Impaired Speed of Information Processing in Nonmedicated Schizotypal Patients

by David L. Braff

Abstract

There is increasing evidence that schizophrenia is associated with an attentional or information processing deficit or both. These "early deficit" theories challenge the position that schizophrenia is primarily a disorder of thinking and higher cognitive operations. A tachistoscopic backward masking task was applied in matched groups of 20 schizophrenic, 20 schizotypal, and 20 depressive psychiatric inpatients. Resulting data are an index of visual input factors and speed of information processing. Paranoid schizophrenic and schizotypal subjects had unimpaired visual input thresholds but abnormally slow processing compared with the depressives. Since all the schizotypal subjects were nonmedicated, the data add important support to the hypothesis that impaired speed of information processing in schizophrenia spectrum disorders is due to schizophrenia per se and is not secondary to medication effects. These data also support the theoretical link between schizophrenic and schizotypal patients. The importance of the results is discussed, with emphasis on the hypothesized relationship between information processing dysfunction and symptom formation in the schizophrenias.

Since Bleuler (1950), schizophrenia has been viewed primarily as a disorder of higher cortical functioning or thinking. During the early 1960s a view emerged that the basic disorder in schizophrenia is one of dysfunctional attentional processes, related disruptions of early information processing, or both. There is growing evidence that an early information processing disturbance in schizophrenia occurs in the first 1,000 msec following stimulus intake (Callaway 1970; Braff, Callaway, and Naylor 1977; Braff et al. 1978). According to this view, the formal thought disorder of schizophrenia may be secondary to the early cognitive deficit. Two of the major "early deficit" theories of schizophrenia are McGhie and Chapman's (1961) theory that schizophrenics have abnormal perception and stimulus filtering and Yates' (1966) theory of generalized slowness of information processing. Slowly, technical advances such as the development of the tachistoscope have allowed us to assess these early information processing functions.

Like the span of apprehension (Neale et al. 1969; Neale 1971) and pattern integration tasks (Knight et al. 1978; Spaulding et al. 1980), the backward masking procedure has provided a significant advance in evaluating the information processing deficit in schizophrenia (Saccuzzo, Hirt, and Spencer 1974; Miller, Saccuzzo, and Braff 1979; Braff and Saccuzzo, in press). This evaluation is viewed as critically important because, once the earliest disrupted stage of processing is isolated, subsequent cognitive disorder may be found...
to be secondary to that early dysfunction. In a backward masking paradigm, a stimulus containing information content, known as the test or target stimulus, is briefly presented tachistoscopically. The test stimulus is followed at an interval by a powerful, noninformational masking stimulus. The masking stimulus prevents the test stimulus from reaching awareness (Kahneman 1968; Spencer 1969; Spencer and Shuntich 1970). As described below, this allows us to assess initial stimulus input factors as well as information processing speed.

The backward masking procedure has supported a model of human information processing that assumes briefly presented test stimuli enter in parallel into a storage system of large capacity but short duration, which Neisser (1967) called iconic storage or memory. Information in iconic memory, although registered in the nervous system, does not reach awareness until a hypothetical scanning mechanism transfers the information serially to more permanent short-term memory. Some of the major evidence supporting the existence of a labile, large capacity but short duration iconic memory bin comes from the work of Sperling (1960). Sperling briefly presented three rows of four letters to subjects. When asked to recall as many letters as possible (whole report), subjects recalled only about 50 percent or less of the letters. In another condition called partial report, the display of the three rows was followed by a tone (high, medium, low) which cued the subject to report the top, middle, or bottom row. If the tone was sounded immediately after the letter display, subjects reported the indicated line with 100 percent accuracy. As the interval between letter display offset and tone onset increased beyond several hundred msec, the subjects’ accuracy decreased. Superiority of partial report at brief interstimulus intervals supports the idea that iconic memory is of larger capacity than whole report would indicate. Further, the rapid decline in partial report accuracy as the interval between letter display and tone is increased supports the idea that iconic memory is subject to rapid decay and is a labile, nonpermanent form of information storage.

