Emotional Priming of Facial Affect Identification in Schizophrenia

by Klaus Höschel and Eva Irle

Abstract

Twenty-three schizophrenia subjects were compared with healthy and clinical control subjects on an emotional priming task. Positive and negative emotional facial expressions were presented as primes, followed by a neutral pattern mask, then an emotionally neutral face as target. The prime-mask-target sequence was arranged to allow conscious perception of only the targets. Subjects had to judge if they had seen a pleasant or an unpleasant facial expression. All subjects judged the neutral target as significantly more unpleasant when negative emotional facial expressions were presented as primes as compared with positive or neutral facial expressions as primes. This judgment shift was significantly stronger in schizophrenia subjects than in control subjects. The stronger priming of schizophrenia subjects may reflect a stronger influence of automatically processed emotional stimuli on judgments. We suggest that increased spreading activation of emotional information might be related to low social/emotional functioning of the individual with schizophrenia.

Keywords: Schizophrenia, priming, facial affect.

within the lexical networks of people with schizophrenia is related to their disorganized thinking and makes unusual associations and intrusions of irrelevant thoughts into utterances more likely.

The concept of two information processing systems can also be applied to emotional information processing. LeDoux (1989) suggested that thalamo-amygdaloid pathways give the possibility to quickly evaluate a stimulus ("quick and dirty processing") and thus allow an immediate response without involvement of more complex and controlled emotional information processing. On the other hand, when more complex evaluations of emotional stimuli are carried out, a strong involvement of cortical information processing may be necessary (Izard 1993).

As is true for the controlled information processing of nonemotional material, schizophrenia subjects show deficits in the controlled information processing of emotional material. For example, most studies agree that schizophrenia subjects have deficits in the perception and processing of emotional facial expressions (Morrison et al. 1988). On the other hand, the physiological responses of schizophrenia subjects to negative emotional stimuli may be stronger than their rating of these stimuli would predict (Payne and Shean 1975), thus indicating a functional dissociation of controlled and automatic emotional information processing in schizophrenia subjects.

The goal of the present study was to investigate if facilitated priming effects of schizophrenia subjects can also be obtained with emotional material. In accordance with the hypothesis of faster and farther spreading activation in schizophrenia, we expected a more pronounced priming effect in schizophrenia subjects than in controls. To test this hypothesis, we used a modification of the priming task of Murphy and Zajonc (1993).

Murphy and Zajonc (1993) were the first to demonstrate the feasibility of priming with emotional stimuli. They used faces with positive (happiness) and negative (anger) emotional expressions as stimuli. After a very short presentation of a prime (4 msec), an emotionally ambiguous target (a Chinese ideograph) was presented for 2,000 msec. The subjects were not aware of the primes. If preceded by positive facial expressions, the targets were rated as significantly more pleasant than if preceded by negative facial expressions. This shift of affective judgment was considered a result of preactivated positive or negative emotional concepts.

A second goal of this study was to examine the relationship between emotional priming and schizophrenic symptoms. According to information processing theories, schizophrenic symptoms emerge from an information overload because of a defect in filtering out irrelevant information (Hemsley 1977; Frith 1979). This model suggests that stronger priming could be expected in subjects with more severe symptoms. We suppose that emotional priming may be especially related to disorganized and negative symptoms. An inappropriate affect may be the result of intruding irrelevant emotional information. On the other hand, an individual with schizophrenia may chronically react to these intrusions by diminishing his or her emotional expressions.

**Methods**

**Subjects.** A consecutive series of 23 inpatients (Department of Psychiatry, University of Göttingen) with schizophrenia according to DSM–IV (American Psychiatric Association 1994) participated in this study. The German version of the Structured Clinical Interview for DSM–III–R (SCID, Wittchen et al. 1991) was administered to assess psychiatric diagnoses. All subjects had a comprehensive psychiatric assessment by two independent interviewers. According to the subtypes of DSM–IV, 3 subjects met criteria for the residual subtype, 5 subjects were disorganized, 2 subjects were catatonic, 11 subjects were paranoid, and 2 subjects represented undifferentiated subtypes. Subjects with additional Axis I or Axis II disorders or neurological disorders were excluded.

