Auditory Laterality and Selective Attention: Normal Performance in Patients With Early-Onset Schizophrenia

by Merete Øie, Bjørn Rishovd Rund, Kjetil Sundet, and Grete Bryhn

Abstract

In this study, auditory laterality and selective attention were examined in patients with early-onset schizophrenia using a dichotic listening (DL) test. Deficient performance on this test has repeatedly been found in adult patients with chronic schizophrenia, indicating abnormalities in left hemisphere function. The hypothesis in the present study was that subjects with early-onset schizophrenia manifest deficits in DL test performance similar to adult chronic patients. A group of 19 patients with early-onset schizophrenia were compared with a group of 20 adolescents with attention-deficit hyperactivity disorder and a group of 30 normal adolescents. Results indicated no significant differences between the three groups on any of the measures. Alternative hypotheses are put forth to explain the findings, among them that deficits in DL performance may be secondary to long-time illness and/or drug treatment, and that these deficits may become apparent only after interaction with maturational neurodevelopmental changes during adolescence.

Key words: Auditory laterality, selective attention, early-onset, dichotic listening.


In the DL technique, two different auditory stimuli are presented simultaneously, one to each ear. The typical finding with consonant-vowel (CV) stimuli is a right-ear advantage (REA), believed to result from left hemisphere lateralization of phonetic function, caused by greater efficiency of the contralateral auditory pathways in the simultaneous stimulus presentation (Kimura 1961, 1967; McKeever et al. 1984). REA is reliably found regardless of gender or age (after age 5) (Kimura 1967; Bradshaw and Nettleton 1988; Hugdahl 1991).

A number of different DL tests have been used in the study of patients with schizophrenia. The tests differ in acoustic content, memory load, and response format in order to tap different aspects of information processing and laterality (Berlin and McNeil 1976). Patients with schizophrenia often show an abnormally large REA (Lerner et al. 1977; Lishman et al. 1978; Walker and McGuire 1982; Kiyota 1987). The REA for verbal stimuli is greater for paranoid than for nonparanoid patients with schizophrenia (Lerner et al. 1977; Gruzelier and Hammond 1980). However, Colbourn and Lishman (1979) tested patients with schizophrenia using synthesized CV syllables and did not find a REA, a result that also has been replicated in other studies (Kiyota 1987; Wexler et al. 1991; Bruder et al. 1995).

Wexler and Heninger (1979) tested patients with schizophrenia on a consonant–vowel–consonant (CVC) syllable test. The main finding was an increase in the REA when the patients recovered from their psychotic episode. Wexler and Heninger’s findings were replicated by Wexler (1986) and Bruder et al. (1995), demonstrating that the DL test is sensitive to clinical state. Green et al. (1994a), using a CV version of the DL test, demonstrated that auditory hallucinations were associated with abnormalities of left hemisphere functioning. These abnormali-
ties may not be limited to the time of the auditory hallucinations.

It is possible to override the REA by shifting attention to the opposite ear (Hugdahl and Andersson 1986; Andersson and Hugdahl 1987). Hugdahl and Andersson (1986) showed that directed attention to either the right or left ear during dichotic stimulus presentations had a significant effect on ear advantage. The typical REA was increased when subjects were instructed to attend to and report from the right ear. This was called forced-right attention. In contrast, when subjects were instructed to attend to and report from the left ear, some subjects showed a left-ear advantage, while others substantially reduced the REA. This was called forced-left attention. Thus, DL test performance reflects two levels of processes: structural factors (auditory laterality) and dynamic (attentional) factors. The ability to override the REA attentionally begins in children at the age of 9 (Andersson and Hugdahl 1987). Green et al. (1994a) found that neither hallucinating nor nonhallucinating patients were able to modify their performance when instructed to attend to the left or the right ear. This is consistent with the literature indicating that patients with schizophrenia have deficits in controlled attentional processes (Nuechterlein and Dawson 1984).

In the present study, a neuropsychiatric comparison group was included, in addition to a comparison group of normally functioning adolescents, to control for the effect of motivation, medical settings, and the generalized effect of having a psychiatric diagnosis. Patients with affective disorders and patients with attention-deficit hyperactivity disorder (ADHD) clearly manifest attentional disturbances. Because there are few young subjects with affective disorders, patients with ADHD were included as a comparable neuropsychiatric group.