Information in iconic memory that is not transferred, due to the limited duration of iconic storage and finite speed of information transfer to short-term memory, is lost. Although the exact mechanism of transfer is not known, the rate of transfer is an index of an individual’s speed of information processing (Felsten and Wasserman 1980). The early stages of information processing thus involve (1) the initial contact between the individual and information, (2) brief perceptual or iconic memory, and (3) speed of information transfer from labile storage to (4) other cognitive functions such as short-term and long-term memory.

Despite differing hypotheses of how the mask acts (Erickson and Schulz 1978; Felsten and Wasserman 1980), current theories of backward masking generally hold that the masking stimulus limits the duration or quality of information in iconic memory (Kahneman 1968; Spencer 1969; Spencer and Shuntich 1970), and thus provides a means of measuring speed of information transfer from iconic storage to conscious registration and processing. By determining the interval between the test and mask stimulus at which the mask no longer interferes with processing of the test stimulus, we can estimate an individual’s rate of information transfer from labile iconic memory to more permanent memory processes. The backward masking paradigm allows us to evaluate several important constructs. We can assess initial stimulus input factors by assessing the critical stimulus duration for stimulus recognition. Speed of processing is estimated using the backward masking technique as described above.

This experiment was designed to replicate and cross-validate previous findings that paranoid schizophrenics have impaired critical stimulus durations and slowed processing from iconic memory to short-term memory and other cognitive operations (Saccuzzo and Braff 1981). Two other hypotheses were tested. First, medication effects have confounded almost all previous studies in this area. Since schizotypal patients can be more easily treated without medications than the generally more symptomatic and overtly psychotic paranoid schizophrenics, the data also serve as a point of comparison of medication effects in these two “schizophrenia spectrum” groups. Second, we wanted to see if Research Diagnostic Criteria/DSM-III—diagnosed schizotypal patients would have an early information processing disturbance in the observed schizophrenic range. Since schizotypal illness or “bor-
derline schizophrenia" has been genetically and clinically placed in the schizophrenia spectrum (e.g., Meehl 1962; Kety et al. 1968, 1971), a positive finding would add psychophysical support to the concept of schizotypal personality disorder as a part of the schizophrenia spectrum.

Method

Subjects. The 60 patients included 20 paranoid schizophrenics, 20 schizotypal patients, and 20 depressives selected from the Inpatient Psychiatric Unit at University Hospital, University of California Medical Center, San Diego. The patients were tested within 1 week of admission. Patients were excluded from the study if they (1) were more than 55 years old, (2) had a history of central nervous system damage or mental retardation, or (3) did not have at least 20/30 correctable vision.

Demographically, samples were grossly matched for gender, race, age, intelligence, and education. Exact matching proved difficult for gender, with 6 of the schizophrenics, 17 of the depressives, and 11 of the schizotypal patients being female. For race, one of the depressive and one of the schizotypal patients were Black. There was one Oriental in the schizophrenic group. All other subjects were Caucasian. All subjects were chosen from an initial pool of 280 consecutive admissions. Cases were then screened for diagnosis by the author (DLB) and a trained Master's level research assistant with 3 years' experience in our laboratory. We used the clinical DSM-III diagnosis (American Psychiatric Association 1980) and the Research Diagnostic Criteria (RDC) of Spitzer, Endicott, and Robins (1978). Also, the author was clinically very familiar with the patients, all of whom were hospitalized on the inpatient service of which he is Director and full-time Attending Physician. Cells of 20 were selected based on availability of at least 20 clearly diagnosed patients in each group.

