Journal of Abnormal Psychology
1983, Vol. 92, No. 1, 4-28

0021-843X/83/9201-0004$00.75

Signal Detection in Vigilance Tasks and Behavioral Attributes Among Offspring of Schizophrenic Mothers and Among Hyperactive Children

Keith H. Nuechterlein
Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles

This research examined the possibility that a subgroup of offspring of schizophrenic mothers would display a deficit in signal detection during vigilance that might index vulnerability to adult schizophrenia. Children of schizophrenic mothers (n = 24), children of mothers with nonpsychotic psychiatric disorders falling outside the schizophrenia spectrum (n = 20), and hyperactive children (n = 14) were examined relative to groups of individually matched comparison children (n = 24, 20, and 14, respectively) and to a representatively stratified group of normal children (n = 67). Children of schizophrenic mothers showed lower mean perceptual sensitivity (d') than matched and stratified normal children and included an excessive number of extremely poor scorers, which was determined by a factor score summarizing performance across five continuous performance test (CPT) conditions. Neither children of mothers with nonpsychotic disorders outside the schizophrenia spectrum nor hyperactive children displayed a significant deficit in perceptual sensitivity. Hyperactive children scored lower on a β (response criterion) factor across vigilance tasks and were rated as higher on an Emotionality factor and lower on a Fearful Inhibition factor than their normal peers. On a degraded stimulus CPT, the perceptual sensitivity deficit among children of schizophrenic mothers was found across motivational feedback conditions and was evident throughout the vigilance period.

The study of offspring of a schizophrenic parent has become a major research strategy for identifying possible antecedents of schizophrenic disorders and indicators of vulnerability to these disorders (Garmezy, 1974; Garmezy & Streitman, 1974; Jones, 1973; Rieder, 1979). Because the focus on this population at heightened risk for schizophrenia allows investigation of genetically predisposed but preschizophrenic individuals, findings are not confounded by common secondary concomitants of the disorder, such as antipsychotic medication, hospitalization, social stigma, and demoralization (Mednick & McNeil, 1968) nor by any direct effects of a prior psychotic episode.

Reports regarding various attentional and information-processing deficits have been prominent among recent findings from studies of high-risk populations. Marcus (1972)

This article is based on data collected initially as a part of a doctoral dissertation submitted to the University of Minnesota and analyzed further at the University of California, Los Angeles.

The research was supported by a Dissertation Research Fellowship to the author and a grant to Norman Garmezy from the Schizophrenia Research Program of the Scottish Rite, Northern Masonic Jurisdiction, U.S.A. Additional analyses were made possible by a subsequent grant from the Scottish Rite awarded jointly to Norman Garmezy and the author. Computing assistance was obtained from the Office of Academic Computing, University of California, Los Angeles.

The author is very grateful to Norman Garmezy, committee chairman, for his wise counsel and assistance, to L. Erlenmeyer-Kimling and B. Cornblatt for providing the details and consultation necessary to replicate their CPT adaptation, and to L. Fisher and G. Rubenstein for providing consultation on their peer evaluation measure. Thanks also to project members Vernon T. Devine, Regina Driscoll, Susan Phipps-Yonas, Margaret O'Dougherty, Mark Vangen, David Pellegrini, Harvey Linder, John Shabatura, Richard Rexiesen, and Daniel Goldstein for their contributions. Michael Dawson and William Edell made valuable comments on an earlier draft of this manuscript.

Requests for reprints should be sent to Keith H. Nuechterlein, Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles, Los Angeles, California 90024.

found that children of schizophrenic mothers had slowed simple reaction time, although they did not display the failure to profit from regularity of preparatory interval that typifies the performance of adult schizophrenic patients (Nuechterlein, 1977a). The reaction time performance deficit was apparent even under conditions of extrinsic incentive and prior information about length of preparatory interval, which suggests a stable deficit in overall mean reaction time.