Some remaining issues are left to be addressed in the research area of DL test performance in patients with schizophrenia. Previous studies have primarily involved adult, chronically institutionalized patients with long histories of medical treatment (see Bruder 1983, 1988). Thus, it is unclear to what extent deficits are present in young patients with early-onset schizophrenia using this technique. Neuropsychological studies of children who exhibit symptoms of schizophrenia have demonstrated deficits similar to those of adult patients in executive function, verbal function, verbal and nonverbal memory, visual attention, and auditory processing (Sherman and Asarnow 1985; Schneider and Asarnow 1987; Asarnow, R.F. et al. 1994; Hendren et al. 1995). Studies comparing neuropsychological performance of patients with first-episode schizophrenia with those with chronic schizophrenia have reported similarities in the impairment of executive functions, verbal memory and learning, spatial memory, attention-vigilance, speeded visual-motor processing and attention, and left and right hemisphere function scales (Hoff et al. 1992; Saykin et al. 1994). Following this line of reasoning, it was predicted that subjects with early-onset schizophrenia would show reduced REA and abnormalities in the modulation of attention comparable to those found in adult chronic patients, indicating abnormalities in left hemisphere function.

**Methods**

**Subjects.** Three groups of subjects were included in the study: a group of adolescents with early-onset schizophrenia, a comparison group of adolescents with ADHD, and a comparison group of normally functioning adolescents. Demographic data for all three groups are reported in table 1.

The schizophrenia group consisted of 19 patients who met the criteria from the *DSM-III-R* (American Psychiatric Association 1987) for a schizophrenia disorder. Eleven patients were recruited from the National Centre for Child and Adolescent Psychiatry in Oslo, Norway, and eight patients were recruited from other hospitals in the region. Fifteen were inpatients; four were outpatients who had never been inpatients.

The diagnoses were based on clinical interviews by senior clinicians and on the patients’ case records. Clinical ratings were performed by clinicians without knowledge of the results on the DL test. Specific diagnoses according to *DSM-III-R* were as follows: schizophrenia disorganized \((n = 11)\), schizophrenia paranoid \((n = 4)\), schizophrenia undifferentiated \((n = 1)\), schizophreniform disorder \((n = 1)\), schizoaffective disorder \((n = 1)\), and delusional disorder \((n = 1)\). A subsample of 13 patients with schizophrenia was diagnosed by two senior psychologists. They agreed on the schizophrenia diagnosis in 12 (92%) of the cases.

Eleven patients in the schizophrenia group were assessed on the Expanded Brief Psychiatric Rating Scale (BPRS; Lukoff et al. 1986) within 1 week of testing. The BPRS covers a 2-week period and intends to indicate general severity of psychotic symptoms. It consists of 24 items that rate severity of psychiatric symptoms on a scale from 1 (not present) to 7 (extremely severe). Ratings of 2–3 indicate nonpathological symptom intensity, while ratings of 4–7 indicate pathological intensity. The inter-rater reliability on the BPRS total score was 0.99 (intraclass correlation ICC = 1.2).

A “positive symptoms” score based on the factor analysis conducted by Ventura and colleagues (1995) was extracted from the BPRS. This score consists of the following seven items: unusual thought content, grandiosity,
hallucinations, conceptual disorganization, bizarre behavior, suspiciousness, and disorientation. Both the total BPRS score and the positive symptoms score indicate that the schizophrenia sample of patients was characterized by clearly psychotic symptomatology. A score of more than 3 on variables in the positive symptom score was present for the following number of these 11 patients: 9 unusual thought content, 3 grandiosity, 7 hallucinations, 3 conceptual disorganization, 4 bizarre behavior, 7 suspiciousness, 2 disorientation. A negative symptoms score based on the same factor analysis consists of the following three items: blunted affect, motor retardation, and emotional withdrawal. The patients were characterized by far more positive symptoms and fewer negative symptoms.