All schizophrenics had a primary DSM-III diagnosis of schizophrenia, paranoid type which requires 6 months of illness. These patients also met the RDC for definite paranoid schizophrenia with one or more of (1) persecutory delusions, (2) grandiose delusions, (3) delusions of jealousy, and (4) hallucinations with a persecutory or grandiose content. The schizophrenic patients thus had at least a 6-month history of symptoms and were generally in the midst of an acute psychotic episode. All schizotypal patients were diagnosed as having a DSM-III diagnosis of schizotypal schizophrenia and an RDC diagnosis of schizotypal features. The schizotypal patients were usually suffering from acute psychosocial disruption in the context of a longstanding personality disorder. The depressed patients all met the RDC criteria for probable or definite minor depressive disorder or major depressive disorder. In general, the depressive subjects were in the midst of a nonpsychotic depressive episode of mild to moderate intensity. The schizophrenics were rated on the prognosis scales of Robins and Guze (1970), Taylor and Abrams (1975), and Strauss and Carpenter (1973). They were generally a poor prognosis group partly because the DSM-III minimum of 6 months' duration of illness weighted selection in the poor prognosis direction. All patients were also rated on the Global Assessment Scale (Endicott et al. 1976), which measures overall severity of psychiatric illness (see Table 1 for scale ranges). It is a general scale which describes behavior, symptoms, and social interactions at numerous intervals. These intervals have descriptions that are specific to each level and do not rely on the interpretation of the observer. The scale was filled out by an experienced Master's level research assistant.

Apparatus and Stimuli. Stimuli were presented in a Gerbrands four-field tachistoscope. The viewing distance was 78.7 cm. A small, dim, back-lighted fixation dot was placed in one viewing field so as to appear in the middle of the subject's visual field. The fixation dot was uniformly presented between trials, providing a lighted background before stimulus presentation. Luminance of the fixation field was set at 2.07 cd/m² throughout the experiment. The test stimuli were single letter target displays constructed by mounting black paratype (Futura Bold No. F29–14) upper case A's and T's on white stimulus cards presented in the second viewing field which had a luminance level of 13.60 cd/m². Stimuli were randomly ordered with the restriction that five A's and five T's appeared in each block of 10 trials. Each target letter subtended a visual angle of 0.20 degrees and appeared in the center of the vis-
### Table 1. Age, Intelligence (WAIS Vocabulary scaled score), and level of functioning (Global Assessment Scale, lowest level of functioning and overall functioning)

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Scaled WAIS Vocabulary score</th>
<th>Global Assessment</th>
<th>Scales</th>
</tr>
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<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Paranoid schizophrenic</td>
<td>26.70</td>
<td>6.51</td>
<td>10.70</td>
<td>2.85</td>
</tr>
<tr>
<td>(n = 20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schizotypal</td>
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<td>6.70</td>
<td>12.15</td>
<td>2.46</td>
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<td>(n = 20)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Depressive</td>
<td>32.30</td>
<td>10.24</td>
<td>11.35</td>
<td>2.91</td>
</tr>
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<td>(n = 20)</td>
<td></td>
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</tbody>
</table>

Range: 0–100
100 reflects superior functioning
Range: 1–7
1 reflects free of symptoms

ual field of the tachistoscope. The third viewing field was blank, allowing us to adjust the interval between the target stimulus and mask. The pattern mask that followed the target letter and interstimulus interval was constructed by placing black paratype upper case X's side by side on the fourth viewing field so that the mask was completely superimposed on the target letter. Luminance in masking field was set at 17.18 cd/m². Luminance was measured at the eyepiece of the tachistoscope by a Spectra Spotmeter Model Photometer.

**Procedure.** Before testing, each subject's visual acuity was checked to be at least 20/30 correctable vision with the use of a Snellen Eye Chart. Subjects meeting this criterion were brought into a dimly lit room and seated comfortably in front of the viewing hood of the tachistoscope. Five minutes were allowed for subjects to adapt to the low light level and become familiar with the apparatus. The standard instructions were presented to each subject (Saccuzzo, Hirt, and Spencer 1974). To acquaint each subject with the stimuli, 10 to 15 practice trials were presented with the letters alone flashed for 100 msec. As with all trials during the experiment, letter presentation immediately followed a “ready” signal. After each subject demonstrated an understanding of this forced-choice detection task, the first experimental trial began. All viewing was binocular.

