Information Dysregulation and Event-Related Potentials in Schizophrenia

by Shin-Ichi Niwa, Ken-Ichi Hiramatsu, Osamu Saitoh, Masato Fukuda, Tomomichi Kameyama, Kenji Itoh, and Seiki Hayashida

Abstract

Clinical experiences indicate that schizophrenic cognitive disturbances may be partly due to the unsuccessful construction of their cognitive context. In this article, two experiments are introduced in which schizophrenic deficits in utilization of information for construction of effective cognitive context were examined through measurements of event-related potentials, particularly P300s. In a 3-tone discrimination task, schizophrenic subjects failed to elicit P300s to frequent nontarget tones that were as important as standard tones for performing the required task. In the second task, consisting of detecting two consecutive identical tones, unlike healthy controls, schizophrenic subjects failed to display P300s to nontarget tones at target position. These results are discussed in relation to ineffective context construction of schizophrenic subjects. Moreover, a single-trial analysis of relationships between P300s and reaction times in the 3-tone discrimination task disclosed a loose coupling between the stimulus set and response set in patients.

Schizophrenic patients have long been noted to demonstrate various psychological deficits (Hunt and Cofer 1944). Among these are disturbances in attentional functioning, which have caught the attention of many investigators (Oades 1982; Cutting 1985). Here, attentional functioning refers not only to the selection of relevant stimuli, but also to the evaluation of stimuli and the selection of appropriate responses; hence cognition and behavior are both involved. Clinical experiences indicate that schizophrenic subjects' deficits in cognition are more easily observed, particularly when they are required to construct frameworks of the cognition and behavior by themselves using various pieces of information given simultaneously or successively. Such experiences suggest that patients suffer from a dysregulation of information.

Information included in the daily interactions of humans is indeed ambiguous. In human cognition, how are these ambiguities processed? To the authors, it seems possible that these ambiguities are overcome by means of constructing cognitive contexts that allow the reduction of ambiguity. In constructing such contexts, even irrelevant or redundant information helps subjects. However, Bellissimo and Steffy (1972) noted, for example, that schizophrenic subjects display deficits in redundant information utilization that seem to prevent them from constructing effective cognitive contexts. This in turn produces cognitive and behavioral dysfunction. Here we introduce the results of two experiments that demonstrate that this aspect of information dysregulation in schizophrenic subjects is revealed as disturbances of the underlying neuronal electrophysiological processes, specifically the processes involved in event-related potentials (ERPs).

A Proposed Model of a Basic Mechanism for Cognition and Behavior

Utena, as cited in Niwa (1984), postulated a model for processing stimuli and eliciting responses in the human brain, shown in figure 1. It...
Figure 1. A proposed model of human cognition and behavior

consists of four sets: the stimulus set, response set, operation set, and imagination set. In this model, the stimulus set involves comparison of the stimulus with memory traces, and evaluation and judgment of the stimulus. The response set involves testing and choosing the appropriate alternatives from a variety of reactions and organizing the output. The stimulus and response sets are not serial but parallel processes. The operation set organizes and modifies the functioning of the stimulus and response sets according to the cognitive context. The imagination set loosely overlaps the operation set, with the imagination set defined here in psychological terms that correspond roughly to "the mind." The operation set monitors both the stimulus and response sets, working actively with perspective toward organizing and maintaining proper cognition and behavior depending on environmental situations. At the same time, the operation set continuously edits and updates itself through the feedback systems of the stimulus and response sets. Information in real-life settings affects the operation set through the imagination set. Delegation of cognitive and behavioral deficits within the framework of such a model may help in understanding schizophrenia and developing therapeutic intervention, which is the main object of this study.

ERPs

Measurements of ERPs have been used in studies on attentional and cognitive functioning. For example, the N100 component in normal subjects is enhanced to all stimuli in the attended channel, while the P300 component is enhanced only to the target stimuli in that attended channel (Hink et al. 1978). The P300 component has attracted particular interest because it is related to important psychological aspects of cognition such as stimulus evaluation, judgment, and context updating. When stimuli are being evaluated, a certain amount of time is required to structure and integrate the information, compare it with the model (which embodies the organism's expectations based on past experience), and judge whether the match is a good one or a bad one (Donchin 1981). Donchin related P300 to the context updating function discussed by Pribram and McGuiness (1975).