The two patient groups were also assessed using the Global Assessment Scale (GAS; Endicott et al. 1976) and the Child Behavior Checklist (CBCL; Achenbach 1991). The GAS is a rating scale with scores from 1 (severe malfunction) to 100 (excellent function) on a subject's psychological and social functioning during a specified time period. The CBCL is a general questionnaire, filled out by parents, containing 113 problem items and generating eight syndrome scale scores. It is one of the best developed empirically derived rating scales currently available for assessing psychopathology and social competence in children and adolescents (Barkley 1990). The scores on the CBCL showed that the level of psychopathology in the patient groups was significantly above that of the normal comparison group ($F = 45.8$, degrees of freedom $[df] = 2.62$, $p < 0.001$). The group of patients with schizophrenia scored significantly lower on the GAS than the group of patients with ADHD ($F = 8.1$, $df = 1.36$, $p < 0.007$).

Eleven of the patients with schizophrenia had not yet started neuroleptic treatment at the time of testing, while three were drug-free during and for at least 5 days before testing and five were receiving standard neuroleptic medication (perphenazine, 3; thioridazine, 1; zuclopenthixol, 1).

Handedness was assessed by a Norwegian translation of the handedness questionnaire developed by Raczkowski et al. (1974). The questionnaire contained 15 questions related to preferred hand for manual performance. For the subject to be regarded as right-handed, 12 of 15 items had to be consistently performed with the right hand. One patient used his left hand because of an accident involving his right hand 6 months before testing; however, he was treated here as right-handed. There was no significant difference in handedness between the groups in the present study.

The ADHD group consisted of 20 patients who met the criteria from the DSM-III-R for ADHD. They were significantly ($p < 0.05$) younger than the other two groups and were all males. The skewed sex distribution here as compared with the other groups reflects the fact that ADHD is more common among boys than girls. The
ADHD group was recruited from the National Centre for Child and Adolescent Psychiatry, Oslo, Norway. All were outpatients.

The diagnoses of the patients with ADHD were based on information obtained from semistructured interviews with the patients' parents. The adolescents fulfilled at least eight of the DSM-III-R criteria for the condition. Attention problems were marked both at home and at school. In addition, all had significant hyperactivity, impulsivity, and inattention between age 6 and 10 as assessed by the Parent's Rating Scale (Wender et al. 1985). None of the patients had a history of psychosis.

Twelve of the subjects with ADHD received stimulant medication (11 used methylphenidate and 1 used dextroamphetamine). The medication was discontinued for at least 24 hours before testing. One patient with ADHD also received a small dose of haloperidol (1 mg per day) because of tics. Eight of the subjects did not receive medication.

A comparison group of 30 normal adolescent volunteers was included. The subjects attended regular school classes at normal grade level, and they received a small compensation to cover their traveling costs. They were screened for mental problems using the CBCL.

There are not yet established norms for these standardized questionnaires in the Scandinavian countries, but according to American norms corrected for sex and age, the 90th percentile is used as a cutoff for psychiatric problems. This corresponds to a rating of 45 on the total behavior problem score and was used in the present study. Recent research has shown that the CBCL is an effective screening instrument for mental problems in the Norwegian population (T.S. Nøvik, personal communication, May 1996). The data on the CBCL scores show that the level of psychopathology in the two patient groups was significantly above that of the normal comparison group ($F = 45.8, df = 2.62, p < 0.001$).

All subjects in the study were screened for mental retardation. Results on Similarities and Block Design on the Wechsler Intelligence Scale for Children–Revised (Wechsler 1974) for all subjects were within normal limits. Further, subjects were excluded if they reported histories of hearing impairment, head injury with significant loss of consciousness, or neurological disorder including seizures. In addition to interviews, data on the patients were also obtained from medical examination records. Thirteen patients with schizophrenia were screened for structural brain abnormalities with computerized tomography. The results were normal.

