number of items (out of 12) for which each subject selected the chimera with the queried trait (e.g., smiling expression) on the viewer’s left. An asymmetry index was computed as the proportion of right choices minus the proportion of left choices. Asymmetry indexes were analyzed with mixed-model analyses of variance (ANOVAs), with group (schizophrenia vs. comparison subjects) as the between-subjects factor and task (emotion, gender, dots, and gradients chimeras) as the within-subjects factor. Post hoc means comparisons were performed with simple effects.

**Results**

Preliminary analyses were conducted in order to determine whether there were significant differences between the inpatient schizophrenia patients and the outpatient schizophrenia patients. We found that the inpatients were significantly older than the outpatients, \( t(43) = 2.69, p < 0.05 \). However, the two schizophrenia groups did not differ significantly in terms of estimated IQ, \( t(43) = -0.82, \text{ns} \). Similarly, the two patient groups did not differ in terms of their mean spatial perceptual biases in response to any of the chimeric tasks; \( t's (df = 43) \) ranged from 0.04 to 1.20, \text{ns} \). The two patient groups were pooled for the remainder of the analyses.

**Responses to Chimeric Stimuli.** Table 2 provides the mean laterality quotients and standard deviations for the groups on the tasks. The community controls displayed the typical response pattern that we observe when using the chimeric tasks, namely, they showed a left perceptual field bias on all tasks, and they were more biased on the emotion task than on the others (Luh et al. 1991; Luh and Gooding 1999). Table 2 also provides the reliabilities for each task by group. The reliabilities are coefficient alphas; in general, the tasks appear comparable. Moreover, neither group was responding randomly to the chimeric stimuli.

The repeated measures ANOVA revealed that mean biases were different for the four tasks, \( F(3, 267) = 9.66, p < 0.001 \). Additionally, the repeated measures ANOVA revealed a significant group-by-task interaction, \( F(3, 267) = 3.60, p < 0.05 \). Post hoc means comparisons were per-
formed with simple effects. Simple effects revealed that the schizophrenia and control groups differed on the emotion task, \( t(89) = 2.65, p < 0.001 \). Thus, the schizophrenia patients displayed significantly less of the expected left spatial perceptual bias in response to the emotion task, relative to the healthy comparison group. Simple effects failed to reveal any between-group differences on the gender, dots, or gradients tasks, \( t(89) = 0.29, -1.08, \) and \( 1.06, ns \), respectively.

We observed no significant association between age and laterality quotient scores on the emotion chimera in our normal subjects, \( r = 0.22, ns \), or in our schizophrenia group, \( r = 0.25, ns \). Similarly, there was no significant association between estimated IQ and laterality quotient scores on the emotion task in the control or schizophrenia group, \( r = -0.19 \) and \( -0.18, ns \), respectively.

Following McNemar (1969), a laterality score was defined as significant if it exceeded the value of the product of the standard error of the score and the \( z \) value from the Gaussian distribution at the desired level of significance. Thus, any laterality quotient greater than 0.47 or less than \(-0.47\) represents a significant bias. In response to the emotion chimera, 70 percent (32 of 46) of controls showed a significant left perceptual bias, whereas only 24 percent of the controls showed no significant bias and 6 percent showed a right bias. In contrast, only 36 percent of the schizophrenia group showed the expected left spatial field bias. Sixty percent (27 out of 45) of the patients showed no significant perceptual bias, and 4 percent showed a right bias.

Table 3 provides the zero-order correlations for the four tasks by group. As expected, the controls showed the strongest intercorrelations between the two face tasks (emotion and gender) and the two nonface tasks (gradients and dots). We used Fisher's \( z \) transformation in a comparison test between the independent correlations; none of the between-task correlations were significantly higher in the schizophrenia group than in the control group.

We compared the schizophrenia patients showing the left perceptual bias to those patients who failed to show the left perceptual bias in response to the emotion chimera (table 4). The patients who failed to show the perceptual bias did not differ from the other patients in terms of age.