Pritchard (1986) noted that the P300 is diminished in schizophrenic patients. Other relevant studies include Roth et al. (1980), Baribeau-Brown et al. (1983), Pfefferbaum et al. (1984), Duncan-Johnson et al. (1984), Saitoh et al. (1984), and Kamelyama et al. (1984). In this study we measured P300s to test our hypothesis that schizophrenic subjects have deficits in irrelevant or redundant information utilization that seem to prevent them from constructing effective cognitive contexts. Specifically, schizophrenic subjects were expected to display different patterns than controls in P300s elicited by stimuli other than targets of required tasks.

Experiment 1

Hiramatsu and colleagues (Hiramatsu et al. 1986; Akimoto et al. 1987a, 1987b) conducted experiment 1 to investigate aberrant information processing in schizophrenic subjects during a 3-tone paradigm.

Subjects. Male schizophrenic outpatients (n = 9) and healthy male volunteers (n = 9) were group-matched for age and educational background. Schizophrenic subjects were a mean age of 28.2 years and control subjects, 28.6 years. All schizophrenic subjects met the diagnostic criteria for schizophrenic disorders in DSM-III (American Psychiatric Association 1980) (residual = 6, paranoid = 2, disorganized = 1). Total Brief Psychiatric Rating Scale scores (BPRS; Overall and Gorham 1962) of these patients ranged from 22 to 38 (mean = 30.1), thus indicating these
schizophrenic subjects had relatively mild symptomatology. Eight patients had been treated with low doses of neuroleptics; the ninth patient was not being treated with neuroleptics at the time of the investigation.

Procedure. A 3-tone paradigm was used, consisting of a series of 300-tone bursts of 150-msec duration, delivered at 2-second regular intervals. The series included tones at 970 hertz (Hz), 1,000 Hz, and 1,030 Hz in random sequence. The 1,000 Hz tone occurred with a probability of 0.66 (frequent), and each of the 970 Hz and 1,030 Hz tones occurred with a probability of 0.17 (infrequent). Before starting the experiments, it was verified that schizophrenic subjects could readily discriminate the three kinds of tones. Tones were delivered at 50 decibel sound pressure level (dBSPPL) binaurally through headphones. In the first run, subjects passively listened to the series of tones ("no task" condition). In the following two runs, subjects were required to press a lever upon detection of one of the two types of infrequent tones as the target in one run as accurately and quickly as possible ("task" condition). Data for the two lever-pressing runs were pooled and analyzed.

Electroencephalograms (EEGs) derived from the Fz, Cz, and Pz regions with Ag/AgCl electrodes referred to linked earlobe electrodes (time constant = 0.3 sec, without high cutoff filter) were recorded on FM tape. Because electro-oculograms (EOGs) were not recorded, trials on which the EEG exceeded 100 µV at any electrode site were rejected. EEG data were then digitized off-line with a sampling frequency of 500 Hz, from 128 msec preceding stimulus onset to 896 msec poststimulus. Data for each type of stimulus from each electrode in each run were averaged separately. Data with incorrect responses were rejected in averaging. The P300 component was defined as peak amplitude relative to the baseline and was measured within the latency window of 250–600 msec. The baseline was determined as the mean voltage over the 128 msec period before stimulus onset.

In experiment 1, we also obtained single-trial ERPs for the targets using the adaptive correlating filter (ACF) technique with the main purpose of assessing single-trial P300 latencies. Details of ACF employed in this study have been described elsewhere (Yamazaki et al. 1984). Using a template of P300 derived from a conventional stimulus synchronized average (SSA) ERP, the single-trial P300s were assessed through calculation of correlation coefficients between the two waveforms. Trials in which the maximum correlation coefficients with the template exceeded 0.8 were included in the analyses that followed the test and were referred to as well-estimated trials. As opposed to SSA, single-trial EEG data reaveraged by aligning each trial at its P300 latency are called latency synchronized average (LSA) ERPs. Single-trial analyses were expected to reveal mechanisms involved in response characteristics of schizophrenic subjects, such as slowness, that reflect further aspects of aberrant information processing within schizophrenic individuals.