Stimuli and Apparatus. The dichotic stimulus materials consisted of six stop-consonants ($b, d, g, p, t$, and $k$) that were paired with the vowel $a$ to form six basic CV syllables: $ba, da, ga, pa, ta, ka$ (Hugdahl and Andersson 1986). The tape was designed so that the CV syllables were simultaneously presented to each ear. The syllables were paired with each other for all possible combinations, yielding 36 dichotic pairs including homonymic pairs such as $ba-ba$. The homonymic pairs were included as a perceptual control to ensure that the subjects did perceive the various stimuli; they were not included in the statistical analysis. Each pair was randomly recorded three times on the tape, resulting in a total of 108 trials. The inter-trial interval between stimulus presentations was about 4 seconds. Each CV syllable had a duration of about 320 milliseconds.

The syllables were played to the subject from a portable cassette player and headphones at a sound intensity level indicated by the subject to be a comfortable listening level. The syllables were read by a male voice, with intonation and intensity held constant. The DL test with CV stimuli has yielded test–retest reliabilities between 0.70 (Bakker et al. 1978) and 0.90 (Harper and Kraft 1986).

Procedure. Consent forms were signed by a parent and the adolescent before the subjects participated in the study. The subjects were tested individually. The DL test was presented as the fourth in a broad neuropsychological test battery consisting of 13 separate tests. The subjects were given standardized instructions regarding direction of attention.

The DL test was administered under three conditions (see Hugdahl and Andersson 1986). During the nonforced (NF) condition, the subjects were informed that they would be presented with a list of CV syllables. Their task was to give a single response after each presentation, either by saying the CV aloud or by pointing to a sheet in front of them that listed all six possible responses in a vertical list. They were told that if they thought they heard more than one syllable, they were to select the one they heard most clearly. During the forced-right (FR) condition, the subjects were told to pay close attention to the right ear syllables, and to report only what they heard in the right ear. During the forced-left (FL) condition, the subjects were told to pay close attention to the left ear syllables and to report only what they heard in the left ear. The NF condition was given first, followed by the FR condition and finally the FL condition. During the FR and the FL conditions, arrows were placed in front of the subjects to remind them which ear to attend to.

Scoring and Statistical Analyses. Responses were scored as number of correctly reported syllables presented either to the left or right ear during each of the three attentional instructions. Because REA is usually not as strong
in left-handed persons (Hugdahl 1991), the responses were analyzed separately for right-handed and non-right-handed subjects. The group differences in performance were addressed by group (schizophrenia, ADHD comparison, normal comparison), by condition (NF, FR, FL), and by ear (right, left) repeated measures analysis of variance (ANOVA), and by subsequent univariate ANOVAs for each of the three conditions.

In addition to the overall ANOVA, an analysis based on the mean ratio of differences between the right ear (RE) and the left ear (LE)—the laterality index—was performed (Marshall et al. 1975; Asbjørnsen et al. 1990). The laterality index takes into account the overall accuracy of the scores, and differences between ear scores are presented as a percentage of the total number of correct responses. The formula is \((RE - LE)/(RE + LE) \times 100\). The laterality index was analyzed in a repeated measurement ANOVA to investigate changes in the magnitude of ear advantages over conditions.

Differences in RE and LE scores between groups may be confounded by differences in performance level, thus caused by a psychometric artifact and not by a true difference in performance asymmetry (Chapman and Chapman 1988). The standard approach for dealing with such a potential artifact is to use an asymmetry index that takes performance level into account. An asymmetry index is obtained by using different adjustments for performance levels less that 50 percent \((R - L)/(R + L)\), and for those greater than 50 percent \((R - L)/(2 - R - L)\), where \(R\) = right-ear performance and \(L\) = left-ear performance (Bruder et al. 1994). The data were reanalyzed (ANOVA) according to this formula.

The frequency of subjects with either a REA or no REA (irrespective of the magnitude of the ear advantage) was analyzed with the chi-square test. The criterion for REA was set at better recall (defined as an advantage with at least one syllable) from the RE (Hugdahl and Carlsson 1994).

The Levene test for homogeneity of variance did not reveal significant differences between the groups in any of the conditions. The presumptions for performing ANOVAs were thus satisfied.