Each subject's critical stimulus duration was the first measure determined. The critical stimulus duration was defined as the minimal stimulus duration necessary for seven consecutive correct identifications of the target letter without the mask. The target stimulus (A or T) was presented for 1 msec, and whenever the subject incorrectly identified the letter the next letter was presented at a duration of 1 msec longer than the duration of the “miss.” Whenever the subject correctly identified the letter, however, the stimulus duration was left unchanged. At each stimulus duration, regardless of whether the subject's response was correct, the target stimulus was changed. The procedure continued until the subject correctly identified seven target letters in succession. This value was then recorded as the subject's critical stimulus duration.

Next, backward masking functions were assessed for three separate target durations. The three durations were the subject's critical stimulus duration and the two fixed stimulus durations of 5 msec and 25 msec. The energy of the pattern mask was high relative to the energy of the stimulus, with equal luminance and a 50 msec duration. Each stimulus duration was paired with four fixed masking intervals between the offset of the target letter and the onset of the mask and a no mask control condition. The
interstimulus intervals were 20, 60, 120, and 300 msec interstimulus intervals, and the no mask (interstimulus interval = infinity) condition. All interstimulus intervals were presented in ascending order. Masking functions were obtained first at each subject's critical stimulus duration and then at the 5 and 25 msec stimulus durations.

The experimental session was divided into two subsessions, each of which lasted approximately 20 minutes. Subjects were given 5- to 10-minute rest breaks between the subsessions and rest as needed throughout testing. Subjects were also provided feedback in order to enhance discriminative learning. Specifically, on each trial after the subject reported a T or A, the experimenter would immediately respond in a low monotone with the correct letter presented.

Results

Table 1 presents the mean age, education, and scaled scores on Vocabulary of the Wechsler Adult Intelligence Scale (WAIS) for the three groups. Single classification analysis of variance indicated no statistically significant age, educational, or WAIS differences among the groups (p > .05). On medication measures, none of the depressives or schizotypals were treated with antipsychotics. The paranoid schizophrenics were receiving antipsychotics, an average of 849 mg chlorpromazine equivalents per day.

Two measures of global assessment were made as reflected in table 1. On global rating of the lowest level of function in the past week, the main effect of analysis of variance (ANOVA) was significant (F = 10.78, df = 2,57, p < .001). On Newman-Keuls paired comparisons, the only significant differences were that the paranoid schizophrenics scored lower than the schizotypal (p < .01) and depressive patients (p < .01). The main effect on the overall global assessment measure of data was also significant (F = 6.55, df = 2,57, p < .001). On Newman-Keuls paired comparisons, the paranoid schizophrenics had more impairment than depressive (p < .01) or schizotypal (p < .05) patients.

Results for the critical stimulus duration were analyzed in a single-factor ANOVA, and no differences were found (F = .87, df = 2,57, p > .05). The three mean critical stimulus durations and standard deviations for the groups were as follows: Schizophrenic patients (X = 9.25, SD = 11.80); schizotypal patients (X = 8.90, SD = 7.73), and depressive patients (X = 7.10, SD = 4.28).

Backward masking data were analyzed in a 3 (Groups) × 3 (Stimulus Duration) × 5 (Interstimulus Intervals) ANOVA with repeated measures on the last two factors. Results showed significant main effects for Diagnostic Group (F = 7.87, df = 2,57, p < .001), Interstimulus Intervals (F = 81.28, df = 4,228, p < .001), and the Diagnosis × Interstimulus Intervals Interaction (F = 4.65, df = 8,228, p < .001). Newman-Keuls pairwise comparisons were based on these values.

Figure 1 and table 2 illustrate group performance over the various interstimulus intervals. Newman-Keuls pairwise tests (Winer 1962) reveal no group differences at the 20 msec and 60 msec interstimulus intervals and in the no mask condition. At the 120 msec interstimulus interval, schizophrenic subjects had significantly fewer correct detections than depressive (p < .01) or schizotypal (p < .05) subjects. At the 300 msec interstimulus inter-
Figure 1. Masking curves of the mean number of correct detections as a function of the masking interstimulus interval

Schizophrenic and schizotypal subjects showed no significant differences ($p > .05$) but both groups performed more poorly than depressives ($p < .01$).