Results of Experiment 1. The behavioral data for both groups show that the omission error rates in schizophrenic subjects (12.9 ± 10.3 percent) tended to be greater than those of normals (7.4 ± 7.7 percent) (t = 1.95, p = 0.06). By contrast, the commission error rates in schizophrenic subjects (0.7 ± 1.4 percent) were smaller than those of normals (1.2 ± 3.5 percent), but this difference did not reach statistical significance. The total error rates were nearly equal in both groups (schizophrenic patients = 2.7 ± 2.3 percent; controls = 2.8 ± 3.3 percent). Figure 2 shows grand averaged SSA waveforms across subjects for both groups. Amplitudes of the waveforms are generally smaller in schizophrenic subjects as compared to the normal controls. In the no-task condition, waveforms for both groups were approximately the same, with the late positive components (250–600 msec poststimulus) to infrequent tones being slightly greater than those for frequent tones in both groups. In the target detection condition, both groups displayed clearly identifiable P300 components with amplitudes greater at the Pz region than the Cz, and least in the Fz region. The amplitude was slightly smaller in the schizophrenic patient group than in the normal controls. Frequent nontarget tones, however, produced quite different waveforms. In the normal control group, frequent nontarget tones produced a clear, positive peak in the following order: Cz > Fz > Pz. On the other hand, in the schizophrenic patient group, frequent nontarget tones elicited unclear late positive components similar to the infrequent nontarget tones in the following order: Cz > Pz > Fz.

Positive peaks elicited by frequent nontarget tones. The SSA waveforms for both groups to frequent nontarget tones recorded at Cz are shown in figure 3. As seen in figure 3, the healthy controls produced clear positive peaks, the latencies of which varied within a rather narrow range. The mean amplitude and the mean latencies of this positive peak in the normal controls were 10.4 ±
Figure 2. Grand averaged stimulus synchronized average waveforms across subjects for healthy control and schizophrenic subject groups

<table>
<thead>
<tr>
<th></th>
<th>Healthy Controls</th>
<th>Schizophrenics</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Task</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
<tr>
<td>Task</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
<tr>
<td>Frequent Non-Target</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
<tr>
<td>Infrequent Target</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
<tr>
<td>Infrequent</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
</tbody>
</table>

The triangles indicate stimulus onset.

4.5 μV and 348 ± 27 msec. On the other hand, the schizophrenic subjects failed to produce such positive peaks. Thus, statistical comparison between the two groups was impossible for this component.

**P300s elicited by target tones.** The mean amplitudes and mean latencies of P300s at Pz to the infrequent target tones for both groups were 12.4 ± 4.5 μV for normal controls and 9.3 ± 4.1 μV for schizophrenic subjects. Latencies were 398 ± 50 msec for normal controls and 415 ± 76 msec for schizophrenic subjects. The P300 amplitude for the schizophrenic group was smaller than that for the normal control group (t = 2.12, p < 0.05). However, there was no significant difference in the P300 latency between the two groups.

**P300s assessed by the ACF technique.** The LSA waveforms to targets derived from Pz for the correctly performed trials in both groups were similar to each other. The amplitudes of the LSA waveforms in schizophrenic subjects (15.1 ± 3.3 μV) were smaller than those of controls (16.5 ± 4.4 μV), although this difference did not reach statistical significance (t = 1.13).