### Results

The DL test results for the three groups across the three conditions are shown in tables 2 and 3. Both of the patient groups and the normal comparison group demonstrated a normal REA in the NF condition, and they were all able to modulate the ear advantage by shifting attention in response to instructions. Subsequent univariate analyses for each condition showed no significant differences.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Schizophrenia ((n = 15))</th>
<th>ADHD ((n = 13))</th>
<th>Normal ((n = 22))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonforced right ear</td>
<td>12.7 (2.7)</td>
<td>12.7 (3.4)</td>
<td>13.0 (2.6)</td>
</tr>
<tr>
<td>Nonforced left ear</td>
<td>10.1 (2.3)</td>
<td>11.0 (2.6)</td>
<td>10.6 (2.8)</td>
</tr>
<tr>
<td>Forced-right right ear</td>
<td>14.0 (4.4)</td>
<td>17.2 (4.2)</td>
<td>14.5 (3.5)</td>
</tr>
<tr>
<td>Forced-right left ear</td>
<td>9.9 (4.5)</td>
<td>7.0 (2.7)</td>
<td>9.4 (2.5)</td>
</tr>
<tr>
<td>Forced-left right ear</td>
<td>11.0 (3.1)</td>
<td>10.4 (3.0)</td>
<td>10.8 (3.3)</td>
</tr>
<tr>
<td>Forced-left left ear</td>
<td>13.7 (4.1)</td>
<td>14.2 (5.2)</td>
<td>13.6 (3.9)</td>
</tr>
</tbody>
</table>

Note.—Data are mean (standard deviation); ADHD = attention-deficit hyperactivity disorder.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Schizophrenia ((n = 4))</th>
<th>ADHD ((n = 7))</th>
<th>Normal ((n = 8))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonforced right ear</td>
<td>17.0 (3.7)</td>
<td>13.0 (4.1)</td>
<td>13.8 (3.0)</td>
</tr>
<tr>
<td>Nonforced left ear</td>
<td>10.5 (3.4)</td>
<td>10.1 (2.9)</td>
<td>10.6 (2.3)</td>
</tr>
<tr>
<td>Forced-right right ear</td>
<td>18.5 (5.1)</td>
<td>13.3 (5.1)</td>
<td>17.4 (4.7)</td>
</tr>
<tr>
<td>Forced-right left ear</td>
<td>9.2 (6.6)</td>
<td>10.4 (2.5)</td>
<td>7.1 (2.6)</td>
</tr>
<tr>
<td>Forced-left right ear</td>
<td>12.0 (3.7)</td>
<td>11.0 (2.7)</td>
<td>9.5 (2.9)</td>
</tr>
<tr>
<td>Forced-left left ear</td>
<td>14.5 (2.4)</td>
<td>12.9 (4.6)</td>
<td>15.0 (4.6)</td>
</tr>
</tbody>
</table>

Note.—Data are mean (standard deviation); ADHD = attention-deficit hyperactivity disorder.

There was a significant main effect of ear (right-handed subjects: \(F = 15.7, df = 1,47, p < 0.001\); non-right-handed subjects: \(F = 7.97, df = 1,16, p < 0.01\), with better right-ear performance. Furthermore, there were significant effects of ear by condition (right-handed subjects: \(F = 29.15, df = 2,94, p < 0.001\); non–right-handed subjects: \(F = 13.22, df = 2,32, p < 0.001\). The main effect was due to significant REA during NF and FR conditions, and a significant LEA during the FL condition. No other source of variance reached significance.
The only significant effect on laterality index between the groups was on the FR laterality index (right-handed subjects: $F = 3.4$, $df = 2.47$, $p < 0.04$). Followup tests with Tukey-B test showed a significantly larger REA in the ADHD group during the FR condition than in the normal comparison group ($p < 0.05$).

Since the subjects with ADHD were significantly younger than the subjects in the other groups, the effect of age was also controlled for by using a covariance procedure. When the effect of age was partialled out, no significant effect of group was found for any of the measures.

The ANOVA on the asymmetry index according to Chapman and Chapman (1988) revealed no significant differences between the groups. Finally, the frequency data revealed no significant differences.

All groups were highly comparable in terms of the total number of correct items (RE + LE) in all conditions. To get a sense of the distribution, the individual data were placed onto scatterplots. On observation, data distribution looked similar, with no apparent deviance.