Another way of analyzing the masking data is to examine the incremental number of correct detections within each diagnostic group as the interstimulus interval increases using Newman-Keuls pairwise comparisons. For schizophrenics, there were significant increases between the 120 to 300 msec interstimulus intervals ($p < .01$) and the 300 msec to no mask conditions ($p < .05$).

Impaired schizophrenic and schizotypal (versus depressive) performance at the 300 msec interstimulus interval.

Schizotypals showed similar results with only one significant increase in correct detections between the 300 msec and no mask condition ($p < .01$). In contrast to the two schizophrenia spectrum groups, the depressives showed the much earlier increases in performance typical of results with normals (Briff et al. 1980). On Newman-Keuls paired comparisons, significantly improved performance occurred between the relatively early 60 to 120 msec interstimulus intervals ($p < .01$).

In further analyses, $t$ tests were used to see at which interstimulus intervals the different groups exceeded chance performance. For schizophrenic subjects, this better than chance performance occurred at the 300 msec interstimulus interval ($t = 4.25, p < .001$) and the no mask condition ($t = 7.09, p < .001$). For schizotypal subjects, the number of correct detections exceeded chance at the 120 msec interstimulus interval ($t = 3.18, p < .005$), 300 msec interstimulus interval ($t = 4.14, p < .001$) and the no mask condition ($t = 12.37, p < .001$). Depressive subjects exceeded chance at the 120 msec interstimulus interval ($t = 5.34, p < .001$), the 300 msec interstimulus interval ($t = 16.31, p < .001$), and the no mask condition ($t = 47.82, p < .001$). In the no mask condition, all three groups also had signifi-

<table>
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<th>Group</th>
<th>20 msec</th>
<th></th>
<th>60 msec</th>
<th></th>
<th>120 msec</th>
<th></th>
<th>300 msec</th>
<th></th>
<th>No mask</th>
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<tbody>
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<td></td>
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<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Paranoid schizophrenic</td>
<td>4.25</td>
<td>1.12</td>
<td>5.20</td>
<td>1.79</td>
<td>4.70</td>
<td>2.08</td>
<td>7.00</td>
<td>2.10</td>
<td>8.25</td>
</tr>
<tr>
<td>Schizotypal</td>
<td>5.05</td>
<td>1.39</td>
<td>5.45</td>
<td>1.54</td>
<td>6.35</td>
<td>1.90</td>
<td>7.10</td>
<td>2.27</td>
<td>8.90</td>
</tr>
<tr>
<td>Depressive</td>
<td>4.15</td>
<td>1.81</td>
<td>5.10</td>
<td>1.77</td>
<td>7.40</td>
<td>2.01</td>
<td>9.20</td>
<td>1.15</td>
<td>9.75</td>
</tr>
</tbody>
</table>
cantly less than perfect (10 of 10 correct detections) performance: The t tests were schizophrenic subjects \((t = -3.82, p < .005)\), depressive subjects \((t = -2.52, p < .05)\), and schizotypal subjects \((t = -3.49, p < .005)\).

Discussion

This study measured visual information processing in groups of patients with RDC/DSM–III diagnoses of paranoid schizophrenia, schizotypal personality disorder, and depressive disorder. Compared with the depressives, both the paranoid schizophrenic and schizotypal personality disordered groups had slowness of information processing. Importantly, the schizotypal patients were not receiving antipsychotic medications but still showed slowness of processing. This is the clearest evidence to date that such slowness is independent of medication effects.