Two groups of subjects without psychiatric or neurologic disorders served as controls. Twenty-nine healthy volunteers (healthy controls) were recruited by advertisement in a local newspaper. The clinical control group consisted of 20 inpatients (Department of Neurosurgery, University of Göttingen) having undergone surgery for slipped disks. These subjects were included to control for possible influences of hospitalization on emotional priming.

All subjects were native German speakers. The samples of schizophrenia subjects, healthy controls, and clinical controls were well matched in age, education, and gender (table 1). However, the groups were not matched in IQ. After subjects were given a complete description of the study, informed consent was obtained.

**Psychopathological Measures.** Schizophrenic symptoms were rated by aid of the Scale for the Assessment of Positive Symptoms (SAPS, Andreasen and Olsen 1982) and the Scale for the Assessment of Negative Symptoms (SANS, Andreasen 1982). Interrater reliabilities of symptom ratings were tested in a subset of 10 subjects. Correlations (Spearman's coefficient rs) between symptom ratings based on the two psychiatric assessments were sufficiently high and significant (two-tailed test, n = 10, α = 0.05). The SAPS subscale "hallucinations" yielded the lowest correlation (rs = 0.64, p < 0.05), and the SANS subscale "avolition/apathy" the highest correlation (rs = 0.88, p < 0.001). Lowest mean symptom scores were found in the subscales "alogia" (mean = 1.7, standard
Table 1. Demographic and clinical characteristics of subjects

<table>
<thead>
<tr>
<th></th>
<th>Schizophrenia subjects (n = 23)</th>
<th>Healthy controls (n = 29)</th>
<th>Clinical controls (n = 20)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs), mean (SD)</td>
<td>37 (13)</td>
<td>40 (9)</td>
<td>41 (7)</td>
<td>F(2;69) = 0.64 (p &lt; 0.53)</td>
</tr>
<tr>
<td>Education (yrs), mean (SD)</td>
<td>15 (4)</td>
<td>15 (3)</td>
<td>15 (3)</td>
<td>F(2;69) = 0.00 (p &lt; 0.99)</td>
</tr>
<tr>
<td>IQ (WAIS-R short form), mean (SD)</td>
<td>102 (19)</td>
<td>123 (24)</td>
<td>112 (19)</td>
<td>F(2;67) = 5.68 (p &lt; 0.005)</td>
</tr>
<tr>
<td>Number of prior hospitalizations, mean (SD)</td>
<td>4 (4)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Years since first hospitalization, mean (SD)</td>
<td>8 (8)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Length of admission (days), mean (SD)</td>
<td>27 (23)</td>
<td>—</td>
<td>20 (6)</td>
<td>—</td>
</tr>
<tr>
<td>Antipsychotic medication (chlorpromazine equivalents), mean (SD)</td>
<td>726 (509)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Sex, n female:n male</td>
<td>10:13</td>
<td>18:11</td>
<td>9:11</td>
<td>$\chi^2(2) = 2.23 (p &lt; 0.33)$</td>
</tr>
</tbody>
</table>

Note.—SD = standard deviation; WAIS-R = Wechsler Adult Intelligence Scale—Revised (Wechsler 1981). Clinical control subjects had been operated on for slipped disks. Analyses of variance or chi-square tests were used to calculate probabilities.

deviation [SD] = 1.6) and “bizarre behavior” (mean = 1.7, SD = 1.7), and the highest mean scores were observed in the subscale “delusions” (mean = 3.1, SD = 1.7).

In another study (Höschel et al. 1998), we conducted a principle component analysis of SANS and SAPS subscales in a larger sample of schizophrenia subjects. This analysis revealed a three-dimensional structure of schizophrenic symptoms. The dimensions are a positive psychotic dimension (hallucinations/delusions), a disorganized dimension, and a negative (deficit) dimension. The standardized scoring coefficients from this analysis were used to calculate the strength of psychotic, disorganized, and negative symptoms of the subjects of this study.

Emotional Priming Task. Three slide projectors (Revue universal 600 AF–S) were used to project images 135 cm X 90 cm onto a screen at eye level at a distance of about 2.75 m. The shutters and the selection of the slides were controlled using an IBM 3/86DX PC and the program “Tachistoskop” of the Wiener Testsystem software (Schuhfried 1995). All images were part of Ekman’s series of pictures of facial affect (Ekman and Friesen 1975; Ekman 1976).