### Table 2. Descriptive statistics for four chimeric tasks for each group

<table>
<thead>
<tr>
<th>Task</th>
<th>Control (n = 46)</th>
<th>Schizophrenia (n = 45)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emotion</td>
<td>Gender</td>
</tr>
<tr>
<td>Mean</td>
<td>-0.521</td>
<td>-0.152</td>
</tr>
<tr>
<td>SD</td>
<td>0.48</td>
<td>0.44</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.80</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>Emotion</td>
<td>Gender</td>
</tr>
<tr>
<td>Mean</td>
<td>-0.274</td>
<td>-0.126</td>
</tr>
<tr>
<td>SD</td>
<td>0.41</td>
<td>0.43</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.57</td>
<td>0.61</td>
</tr>
</tbody>
</table>

**Note.**—SD = standard deviation. Mean scores can range between +1 and -1; more negative values represent larger left spatial field biases.

\(^1\) Reliability was assessed using coefficient alpha.

### Table 3. Zero-order correlation matrix of four chimeric tasks for each group

<table>
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<th>Task</th>
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<td></td>
<td>Emotion</td>
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<td>Gender</td>
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<tr>
<td></td>
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<td>Gender</td>
</tr>
</tbody>
</table>

**Note.**—Mean scores can range between +1 and -1; more negative values represent larger left spatial field biases.

\( * p < 0.05; \) \( ** p < 0.01; \) \( *** p < 0.001 \), 1-tailed.
Discussion

Our main finding was that patients with schizophrenia show decreased left perceptual biases in response to the emotion chimera. Our observation of schizophrenia patients' differential response to the emotion chimera but not to the other face task, the gender chimera, was not wholly expected. We had hypothesized that schizophrenia patients would display decreased left spatial field biases in response to the face chimeric stimuli. Our use of both emotion and nonemotion (gender) facial chimeric stimuli was helpful in distinguishing whether schizophrenia patients respond differently to faces in general or whether their differential response is limited to emotion stimuli. Because we did not observe the predicted differential response to the gender chimera, we cannot conclude that these schizophrenia patients displayed global right hemispheric dysfunction.

Comparisons with prior samples of normal controls (Luh et al. 1991; Luh and Gooding 1999) are consistent with our present findings for the control group, namely that in general, right-handed individuals display greater left perceptual biases in response to the face chimera relative to the nonface chimera. Although the mean laterality scores may vary somewhat from one sample to another, the pattern remains consistent. That is, facial stimuli induce greater perceptual asymmetries than the nonface stimuli, and in general, for right-handers, the mean asymmetries on face tasks with an emotional content are larger than the mean asymmetries on face tasks without an emotional content. Compared to the controls, the schizophrenia patients showed decreased left perceptual biases only in response to the emotion chimera.

Our use of the chimera task is an alternative approach to specifically testing emotional deficits and allows us to get around the issue of cognitive deficits and cognitive impairment. The chimeric task is relatively simple and can be administered to individuals of varying ages and levels of cognitive functioning. Our results suggest that right-handed individuals with schizophrenia are not responding to the emotion chimera in the same manner as most right-handed normal individuals. The fact that we observed differential response to emotion chimera and not to the other chimeric tasks suggests that schizophrenia patients process emotion differently. Our results are consistent with the assertion that patients with schizophrenia have difficulty comprehending emotional facial cues but not nonemotional facial cues. However, these results are preliminary because we did not include any measure of the accuracy of patients' emotional comprehension.

An alternative explanation for the observation that schizophrenia patients show decreased left perceptual biases in response to the emotion chimera is that the emotion discrimination task may have been the most difficult task—overly difficult for the patient group. However, this alternative is less plausible, given that the patients did not respond more randomly to the emotion chimera than to the other chimera. The schizophrenia patients were not less reliable on the emotion task compared to the other three chimeric tasks (see table 2). Although the schizophrenia patients did not display a random response pattern, it remains possible that the emotion chimera was better able to differentiate between the patients and controls because of its greater difficulty, relative to the other chimeric tasks. Further research is needed in order to but-
tress support for our assertion that the patients' differential response to emotion chimera does not reflect a generalized deficit.

Our comparisons of inpatients and outpatients yielded no discernable differences, suggesting that the schizophrenia patients' reduced perceptual biases in response to the emotion chimera cannot be attributed to an impoverished social environment. Furthermore, because we carefully screened the schizophrenia patients, we are able to assert that the differential perceptual processing response we observed among a subset is not likely to be due to confounding factors such as other medical conditions, neurological illnesses, and comorbid Axis I disorders. Moreover, our comparison of schizophrenia patients who showed the expected left perceptual bias and patients who failed to show the left perceptual bias suggests that neither duration of illness nor medication status can account for the differential perceptual response displayed by the schizophrenia group. Other investigators (Mueser et al. 1997) have found that chronic schizophrenia patients, but not acute schizophrenia patients, display less accurate performance on the emotion perception tasks. It is plausible that chronic patients display a greater number of negative or deficit symptoms; this greater severity of illness may result in greater emotion processing impairment.