On the critical stimulus duration measure, there was no significant difference among groups. Although the paranoid schizophrenic and schizotypal subjects showed somewhat higher critical stimulus durations than depressive subjects, the difference was nonsignificant. This confirms the finding that at least some paranoid schizophrenics have critical stimulus durations in the normal range (Saccuzzo, Hirt, and Spencer 1974; Saccuzzo and Braff 1981). The literature about critical stimulus durations in schizophrenia remains ambiguous. Almost all reports reveal that some schizophrenics have increased critical stimulus durations, but this finding does not always reach statistical significance (Brody, Saccuzzo, and Braff 1980; Saccuzzo and Braff 1981; Braff and Saccuzzo, in press). It seems that the larger critical stimulus durations and great variability of the data may relate to the fact that the more chronic, poor prognosis patients have increased critical stimulus durations while other subgroups do not (Braff and Saccuzzo, in press). Even with a poor prognosis sample, this finding is variable, and unexamined factors (e.g., organic dysfunction, premorbid status) may partly account for the critical stimulus duration findings. This remains an area requiring further research.

The slowness of processing of the two schizophrenic groups is clear from the study. Figure 1 illustrates the backward masking data which are an index of speed of information processing from labile, iconic memory to more permanent registration. At the 20 msec, 60 msec, and no mask interstimulus interval conditions, the three groups displayed nonsignificantly different performance for number of correct detections. This is expected since with brief interstimulus intervals the target stimulus is subject to disruption by the masking stimulus for all subjects. In the no-mask condition, the groups performed equivalently since each individual was identifying an unmasked target stimulus presented at his critical stimulus duration. At the 300 msec interstimulus interval, schizophrenic and schizotypal subjects had significantly fewer correct detections than depressive subjects. The inferior performance of the schizophrenic and schizotypal groups reflects slowness of processing, with the target stimulus remaining abnormally vulnerable to the effects of the mask. In contrast, in depressives at this interval, the target stimulus had quickly and efficiently left vulnerable iconic storage and was not subject to the disrupting effects of the masking stimulus. Another way of analyzing the masking data is to look within each group at where the performance increases significantly. The rationale for this approach is that significant unmasking occurs at brief interstimulus intervals in groups that process information faster from labile to more permanent registration. Using this criterion, we see that the depressives unmask between the 60 and 120 msec interstimulus intervals. The two schizophrenia spectrum groups (versus the depressive group) have increased vulnerability to masking stimuli at longer interstimulus intervals and thus unmask at later intervals.

The most commonly accepted interpretation of these data (Saccuzzo, Hirt, and Spencer 1974; Saccuzzo and Braff 1981; Braff and Saccuzzo, in press) is that with slowness of processing, the normal flow of information is disturbed. Chains of stimuli that normally are serially processed in smooth and rapid order suffer disruption. The slowness of processing means that before one stimulus is fully transferred to higher processes, the next stimulus enters labile storage, causing a disruption of information processing through abnormal integration with or interruption of information processing of the target stimulus (Felsten and Wasserman 1980). This dysfunction theoretically correlates with or results in secondary cognitive disruption which is expressed as abnormal perceptions, disorganized
thinking, and confusion (Braff and Saccuzzo, in press).

Controlling for the effect of antipsychotic medication has been a major problem in assessing information processing in schizophrenia (Braff and Saccuzzo, in press). Although the available evidence indicates that such medication effects are not mainly responsible for slowness of processing, this evidence is largely indirect (Saccuzzo and Braff 1981) or relies on small comparison groups (Brody, Saccuzzo, and Braff 1980). In this study, we selected an unmedicated group of schizophrenic spectrum patients in order to assess their performance on the masking task. The schizotypal patients showed slow processing as did the matched schizophrenic patients. Further, this rough equivalence of performance occurred in the unmedicated schizotypal patients versus the schizophrenic group treated with a mean of 849 mg chlorpromazine equivalents per day. Certainly, if antipsychotic drugs slow information processing, the selection of nonmedicated schizotypal patients would have prejudiced this study against the finding of impaired schizotypal performance. It is also possible that antipsychotic medication may have improved the more impaired schizophrenic performance, bringing them into rough equivalence with the schizotypal subjects. Supporting this interpretation, there is evidence that antipsychotic medications improve speed of processing in normals (Stone et al. 1969). Thus, the present study provides the clearest evidence to date that the observed visual information processing deficit in schizophrenia spectrum patients is not an effect of medication.