Task items consisted of the presentation of the prime (20 msec) followed by the presentation of a pattern mask (20 msec) and a target (50 msec). The prime-mask-target sequence was presented four times, with a free interval of 50 msec. After this, subjects pressed a right-hand button if they believed they had seen a pleasant facial expression or a left-hand button if they believed they had seen an unpleasant facial expression. Two seconds later a buzzer signal announced the next item. The order of prime presentation was the same for all subjects. Examples of task items are illustrated in figure 1. The characteristics of all task items are summarized in table 2.

The emotionally neutral pattern mask and the target picture were the same in each item. An image of a blond woman (picture 45 C from Ekman and Friesen 1975; figure 1) with a neutral expression was used as the target. Images of the same actress (“Patricia”) were used as prime pictures in the experimental items. There were two experimental conditions: the positive prime condition and the negative prime condition. In the positive prime condition, primes consisted of two pictures of joyful people with closed or open mouth. In the negative prime condition, primes consisted of two pictures showing an anger-disgust blend, sadness, or fear. In order to obtain a baseline, a neutral prime condition was included. In this condition, the neutral target picture was used as prime (table 2).

The task included two further control conditions: The first items of the task were practice items. Perception items were interspersed among task items in order to control for possible conscious perception of the primes (table 2). The perception items consisted of prime pictures of persons physiognomically clearly different from Patricia. After completion of the task, subjects were asked in a multiple-choice questionnaire (1) if they had seen the image of only a blond woman (Patricia), (2) if they had seen a blond woman and images of additional persons, or (3) if they had seen pictures of different persons but no blond woman. Alternative A indicated the subjects’ awareness of the target but not the primes, alternative B indi-
Figure 1. Illustration of each item of the positive (top), neutral (middle), and negative (bottom) prime condition of the emotional priming task. The mask and the emotionally neutral target face were the same in each item.

For calculating judgment shifts, the numbers of pleasant and unpleasant judgments were summed up separately for items with positive, negative, and neutral primes. For each experimental condition, these numbers were then divided by the total number of items, resulting in percentages of pleasant and unpleasant judgments for the positive, the negative, and the neutral prime condition. The difference of percentages of pleasant judgments in the positive versus the neutral prime condition was defined as the positive judgment shift. The negative judgment shift was defined as the difference of percentages of unpleasant judgments between the negative and the neutral prime condition. The total judgment shift was defined as the difference of percentages of pleasant judgments between the positive and the negative prime condition.

Pilot experiments with normal volunteers and psychiatric (schizophrenia and depressive) patients pointed out that an item presentation in which the subject saw the target recurring four times on the screen increased the probability of judgment shifts and produced more homogeneous responding of subjects when compared with a single presentation of the prime-mask-target sequence. We applied only a small number of experimental items, as the pilot experiments with schizophrenia and depressive patients showed that many patients were not motivated to follow the task for more than a few minutes. Furthermore, we chose a forced-choice response modus (positive vs. negative) instead of a Likert scale rating. The pilot experiments showed that some subjects had a strong tendency to judge all items in the middle of
Table 2. Items of the emotional priming task