Given the relatively small number of patients with the specific subtypes of DSM-IV schizophrenia, as well as the omission of more phenomenological data, we were unable to determine whether the patients displaying the differential emotional processing response were characterized by different symptoms (negative, positive, disorganized) than the patients who displayed the left perceptual bias in response to the emotion chimera. Future investigations would be enhanced by assessment of the predominance of negative versus positive symptomatology in schizophrenia patients displaying the emotion processing deficit. Several investigations (see Strauss 1993 for a review) indicate that paranoid and nonparanoid patients may differ in terms of their information processing dysfunctions. Interestingly, our post hoc comparison of paranoid versus nonparanoid patients in terms of response to the chimeric tasks revealed no significant differences. Most notably, the group of patients who failed to show a perceptual bias in response to the emotion chimera did not have a higher percentage of nonparanoid patients than the group of patients who showed the expected perceptual bias.

One limitation of the present study is the fact that we included only positively valenced emotion in the emotion chimera task. As we have noted from the work of Davidson (c.f. Davidson et al. 1990) and others, greater left frontal than right frontal activation is associated with approach behaviors and positive affect. Using a regional cerebral blood flow technique, Gur and colleagues (1994) observed that performance on a happy discrimination task was correlated with left frontal activation. It would be interesting to assess schizophrenia patients' perceptual biases in response to emotion chimera using angry faces as well as happy faces. Although in normal individuals, angry chimera elicit perceptual biases that are at least as left-biased as happy chimera (Christman and Hackworth 1993; Luh 1999), individuals with schizophrenia may show even greater reductions in their left perceptual biases to negatively valenced emotions, given suggestive evidence that schizophrenia patients have an emotion-specific recognition deficit for negative emotions (c.f. Walker et al. 1980; Mandal et al. 1998). Future research regarding emotion perception in schizophrenia would be enhanced by the inclusion of more than one emotion, preferably a negatively valenced emotion in addition to a positively valenced one.

The causal process underlying schizophrenia patients' differential processing of emotion is presently unknown. Our finding of schizophrenia patients' reduced perceptual biases to the emotion chimera is consistent with two alternatives: (1) patients with schizophrenia may have a primary emotion processing impairment; or (2) schizophrenia patients have an emotion processing deficit that is secondary to a cognitive deficit, that is, an affective information processing deficit. The schizophrenia patients' differential response to the emotion chimera may reflect a disruption in the neural circuitry underlying the interaction between affect and cognition (i.e., the prefrontal-limbic pathways that modulate affective response to stimuli). Thus, the schizophrenia patients in the present study may have responded differently to the emotion chimera relative to normal individuals because of an impaired ability to maintain or retrieve affective information.

On the basis of the present results, it appears likely that the oft-cited emotional impairments displayed by schizophrenia patients reflect a specific affective processing deficit rather than a generalized perceptual processing deficit, because the schizophrenia patients do not show less of the expected left perceptual bias in response to the other types of chimera. Similarly, the schizophrenia patients did not show a global impairment in the visuo-spatial processing of facial stimuli. Rather, the schizophrenia patients showed a differential response to facial stimuli that involved affective information.

The use of emotion chimera in terms of the examination of emotional processing in schizophrenia patients is in its incipient stages. Further research is necessary in order to determine the functional significance of some patients' lack of a left perceptual field bias. Ultimately, we
would like to study the ways in which schizophrenia patients' atypical responses to the emotion chimera are associated with other measures of emotional processing. Certainly one's ability to perceive and respond to emotional stimuli within the context of social interactions affects subsequent behaviors, on the part of the observer and the other participant (Silverstein 1997). Differences in patients' level of emotional perception may be related to differences in their social functioning. Evidence indicating that schizophrenia patients who fail to show the expected left perceptual bias are more likely to display emotional processing deficits on emotion recognition, identification, or labeling tasks would buttress support for the hypothesis that schizophrenia patients have a specific emotion processing deficit. If future studies were to suggest that performance on the emotion chimera task relates to other aspects of social cognition, this, in turn, would instigate further research into whether such emotion processing deficits are amenable to remediation, perhaps as an adjunct to social skills training.

References


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