Because of the skewed sex distribution in the groups, male performance was compared with female performance on all conditions within the group of normals as well as within the group of patients with schizophrenia. No significant sex-difference was found for any of the conditions.

There was no relationship between DL test performance and severity of illness as measured by BPRS or GAS. Separate analyses revealed no significant differences between patients with paranoid and nonparanoid schizophrenia. In addition, the ANOVAs were recalculated excluding data on the patients with schizoaffective, schizophreniform, and delusional disorder and identical findings resulted. There was no difference between subjects who used medication and those who did not use medication.

**Discussion**

A normal REA was observed in the patients with schizophrenia during the NF condition. In addition, they were able to modulate the ear advantage in response to attentional instructions. There were no significant differences between the schizophrenia group and the two comparison groups.

The results did not confirm the hypothesis that young patients with early-onset schizophrenia manifest deficits in the DL test similar to those found in adult chronic patients (Colbourn and Lishman 1979; Kiyota 1987; Wexler et al. 1991; Green et al. 1994a; Bruder et al. 1995). Thus, a deficit in auditory laterality as measured by a DL test seems not to be apparent early in the illness process of schizophrenia. Similarly, the young patients with schizophrenia did not reveal any signs of the attentional dysfunctions that have been reported for adult patients (Green et al. 1994a).

The earlier mentioned studies on children with schizophrenia and on patients with first-episode schizophrenia have suggested that brain structure and cognitive abnormalities may be present at the onset of the disorder, at birth, or soon thereafter. However, looking at the results of the present study, this might not apply for deficits in auditory laterality or in modulation of attention according to instructions. A hypothesis based on the present results is that left hemisphere deficits observed in other DL studies are the result of having schizophrenia for many years. The adolescent patients in the present study were in an early phase of the illness, when psychosis had not yet become so established.

It has been proposed that schizophrenia is a neurodevelopmental disorder in which a fixed brain lesion from early in life interacts with certain normal maturation events. The lesion remains relatively quiet until early adulthood when the normal maturation of certain brain structures occurs (Weinberger 1987). Thus, it could be possible that the deficits in DL test performance are apparent only after such neurodevelopmental changes in adolescence.

Diagnosis of young individuals experiencing a first episode of schizophrenia is difficult. However, in a recent report by Asarnow, J.R. et al. (1994), it was argued that schizophrenia in childhood can be diagnosed using the same criteria as for adults, and that most individuals with childhood onset show continuing schizophrenia in adolescence.

Young psychotic patients often need to be followed up over a period of several months in order to confirm the diagnosis of schizophrenia. The patients in the present study, whose diagnosis was more uncertain, were followed up 6 months after discharge and 1 year thereafter to confirm the initial diagnosis. The diagnoses were unchanged. Further, these patients showed significant deficits compared with normal controls on a backward masking paradigm (Rund et al. 1996). Deficient performance on the visual mask paradigm has repeatedly been found in patients with schizophrenia (see Rund 1993; Green et al. 1994b).

The studies of patients with chronic schizophrenia include primarily patients for whom the course of illness already has proven to be unfavorable. The schizophrenia group in the present study can be characterized as heterogeneous, given the fact that these patients most likely will vary in outcome. Thus, the differences between our DL test results and the results of other studies may be due to
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the difference in prognosis of the patients. There have been only limited studies on adolescent-onset schizophrenia, but results suggest that it runs a variety of courses (recovery, relapsing, chronic) rather similar to the adult forms (Eggers 1978, 1989; Werry et al. 1991).

The schizophrenia group showed an REA comparable to that which Wexler and Heninger (1979) found in patients who were recovering from a psychotic episode. Most of the patients with schizophrenia in the present study were still actively psychotic at the time of testing, which is also reflected in their BPRS scores. Thus, the patients' clinical state during the tests cannot explain the lack of significant deficits.

Green et al. (1994a) suggested that the clinical variable of importance for abnormalities in left hemisphere function is auditory hallucinations, as opposed to psychotic symptoms in general. The patients in the present study were not interviewed on the day of testing to determine if they had experienced auditory hallucinations immediately prior to testing. However, according to the BPRS interview, most patients reported that they had had auditory hallucinations within 1 week of testing. Further, the patients had recently been admitted to the ward, and most of them had not yet started drug treatment for their psychotic symptoms. Based on these facts, it seems likely that most of them did have auditory hallucinations during the testing. Thus, an absence of auditory hallucinations could not explain the lack of deficits in the DL test performance.