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Task condition</th>
<th>Person</th>
<th>Expression</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Practice</td>
<td>Patricia</td>
<td>Surprised</td>
<td>11 D</td>
</tr>
<tr>
<td>2</td>
<td>Practice</td>
<td>Patricia</td>
<td>Sad</td>
<td>54 A</td>
</tr>
<tr>
<td>3</td>
<td>Perception</td>
<td>Dark-haired male</td>
<td>Neutral</td>
<td>13 A</td>
</tr>
<tr>
<td>4</td>
<td>Practice</td>
<td>Patricia</td>
<td>Angry</td>
<td>38 A</td>
</tr>
<tr>
<td>5</td>
<td>Perception</td>
<td>Dark-haired female</td>
<td>Anxious</td>
<td>52</td>
</tr>
<tr>
<td>6</td>
<td>Practice</td>
<td>Patricia</td>
<td>Disgusted</td>
<td>38 B</td>
</tr>
<tr>
<td>7</td>
<td>Perception</td>
<td>Dark-haired female</td>
<td>Angry</td>
<td>23</td>
</tr>
<tr>
<td>8</td>
<td>Positive</td>
<td>Patricia</td>
<td>Happy (intensely)</td>
<td>43 B</td>
</tr>
<tr>
<td>9</td>
<td>Positive</td>
<td>Patricia</td>
<td>Happy</td>
<td>43 A</td>
</tr>
<tr>
<td>10</td>
<td>Negative</td>
<td>Patricia</td>
<td>Angry/disgusted</td>
<td>38 C</td>
</tr>
<tr>
<td>11</td>
<td>Negative</td>
<td>Patricia</td>
<td>Sad (intensely)</td>
<td>60 A</td>
</tr>
<tr>
<td>12</td>
<td>Neutral</td>
<td>Patricia</td>
<td>Neutral</td>
<td>45 C</td>
</tr>
<tr>
<td>13</td>
<td>Perception</td>
<td>Dark-haired female</td>
<td>Sad</td>
<td>43</td>
</tr>
<tr>
<td>14</td>
<td>Perception</td>
<td>Dark-haired male</td>
<td>Happy</td>
<td>44 A</td>
</tr>
<tr>
<td>15</td>
<td>Negative</td>
<td>Patricia</td>
<td>Anxious</td>
<td>22 B</td>
</tr>
<tr>
<td>16</td>
<td>Negative</td>
<td>Patricia</td>
<td>Anxious</td>
<td>22 B</td>
</tr>
<tr>
<td>17</td>
<td>Perception</td>
<td>Dark-haired male</td>
<td>Happy</td>
<td>44 A</td>
</tr>
<tr>
<td>18</td>
<td>Perception</td>
<td>Dark-haired female</td>
<td>Sad</td>
<td>43</td>
</tr>
<tr>
<td>19</td>
<td>Neutral</td>
<td>Patricia</td>
<td>Neutral</td>
<td>45 C</td>
</tr>
<tr>
<td>20</td>
<td>Negative</td>
<td>Patricia</td>
<td>Sad (intensely)</td>
<td>60 A</td>
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<td>Patricia</td>
<td>Happy</td>
<td>43</td>
</tr>
<tr>
<td>23</td>
<td>Positive</td>
<td>Patricia</td>
<td>Happy (intensely)</td>
<td>43 B</td>
</tr>
</tbody>
</table>

1 From Ekman and Friesen (1975).
2 From Ekman (1976).

the Likert scale. However, the forced-choice response modus had the disadvantage that the subjects of this study were forced to misclassify neutral items as positive or negative.

Testing Procedure. The SCID and the psychiatric assessment were performed first. Control subjects were not examined with the SCID but were carefully interviewed to identify possible exclusion criteria. Symptom ratings were done immediately after the interview and without knowledge of performance in the emotional priming task.

In the emotional priming task, subjects were instructed to judge the facial expression of the blond woman by pressing the pleasant button or the unpleasant button after presentation of each item. They were told that minimal differences between the emotional expression of the items existed and that they should guess the difference even when they were uncertain. After completion of all 23 items of the task (which took about 3 to 5 minutes), subjects answered the multiple-choice questionnaire.

Statistical Analyses. Because of significant (Shapiro-Wilk's statistic $W; \alpha = 0.05$) deviations of percentages of pleasant and unpleasant judgments from normal distribution in all groups, statistical analyses of these variables were performed using nonparametric methods. All analyses were two-tailed, and the alpha was defined as 0.05.

Testing for judgment shifts, we expected higher percentages of pleasant judgments in the positive versus the neutral or the negative prime condition, and higher percentages of unpleasant judgments in the negative versus the neutral prime condition. These relations were tested by signed-rank tests in the schizophrenia group and in the two control groups separately.