Single-trial analysis of the relationship between P300 latencies and reaction times (RTs). The P300 latencies as well as RTs for well-estimated single trials were obtained through the ACF technique in each subject for each run. The medians of P300 latencies in schizophrenic subjects (423 ± 34 msec) were not significantly different from those of control subjects (401 ± 46 msec) (t = 1.67). The RTs for schizophrenic subjects (602 ± 147 msec) were larger than those of control subjects (502 ± 109 msec) (t = 3.00, p < 0.05). Figure 4 shows the correlation coefficients between P300 latencies and RTs for all correct well-estimated trials of each subject in both groups. The mean correlation coefficients for each group are also shown in figure 4. Both groups showed low but significant positive correlations (r = 0.32 in the healthy controls; r = 0.19 in the schizophrenic patients). The correlation coefficient in the control subjects was greater than that of the schizophrenic patients (r = 2.17, p < 0.05 [two-tailed]).

**Discussion.** Our paradigm (1) indicated difficulties in discriminating 30 Hz difference between tones, (2) utilized the frequent tone as a middle tone in between the two infrequent tones, and (3) ensured that the probability of the infrequent tone was not extremely low. As has been noted in Hiramatsu and colleagues (1987), these characteristics seemed to compel the subjects to maintain or update the representation of the frequent 1,000 Hz tone in their working memories as a necessary template to judge the infrequent tones as higher or lower than the standard. Such speculation was supported by the subjects' reports that they always remembered and confirmed the middle tone and that they judged the...
Figure 3. The stimulus synchronized average waveforms for healthy control and schizophrenic subject groups to frequent nontarget tones recorded at Cz

[Waveform images for healthy controls and schizophrenics]

Waveforms for each individual are superimposed.

The appearance of the P300 for frequent tones could be indicative of an effective use of frequent stimuli for the construction of an appropriate task-performing strategy.

The a priori probabilities of the infrequent targets and infrequent nontargets were equal in the task employed here. The probability effect due to low frequency is reflected in P300s by infrequent nontargets, and the task relevancy effect is reflected in P300s by infrequent targets. Thus, the schizophrenic subjects failed to use the clues conveyed by frequent tones as a standard, and instead simply ignored them. Therefore, it was speculated that the schizophrenic subjects employed a strategy different from that of the normal controls.

While the P300 latencies for correct well-estimated trials were not delayed in schizophrenic subjects, the RTs were longer than those of normal subjects. Furthermore, single-trial P300/RT correlation coefficients were lower in schizophrenic subjects. Kutas and colleagues (1977) measured single-trial P300 latency in normal subjects employing the ACF technique and reported that the P300 latency provides an estimate of stimulus-evaluation time independent of response-processing time. This suggests that the stimulus-processing time represented by P300 latency is not delayed in the schizophrenic patients in the present study.

Lack of prolonged P300 latency in schizophrenic patients is inconsistent with the result of Pfefferbaum and colleagues (1984), but this difference may be mainly due to sample bias. Schizophrenic patients in the present study were outpatients with mild symptomatology, while Pfefferbaum and coworkers' schizophrenic patients were inpatients with impaired performance on the Mini Mental State Exam (Folstein et al. 1975).

In spite of no prolonged P300 latency, schizophrenic patients displayed slow RTs and low correlations between P300 latencies and RTs. This suggests that slow RTs for the schizophrenic subjects in the present study are due not to a delay in the stimulus-evaluation process, but to a delay in the response organization process. It also suggests that the stimulus and response processes are more loosely coupled in schizophrenic patients than in control subjects.

What is an appropriate explanation for the delay in the responses as well as the decoupling between the stimulus and response process in schizophrenic subjects? Regarding normal subjects, Pfefferbaum and colleagues (1984) have suggested that, in difficult and unfamiliar sensory discrimination tasks, subjects may be less confident and have some doubts remaining after the full evaluation of a stimulus. This may lead to hesitation before pressing a button, thereby decoupling P300 latencies.
Figure 4. The correlation coefficients between P300 latencies and reaction times (RTs) for all adaptive correlating filter well-estimated correct trials of each subject in healthy control and schizophrenic subject groups.

The mean correlation coefficients for each group are also shown.