It is possible that these results reflect the effects of gross psychopathology rather than a specific schizophrenia spectrum deficit. A comparison of the two schizophrenia spectrum groups is useful in answering this question. On one of the two global assessment measures, the schizotypals were less impaired. This should weigh the possible impairing effects of gross psychopathology in the direction of finding poorer performance in the paranoid schizophrenic group. But the schizotypal subjects did about as poorly as the schizophrenic subjects. Still, these data do not rule out gross psychopathology as largely causing the observed slowness of processing. In related studies with similar populations, we have found this typical schizophrenic performance in remitted schizophrenics (Miller, Saccuzzo, and Braff 1979) and have found normal performance in a very disturbed manic control group (Saccuzzo and Braff 1981). Further, Steronko and Woods (1978) found impaired masking performance in asymptomatic schizotypal student volunteers. Thus, the available evidence from this and related studies indicates that the slowness of processing is a finding specific to the schizophrenia spectrum and not primarily a reflection of gross psychopathology.

Several caveats remain about how we examine and interpret these masking data. First, results such as these are widely interpreted in terms of slowness of transfer from iconic to short-term memory. Yet, some authors believe it is unparsimonious to hypothesize separate processing stores or registers (Eriksen and Shulz 1978). Further, it is possible that masking effects are mostly peripheral (integrative) at brief interstimulus intervals and more central (interruptive) at longer interstimulus intervals. So, these results may reflect two different processes (Felsten and Wasserman 1980). Still, the mask by definition must act on a labile store of information. The last stage of processing which is vulnerable to interruption by the mask is usually defined as the transfer of information from labile storage to short-term memory (Kahneman 1968). It is still unclear if the mask acts on a late stage of iconic memory or on the transfer processes.

Second, it is also possible, though unlikely, that the results are due to fatigue or sequence effects. Yet the two schizophrenia spectrum groups were roughly equivalent to each other and the depressives in the no mask condition, which argues against gross fatigue effects. Since all patients did better than chance but less than perfectly in the no mask condition, this question deserves further study. Sequence effects are unlikely since previous published and unpublished work with random versus ascending trial blocks has yielded similar results for the two methods of presentation (Saccuzzo, Hirt, and Spencer 1974; Brody, Saccuzzo, and Braff 1980). As with fatigue effects, sequence effects also should be examined more closely in future research.

Lastly, the current results bear an interesting relationship to a number of other studies of iconic memory in schizophrenia. Spaulding et al. (1980) divide icon-
cic memory into three stages: (1) icon formation or input factors which act over the first 5 msec or so of stimulus input; (2) icon integration; and (3) icon decay. The critical stimulus duration measure corresponds best to input factors, although it is important to note that a later deficit may account for a critical stimulus duration dysfunction. Both Spaulding et al. (1980) and Knight et al. (1978) have found schizophrenics to be normal on a pattern or picture integration task. In this paradigm, two stimuli of long duration (25 to 100 msec) are constructed to be complementary halves of a recognizable pattern. With less than a 100 msec interstimulus interval the halves are fused, and the pattern is recognized. When the interstimulus interval is over 100 msec, there is no effective pattern or picture integration in both schizophrenics and controls. At first, this finding seems incompatible with our results, but it is quite possible that icon integration is normal in schizophrenics while there are deficits in icon input or transfer to short-term memory (Braff and Saccuzzo, in press). In order to clarify more precisely where the deficit lies, future research should helpfully reviewed this manuscript, and June Sprock, M.S., who helped with testing and with data analysis. Leigh Silzerton, Arthur Pearlman, Delanna Brody, and Bob Hails also helped with data collection.

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Kety, S.S.; Rosenthal, D.; Wender, P.H.; and Schulsinger, F. The types and prevalence of mental ill-


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