Second, we wanted to compare the magnitude of the judgment shifts in schizophrenia versus healthy control subjects. The hypothesis of stronger emotional priming in schizophrenia subjects was tested by a comparison of percentages of pleasant and unpleasant judgments in schizophrenia versus healthy control subjects (Mann-Whitney U tests, and a nonparametric version of the classical mixed model, Akritas and Brunner 1997). In addition, judgment shifts were compared in healthy versus clinical control subjects in order to uncover possible influences of hospitalization on emotional priming.
The third question dealt with the relationship between schizophrenic symptoms and the strength of judgment shifts. Spearman's rank correlations ($r_j$) were used to test the hypothesis of stronger emotional priming in subjects with more severe symptoms.

**Results**

The emotional priming task was completed by all subjects. One schizophrenia subject and one healthy control subject reported seeing the blond woman and other persons on the slides. These two subjects were excluded from the analysis because they might have been aware of the primes.

**Judgment Shifts.** Strong and significant total judgment shifts (percentage of pleasant judgments in the positive prime condition minus percentage of pleasant judgments in the negative prime condition) occurred in each group (table 3, table 4). Schizophrenia subjects showed the strongest total judgment shift. The total judgment shift of schizophrenia subjects differed significantly from that of healthy control subjects ($U$ test: $z = -2.6, p < 0.02$). The total judgment shift of healthy control subjects did not differ significantly from that of clinical control subjects ($z = -0.14, p > 0.88$). A nonparametric version of the classical mixed model (analysis of variance [ANOVA]) (Akritas and Brunner 1997) was computed with the factors group (schizophrenia vs. healthy control subjects) and prime valence (positive vs. negative prime condition). Significant effects were obtained for the factor group ($B = 4.7, p = 0.03$) and prime valence ($B = 53.3, p < 0.001$). The interaction also yielded significance ($B = 7.4, p < 0.006$), indicating lower percentages of pleasant judgments of schizophrenia subjects in the negative prime condition (table 3).

It could be argued that the finding of increased priming of schizophrenia subjects relative to control subjects is confounded by differences in overall performance between the groups (Chapman and Chapman 1989). We converted the scores of the negative prime condition to residualized scores, using the regression of the scores of the negative prime condition ($B$) on the scores of the positive prime condition ($A$) as determined by our healthy control subjects ($B' = 1.23 \times A - 35$, with a standard error of observed $B$ scores around the regression line of 22). The resulting standard residualized scores of the schizophrenia group (mean = 0.66, SD = 0.87) were sig-

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**Table 3. Results of the emotional priming task: Pleasant judgments and unpleasant judgments and prime conditions**

<table>
<thead>
<tr>
<th>Schizophrenia Subjects ($n = 22$)</th>
<th>Healthy Controls ($n = 28$)</th>
<th>Clinical Controls ($n = 20$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleasant judgments, mean (SD)</td>
<td>Pleasant judgments, mean (SD)</td>
<td>Pleasant judgments, mean (SD)</td>
</tr>
<tr>
<td>Unpleasant judgments, mean (SD)</td>
<td>Unpleasant judgments, mean (SD)</td>
<td>Unpleasant judgments, mean (SD)</td>
</tr>
<tr>
<td>Positive prime condition</td>
<td>85% (17%)</td>
<td>88% (14%)</td>
</tr>
<tr>
<td>Neutral prime condition</td>
<td>77% (25%)</td>
<td>87% (28%)</td>
</tr>
<tr>
<td>Negative prime condition</td>
<td>55% (23%)</td>
<td>74% (29%)</td>
</tr>
</tbody>
</table>

*Note.* — SD = standard deviation.

**Table 4. Results of the emotional priming task: Judgment shifts**

<table>
<thead>
<tr>
<th>Schizophrenia subjects ($n = 22$), mean (SD)</th>
<th>Healthy controls ($n = 28$), mean (SD)</th>
<th>Clinical controls ($n = 20$), mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total judgment shift$^1$</td>
<td>30% (18%)$^{**}$</td>
<td>15% (23%)$^{**}$</td>
</tr>
<tr>
<td>Positive judgment shift$^2$</td>
<td>8% (26%)</td>
<td>1% (25%)</td>
</tr>
<tr>
<td>Negative judgment shift$^3$</td>
<td>22% (28%)$^*$</td>
<td>14% (30%)$^*$</td>
</tr>
</tbody>
</table>

*Note.* — SD = standard deviation.