Another explanation of the results in the present study is that the sensitivity of the DL test was weakened because of the acuteness of the illness in the patients with schizophrenia. The patients were highly psychotic, and most of them were not being treated with neuroleptics at the time of testing. However, the mean and the distribution of the scores were almost identical to a large normative sample in another study consisting of 488 right-handed subjects in the NF condition and 303 right-handed subjects in the FR and FL conditions (Hugdahl 1995). If the DL test was not sensitive enough to measure auditory selective attention in the patient group, one would not expect the distribution of the scores to be similar in all conditions compared with the normative sample. Thus, the DL test did validly measure a normal performance in the schizophrenia group.

Three subjects in the present sample did not get a diagnosis within the "classical definition" of schizophrenia. However, excluding these three patients from the statistical analyses did not result in significant changes.

Because REA has been found to be greater for paranoid than for nonparanoid patients with schizophrenia (Lerner et al. 1977; Gruzelier and Hammond 1980), the paranoid and the nonparanoid subgroups of patients were compared. No group difference appeared, indicating that the inclusion of patients with a subdiagnosis of paranoid schizophrenia could not explain the results.

Only 5 of the 19 patients with schizophrenia were using neuroleptic medication at the time of testing. There was no significant difference on any of the DL test measures between medicated and nonmedicated patients. It therefore seems unlikely that neuroleptic medication can explain our results.

Some studies have suggested that antipsychotic medications may improve left hemisphere functioning (Toner and Flor-Henry 1989). Seidman et al. (1993) reported a trend toward significant improvement with more extreme to less extreme REA in chronic patients with schizophrenia following an 80 to 90 percent neuroleptic dose reduction. However, other studies have reported increased REA on verbal dichotic listening tests following introduction of neuroleptic medication (Hammond and Gruzelier 1978; Gruzelier and Hammond 1980). As far as we know, no studies have examined the effect of neuroleptic medication on a CV version of the dichotic listening test. The patient with the highest dosage of neuroleptic medication in the present study was the only right-handed subject in the schizophrenia group who did not show a REA, although he was not rated the most impaired on BPRS or GAS. Thus, it is possible that a high dosage of medication contributed to poor performance, and that results from studies with more chronic patients also demonstrate this effect. However, the consequence of neuroleptic medication might not be the same for adolescent patients as for older patients because of neurophysiological immaturity in adolescence (Fish 1970). Fish suggested that the neurophysiologically immature nervous system may be less amenable to benefit from neuroleptic treatment.

Further support for the hypothesis that neuroleptic medication may contribute to deficits in DL test performance in chronic patients comes from a recent review suggesting that chronic administration of antipsychotic drugs may produce qualitative changes in the brain by altering the functional activity of critical neural circuits (Hyman and Nestler 1996).

The subjects with ADHD did not show any dysfunctions in either auditory laterality or selective attention. This is comparable to other DL studies in children with ADHD (Davidson and Prior 1978; Hiscock et al. 1979; Prior et al. 1985) and to some extent to Loiselle et al.'s study (1980), which found only "moderate deficiencies" in a hyperactive sample for RE stimuli in a free recall condition.

The relatively small sample size presents a methodological shortcoming in the present study. The lack of significant differences between groups might be due to an insufficient statistical power. The lack of deficits in the
schizophrenia group might suggest that the difficulty level of our DL procedure was too low.

In conclusion, the present findings suggest that young patients with early-onset schizophrenia are not impaired in auditory laterality or in selective attention. The results do not confirm the hypothesis that young patients with early-onset schizophrenia show impaired left hemisphere function, as is observed in adult patients with chronic schizophrenia. Although deficits in auditory laterality and selective attention are not present early in the schizophrenia illness process, these may be secondary to long-time illness and/or drug treatment. Finally, these deficits may become apparent only after interaction with maturational neurodevelopmental changes during adolescence.

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