0.6
0.5
0.4
0.3
0.2
0.1
0

O : NORMAL CONTROLS (9 subjects)
● : SCHIZOPHRENICS (9 subjects)
○ : NORMAL CONTROLS (725 trials)
□ : SCHIZOPHRENICS (602 trials)
*: p<0.05 (two-tailed)

from RTs. Thus, the schizophrenic subjects in the present study would have hesitated more than the normal control subjects. This hesitation seems consistent with the tendency for schizophrenic subjects to make more omission errors. However, our result of P300s for omission-error trials (nonresponse trials to targets) does not necessarily support this speculation. Although we have not reported the details here, the healthy controls and schizophrenic subjects failed to demonstrate clear P300 peaks in nonresponse trials to targets; waveforms were similar to those for infrequent nontarget tones (see figure 2). This indicates that no response to targets is due to a failure in evaluating stimuli rather than to a failure in selecting and executing response behaviors. This speculation is based on the assumption that if stimulus evaluation were correct and response organization were erroneous, then P300s would be elicited even on nonresponse trials. This addresses the question about whether the increase in omission errors in schizophrenic patients on selective response tasks is due to a disorder in stimulus evaluation or response organization. The "hesitation after full evaluation" hypothesis seems implausible. As far as normal psychological processes are concerned, "hesitation" fits the explanation of the decoupling; however, in schizophrenic subjects some deficits in allocation of processing resources should be taken into account. The organizing system controlling the stimulus and response processes and their relationship may be disturbed to a greater extent in schizophrenic subjects, thus leading to a decoupling between the two processes as stimulus discrimination becomes more difficult. This decoupling seems to be responsible for slow RTs in schizophrenic patients. Barbeau-Brown and colleagues (1983) have also discussed the idea that the slowness and inefficiency of schizophrenic information processing could result from an inability to organize the processes of stimulus set and response set as defined by Broadbent (1971) in an optimal manner.

To get further insight into dysfunctional information processing in schizophrenic subjects, particularly in constructing cognitive context, we conducted another experiment measuring ERPs. Our hypothesis was that schizophrenic subjects differ from normal subjects in processing stimuli that are physically identical to targets but bear less significant meaning in performing required tasks. Healthy subjects are expected to use even less significant information in efficient context construction. We predicted that this difference would be reflected in ERPs.

Experiment 2

In experiment 2 (Saitoh et al. 1989), a series of two tone bursts (A and B) with equal a priori probabilities, B A B A B A ..., were presented as stimuli (figure 5). This paradigm was originally devised by Saitoh et al. (1987) to investigate contextual effects on P300s in normal subjects. Subjects were required to respond upon detection of two con-
Figure 5. A schematic representation of a tonal series employed in this experiment

```
“AB”  “BB”

B A B A

• • •

“BA”  “A A”

B B A

• • •
```

Tonal stimuli can be categorized into four groups, abbreviated as follows: $A_A$ = target A tone; $B_A$ = nontarget A tone; $A_B$ = nontarget B tone following $B_A$ tone; $B_B$ = nontarget B tone following $A_A$ tone. Consecutive A tones in a tonal series. Thus, physically identical A tones, that is ••• A A ••• and ••• B A •••, might produce different interpretations according to the anticipatory context established by the preceding tones. We devised this paradigm to look more closely at possible deficits in schizophrenic subjects in constructing cognitive context differentially to ••• A A ••• and other stimuli, as reflected in P300s.

Subjects. Seventeen DSM-III schizophrenic outpatients with mild symptomatology, 9 male and 8 female (mean age = 33.4 years), and 17 healthy controls, 16 male and 1 female (mean age = 26.2 years) were tested. All schizophrenic subjects except one were receiving psychotropic medication during experiment 2.

Procedures. Two tones (1 kHz and 2 kHz bursts) with durations of 200 msec were presented binaurally through headphones at 60 dBSPL, with interstimulus intervals varying randomly between 1,500 and 1,700 msec. The assignment of these two tones as the A or B tone alternated among sessions. A series of tones containing 100 occurrences of each tone were presented pseudo-randomly. A tones after A ($A_A$; see figure 5 legend for detailed explanations of abbreviations) required mental counting (MC) of its total number. EEGs, along with EOGs, were derived from the Fz, Cz, and Pz regions with Ag/AgCl electrodes monopolarly referred to linked earlobe electrodes through a band-pass filter of 0.15–300 Hz. EEG data were analyzed on-line through a minicomputer with a sampling frequency of 250 Hz/Ch from 128 msec preceding stimulus onset to 896 msec poststimulus. Trials in which EEG amplitudes exceeded 100 $\mu$V or were accompanied by EOGs of more than 150 $\mu$V during the period of 40 msec pre-stimulus to 600 msec poststimulus were automatically excluded from the averaging to avoid eye-movement artifacts.