$^1$ Percentage of pleasant judgments in the positive prime condition minus percentage of pleasant judgments in the negative prime condition.

$^2$ Percentage of pleasant judgments in the positive prime condition minus percentage of pleasant judgments in the neutral prime condition.

$^3$ Percentage of unpleasant judgments in the negative prime condition minus percentage of unpleasant judgments in the neutral prime condition.

$^*$ $p < 0.02$; $^{**} p < 0.002$ (signed-rank tests for the comparison of the prime conditions within each group)
A significant positive judgment shift (percentage of pleasant judgments in the positive prime condition minus percentage of pleasant judgments in the neutral prime condition) did not occur in schizophrenia or control subjects. Neutral primes, although defined as unemotional (Ekman and Friesen 1975), were already judged as pleasant in most cases by control as well as schizophrenia subjects (table 3). This might have been related to the physical attractiveness of the actress shown in our prime and target pictures (figure 1). Significant inverse correlations were obtained for percentages of pleasant judgments in the neutral prime condition and the magnitude of the positive judgment shift (people with schizophrenia: $r_s = -0.80$, $p < 0.01$; healthy controls: $r_s = -0.71$, $p < 0.01$; clinical controls: $r_s = -0.64$, $p < 0.01$). Thus, the occurrence of a positive judgment shift was probably hindered by a ceiling effect.

Strong and significant negative judgment shifts (percentage of unpleasant judgments in the negative prime condition minus percentage of unpleasant judgments in the neutral prime condition) occurred in each group (table 3, table 4). Schizophrenia subjects showed the strongest negative judgment shift. The difference between schizophrenia and healthy control subjects in the percentage of unpleasant judgments in the negative prime condition was significant (U test: $z = -2.4$, $p < 0.02$), indicating more frequent unpleasant judgments in the schizophrenia group. The same was true when Chapman and Chapman’s (1989) residualized scores were used in the analysis (U test: $z = 2.4$, $p < 0.02$). The comparison of healthy and clinical control subjects did not reach statistical significance ($z = -0.06$, $p > 0.95$).

**Relationships Between Emotional Priming and Psychopathological Measures.** Because of difficulties in interpreting pleasant judgments in the positive versus the neutral prime condition (see above), only the negative judgment shift was used for calculating correlations. None of the clinical and demographic variables (table 1) showed significant correlations with the negative judgment shift or the factor scores of psychotic, disorganized, or negative symptoms.

The correlation between the intensity of psychotic symptoms (as indicated by the delusional-hallucinatory factor scores) and the magnitude of the negative judgment shift was near zero ($r_s = -0.03$, $p = 0.91$). The strength of disorganized symptoms was negatively correlated with the magnitude of the negative judgment shift ($r_s = -0.39$, $p = 0.07$), thus indicating stronger emotional priming in schizophrenia subjects with less severe disorganized symptoms. In contrast, the strength of negative symptoms was positively related to the magnitude of the negative judgment shift ($r_s = 0.30$, $p = 0.17$). However, both correlations failed to reach conventional levels of significance. Correlations between subscales measuring psychotic, disorganized, or negative symptoms and the negative judgment shift were all statistically nonsignificant.

**Discussion**

In this experiment, emotionally negative facial expressions produced a significant negative judgment shift of a target face in three groups of subjects. No positive judgment shift was obtained with positive facial expressions because of a strong tendency of all subjects to judge the target face as pleasant even in the neutral prime condition (baseline condition). The significant negative judgment shift of our study gives further evidence of emotional priming with minimal stimulus input and without subjects’ awareness of the primes.

Our results support and extend Murphy and Zajonc’s (1993) demonstration of priming with emotional stimuli. Murphy and Zajonc demonstrated in healthy subjects that significantly more pleasant judgments of a Chinese ideograph (target) occurred when the target was preceded by a positive facial expression as prime than if preceded by a negative facial expression as prime. Like our subjects, the subjects of the study of Murphy and Zajonc were not aware of the primes.

To our knowledge, this is the first study to examine priming with emotional stimuli in schizophrenia subjects. Our results provide support for the hypothesis of stronger emotional priming in schizophrenia subjects. Furthermore, our results are consistent with results from previous studies showing stronger semantic priming in schizophrenia subjects (Manschreck et al. 1988; Kwapil et al. 1990; Spitzer et al. 1993, 1994).

**Methodological Limitations.** Because of a ceiling effect (see Results, Judgment Shifts), the judgments in the positive prime condition cannot be interpreted as a reliable and valid measure. Neutral primes, although defined as unemotional (Ekman and Friesen 1975), were already judged as pleasant in most cases by control as well as schizophrenia subjects (table 3). Future studies using pictures of other persons included in the Ekman series should clarify if a positive judgment shift can be obtained when a target picture of a person less attractive than that used in our study (figure 1) is used.

Cronbach’s alpha, an index of internal consistency, was calculated for the items of the neutral and the items of the negative prime condition. The reliability of the negative prime condition was quite high ($\alpha = 0.74$). However,
the reliability of the neutral prime condition was low ($\alpha = 0.36$), implying a high proportion of erroneous variance of the judgments in this experimental condition. A high proportion of erroneous variance may lead to an enhanced probability of type II errors ($\beta$) and thus may cover true judgment shifts. Type I errors ($\alpha$) may not have been affected by the restricted reliability of the neutral prime condition. We think that a priming task should be considered as an experimental procedure and not as a highly reliable psychological test.

For each item of the emotional priming task, the prime-mask-target sequence occurred four times on the screen. Pilot experiments in our laboratory pointed out that a recurrence of the sequence increased the probability of judgment shifts. Similar findings were reported by Bornstein et al. (1987). They found a significant increase of affect ratings after five consecutive subliminal stimulus exposures using a forced choice preference task. Thus, it may be possible that the judgment shifts demonstrated in our study can be obtained only with several consecutive stimulus presentations.

Furthermore, it could be possible that the repeated target presentation results in a mere exposure effect. On the other hand, the higher proportion of negative prime-target pairs compared with positive or neutral prime-target pairs could create an expectancy or bias to the negative cue. However, we could not find any evidence for both arguments, as the judgment shifts produced by the experimental items in the first half of the task were nearly identical to the judgment shifts produced by the experimental items in the second half of the task. Posner and Snyder (1975) view expectancy in subliminal priming as unlikely. They argue that expectancy may be under a person's strategic control and may not occur without a person's intention or awareness.

A Spreading Activation Model of Emotional Priming.
A spreading activation model of emotional priming implies that a preactivation of basic emotional concepts (pleasant vs. unpleasant) may be induced by a very short presentation of affectively charged facial expressions as primes even if subjects are not aware of the primes. The preactivated emotional concept thus may become more accessible when an emotional judgment of the target is demanded. In the present study, the expected judgment shift took place in all groups, with the strongest shift in schizophrenia subjects.

Neely (1991) suggests from experiments studying semantic priming that a spreading activation model can best account for most of the observed priming effects. Priming with subliminal cues may give the strongest piece of evidence for the spreading activation model, because this model can account for subliminal priming, whereas other theoretical mechanisms (e.g., expectancy) cannot. We assume that semantic as well as nonverbal (i.e., emotional) priming may indicate a quite similar process, no matter if the effect is measured by reaction time (as normally done in semantic priming experiments) or by shift in judgment score (as done in our experiment and in that of Murphy and Zajonc 1993).

It may be justified to attribute the emotional priming in our study to a large degree to automatic information processing. According to Shiffrin and Schneider (1977), automatic processing may not require attention, and Callaway and Naghdi (1982) suggest that automatic processing in some instances may operate outside of awareness. In our experiment, part of the processing was certainly carried out with attention and awareness (e.g., thinking about the most appropriate judgment, searching for differences in the target slide, moving a hand to the button and pressing it). However, the judgment shifts elicited by the unidentified primes likely took place without subjects' awareness and without controlled attention. This view is underlined by the fact that the judgment shifts of the schizophrenia as well as control subjects of our study were not significantly correlated with standard neuropsychological measures of attention.