Results of Experiment 2. In the MC task, the healthy control subjects produced large P300s for $A_A$ and $A_B$ (see figure 6). To be more precise, the P300 amplitudes for $A_A$ were significantly larger than for $B_A$, while those for $A_B$ were significantly larger than for $B_B$. In the schizophrenic subjects, $A_A$ produced relatively large P300s; however, $A_B$ elicited much less clear peaks of P300s. $B_A$ and $B_B$ did not produce P300s at all similar to those of the normal subjects.

Analysis of variance (ANOVA) of the results for P300 amplitudes, employing subject’s gender, diagnosis, stimulus category ($A_A$ or $A_B$), and electrode location as independent variables with subject’s age as covariate, revealed that the main effect of diagnosis ($F[1,178] = 10.891, p < 0.01$) and the interaction between stimulus category and electrode location ($F[2,178] = 4.138, p < 0.05$) were significant. The mean amplitudes of P300s at Cz are 9.7 $\mu$V to $A_A$ and 12.3 $\mu$V to $A_B$ in the healthy controls, and 9.0 $\mu$V to $A_A$ and 8.5 $\mu$V to $A_B$ in the schizophrenic subjects. These values at Pz were 10.1 $\mu$V to $A_A$ and 10.3 $\mu$V to $A_B$ in the controls, and 9.6 $\mu$V to $A_A$ and 7.6 $\mu$V to $A_B$ in the patients. Hence, P300s as a whole are larger in the controls than the patients. Also P300s for $A_A$ are larger at Pz, while those for $A_B$ are larger at Cz. The results indicate the difference in P300s between the two groups to $A_B$ is greater than that to $A_A$. Similar ANOVA of P300 amplitudes, when done separately for $A_A$ and $A_B$, revealed that the main effect of diagnosis was significant for $A_B$ ($F[1,88] = 11.11, p < 0.01$), but not for $A_A$.

Discussion. What are the implications of these large P300s in normal subjects, which were elicited by both targets $A_A$ and nontargets $A_B$? $A_A$ and $A_B$ are similar in that both are
Figure 6. Event-related potential waveforms derived from the Fz, Cz, and Pz regions in the mental-counting tasks for the healthy control and schizophrenic groups

Tonal stimuli can be categorized into four groups, abbreviated as follows: AA = target A tone; BA = nontarget A tone; AB = nontarget B tone following BA tone; BB = nontarget B tone following B or AA tone. Triangles indicate stimulus onset.

The task requirement of responding to AA encouraged subjects to develop a frame of reference in which an anticipation of the forthcoming stimulus tended to elicit preparation for a second A tone. This preparation for a possible second A tone (target-location effect) seems to be related to the production of the large P300s. If stimuli were processed with no subjective expectation or cognitive context, then whenever B tones were initially recognized as B and judged as nontargets, we would expect to find no differences between ERPs for BB and AB. The specific elicitation of P300s by AA and AB was an electrophysiological reflection of a working subjective strategy that led to a selective processing, with the initial A serving as an effective indicator in preparation for the detection of designated targets.