The magnitude of the emotional priming can be interpreted as the strength of influence of automatically processed emotional facial expressions on emotional judgments, which are thought to be carried out in working memory. In this manner, the stronger priming of schizophrenia subjects may reflect a stronger influence of automatically processed emotional stimuli on judgments. In terms of the filter theory, a fundamental defect in filter mechanisms might be responsible for this—that is, automatically processed emotional information may intrude to a higher degree on the working memory of people with schizophrenia than on that of normal persons (see also Plagnol et al. 1996 and Spitzer 1997).

Neural Models of Emotional Priming. Using activation paradigms, recent studies reported evidence for sustained activity of prefrontal cortical areas during working memory tasks (Cohen et al. 1997; Courtney et al. 1997). For schizophrenia subjects, a deficit to activate their prefrontal cortex while performing working memory tasks has been frequently reported (e.g., Weinberger et al. 1986; Yurgelun-Todd et al. 1996). On the other hand, automatic information processing, like priming, seems to depend on posterior cortical areas (Squire et al. 1992; Schneider et al. 1994; Schacter and Buckner 1998). Future studies using activation paradigms are needed to clarify whether enhanced priming effects of schizophrenia subjects are associated with a presently hypothetical functional imbalance of their prefrontal and posterior cortical areas.

The amygdala seems to be a critical site for the processing of emotional information. In humans and animals, lesions of the amygdala are followed by deficits in the
recognition and processing of emotional, especially negative, stimuli (Ledaun 1989; Adolphs et al. 1994; Irl et al. 1994; Young et al. 1995). Several studies demonstrated volume reductions of the hippocampus and the amygdala in schizophrenia subjects (Nelson et al. 1998). Studies using activation paradigms showed that the amygdala is activated in healthy subjects by the masked presentation of fearful faces (Morris et al. 1998; Whalen et al. 1998).

These results support the idea that a dysfunction or disconnection of mesial temporal lobe structures represents a factor for the development of emotional schizophrenic symptoms (Mesulam and Geschwind 1978; Aggleton 1993). Andreasen (1999) proposes that the apparently heterogeneous schizophrenic symptoms may relate to a common neural dysfunction in the cortico-cerebellar-thalamic-cortical circuit. Emotional as well as non-emotional symptoms should be considered the result of a basic neural deficit. The assumption of a single unitary model for the widespread functional deficits of schizophrenia in our opinion best accounts for the facilitated emotional priming as well as the facilitated semantic priming of schizophrenia subjects.

Schizophrenic Symptoms and Emotional Priming. We found stronger negative judgment shifts in subjects with more pronounced negative symptoms ($r = 0.31$) and less pronounced disorganized symptoms ($r = 0.39$); however, both correlations failed to reach conventional levels of significance. Contrary to our results, Spitzer et al. (1993, 1994) found stronger semantic priming in severely disorganized schizophrenia subjects. A possible explanation might be that negative and disorganized symptoms have a differential influence on the priming of semantic or non-verbal (i.e., emotional) information. However, future studies using samples of various schizophrenia subtypes are needed to answer these questions.

It might be speculated that schizophrenia subjects with pronounced symptoms of anhedonia or depression are more prone to a negative judgment shift than subjects with less pronounced symptoms. However, we could not find a correlation between the SANS subscale anhedonia and negative judgment shift exceeding the correlation between the negative factor score and negative judgment shift. In another study (Koschak et al., submitted for publication), we applied the emotional priming task to a group of 25 subjects with the diagnosis of major depression. Compared with the schizophrenia subjects of this study, depressive subjects judged items of the neutral and positive prime condition, but not items of the negative prime condition, more frequently as negative. These results support the idea that the strong negative judgment shift of our schizophrenia subjects reflects a heightened sensitivity to negative stimuli, which is rather independent from the affective status of the individual.

The strong negative judgment shift of our schizophrenia subjects suggests that they may not be able to suppress emotionally charged information. It has been shown that contact with emotionally negative relatives can cause stronger autonomic stress reactions in schizophrenia subjects than in healthy persons (Tarrier et al. 1979) and can predict relapse of acute symptoms (Brown et al. 1972; Vaughn and Leff 1976). We suggest from our results that increased spreading activation of emotional information might be related to low social/emotional functioning of the individual with schizophrenia. Future studies should show if increased emotional priming can predict the course of the schizophrenia or can predict if negative symptoms become steadily more prominent during the course of the illness.

References


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