Contrary to normal subjects, the schizophrenic subjects failed to produce P300s to AB, but did produce clear P300s to AA. Based on the above speculation, this result indicates that schizophrenic subjects used a different psychological task-performing strategy than the normal subjects, who relied on cognitive context. In schizophrenic patients, the mechanism of eliciting P300s and detection of targets seems to remain less disturbed, while the mechanism of eliciting P300s to nontargets in the target position seems markedly disturbed. This indicates that schizophrenic patients fail to create a major cognitive context that enables anticipation of the forthcoming stimuli. Both experiments 1 and 2 indicated that schizophrenic patients have a greater deficit in creating effective task-performing strategies.
General Discussion

Schizophrenic subjects were found to exhibit the following cognitive and behavioral characteristics in laboratory experimental situations, even though their symptomatology is less severe:

- Schizophrenic subjects screen out and/or fail to use irrelevant information in creating effective strategies; instead they employ less effective strategies.
- They frequently have difficulty in evaluating information accurately and consistently and show frequent fluctuations in their ability to function reliably.
- Schizophrenic subjects display loose functional coupling between the stimulus-evaluation process and the response-organization process.
- They usually display a definite time delay in the response organization process.

We can make inferences about clinical or real-life settings based on this delineation of schizophrenic subjects' cognitive and behavioral characteristics in experimental laboratory situations. First of all, viewed from the framework of cognition and behavior, there is a big difference between real-life and experimental laboratory situations. First of all, viewed from the cognitive context construction in information processing deficits, creating more effective treatments for such neuronal dysfunctions.

The schizophrenic dysfunction of cognitive context construction in information processing, as described above, is thought to correspond to the impairment in neuronal functioning due to the illness itself as defined by Utena (1984). Delineation of the schizophrenic deficit within the framework of the model for cognition and behavior has been the main purpose of this study. Referring to our model (figure 1), such impairment is naturally speculated to originate from the dysfunctioning of the operation set. However, the present study is insufficient in that pathological control subjects were not employed and most of the patients were on medication at the time of investigation. If further such studies of schizophrenia are conducted in a comprehensive and systematic manner to more precisely describe the neuronal impairment level of schizophrenia, results will yield a more precise description of the mechanisms of cognitive dysfunction and information processing deficits, creating more effective treatments for such neuronal dysfunctions.

References


Folstein, M.F.; Folstein, S.E.; and McHugh, P.R. Mini-Mental State: A practical method for grading the cognitive state of patients for the clini-


**Acknowledgments**

The authors are grateful for helpful comments from Drs. Kazuyuki Nakagome, Teikyo University; Akira Iwanami, Matsuzawa Metropolitan Hospital; and Tsukasa Sasaki, Neuropsychiatric Research Institute, Seiwa Hospital, in preparing this article.

**The Authors**

Shin-Ichi Niwa, M.D., Ken-Ichi Hiramatsu, M.D., and Masato Fukuda, M.D., are Lecturers in the Department of Neuropsychiatry, Tokyo University Hospital. Osamu Saitoh, M.D., is Staff Psychiatrist in the National Center Hospital for Mental, Nervous and Muscular Disorders, National Center of Neurology and...
Psychiatry. Tomomichi Kameyama, M.D., is Staff Psychiatrist at the Posts and Telecommunications Tokyo Hospital. Kenji Itoh, Ph.D., is a Lecturer in the Research Institute of Logopedics and Phoniatrics, Faculty of Medicine, University of Tokyo. Seiki Hayashida, B.A., is a postgraduate student in the Research Institute of Medical Engineering, Faculty of Medicine, University of Tokyo, Tokyo, Japan.

Back Issues Available

Several back issues of the *Schizophrenia Bulletin* are still available to requesters:

  (Assorted topics, including prognosis and phenomenology)

- **Schizophrenia Bulletin**, Vol. 15, No. 1, 1989

- **Schizophrenia Bulletin**, Vol. 15, No. 4, 1989
  (Issue theme: U.S. and Soviet Perspectives on the Diagnosis of Schizophrenia and Associated Dangerousness)

  (Issue theme: Gender and Schizophrenia)

  (Issue theme: Frontal Lobes, Basal Ganglia, Temporal Lobes—Three Sites for Schizophrenia)

If any or all of these issues are missing from your collection, let us know, and we will send you a copy free of charge. Requests should be sent to the following address:

**Research Publications and Operations**
National Institute of Mental Health
5600 Fishers Lane, Rm. 10C-16
Rockville, MD 20857