Grunebaum, Weiss, Gallant, and Cohler (1974) and Gallant (1972) reported deficits among children of psychotic mothers (schizophrenic, schizoaffective, or affectively disordered) relative to children of normal parents on versions of the continous performance test (CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956), a visual vigilance task that has been shown to be sensitive to performance deficits among chronic hospitalized schizophrenic patients (Orzack & Kornetsky, 1966) and remitted schizophrenic patients on medication (Asarnow & MacCrimmon, 1978) or off medication (Wohlberg & Kornetsky, 1973). The CPT involves monitoring a series of briefly presented stimuli that appear at a rapid fixed rate and signaling by a button press each time a predesignated target stimulus is presented. Whereas children of schizophrenic mothers detected fewer CPT targets (made more errors of omission) than children of affectively disordered mothers and children of nonpsychiatric control subjects in the 5-year-old sample (Gallant, 1972; Grunebaum et al., 1974), no differences in CPT performance were found among 6-year-old children. The 5-year-old, but not the 6-year-old, children of schizophrenic mothers also tended to make more incorrect presses (false alarms or errors of comission) than the children of nonpsychiatric mothers. Unfortunately, it is not possible to interpret clearly the unstable relationship between maternal diagnosis and children's attentional functioning in this study because the 5-year-olds differ from the 6-year-olds in CPT stimulus type, chronicity of maternal mental illness, and diagnostic group sample size (Gallant, 1972), as well as in age. A later report from this project (Cohler, Grunebaum, Weiss, Gamer, & Gallant, 1977) noted that the combined 5- and 6-year-old performance on the continuous performance test versions did not differ significantly for children of schizophrenic, depressive, and well mothers. However, since the version of the CPT employed with 5-year-olds was considerably more difficult and probably had better discriminating power than the X version of the CPT administered to 6-year-olds (Gallant, 1972; Gruenbaum et al., 1974), the combination of these two age groups may have actually obscured subtle performance deficits among children of psychotic mothers in this sample.

The New York State Psychiatric Institute's high-risk research group found that 7- to 12-year-old children with one schizophrenic parent obtained significantly fewer target hits, more false alarms to clearly irrelevant stimuli, and lower sensitivity (d') in an adapted CPT than did children of parents without psychiatric illness (Erlenmeyer-Kimling & Cornblatt, 1978; Rutschmann, Cornblatt, & Erlenmeyer-Kimling, 1977). This version of the CPT involved monitoring slides of playing-card stimuli and responding each time that two identical cards appeared consecutively. This playing-card CPT differs substantially from conventional forms of the task by demanding processing of two stimulus dimensions (suit and number), a relative rather than absolute target criterion, and successive matching-to-sample operations. The increased memory load may alter task performance characteristics (Parasuraman, 1979; Parasuraman & Davies, 1977) and demands more complex cognitive processes than the conventional CPT.

The possibility that specific task characteristics may influence the ability of continuous performance test versions to detect attentional deficits among high-risk children is evident in the research reported by Asarnow, Steffy, MacCrimmon, and Cleghorn (1977). Using a conventional version that employs a single numeral stimulus as the target, Asarnow et al. (1977) found no CPT deficit among children of schizophrenic mothers as compared to two comparison groups. Their positive findings with other tasks, including a forced-choice span of apprehension task, the Spokes Test, and a concept-attainment task, indicate that the negative findings for the CPT do not reflect a lack of performance deficit among this sample of high-risk chil-

dren. Rather, the nature of the target stimulus and the relatively low difficulty level of the CPT version employed may be the source of the negative findings.

Performance of children born to schizophrenic (or psychotic) mothers has also recently been reported to be deficient in certain other attentional and information-processing tasks, including an auditory attention span task (Erlenmeyer-Kimling & Cornblatt, 1978), the Children's Embedded Figures Test (Gamer, Gallant, Grunebaum, & Cohler, 1977; Grunebaum et al., 1974), and auditory distraction, visual search, word-communication, and object-sorting tasks (Harvey, Winters, Weintraub, & Neale, 1981; Neale, 1982; Oltmanns, Weintraub, Stone, & Neale, 1978).

Rather than examining performance across a variety of tasks with highly varied presentation formats and processing demands, the present study focused on stimulus and response manipulations within the basic paradigm of the vigilance task through the use of conventional and adapted versions of the CPT. In addition, the current research addressed several other prominent issues in this area, including (a) the isolation of a subgroup of children born to schizophrenic mothers who may be at particularly high risk for later schizophrenia, (b) the specificity of certain CPT deficits to children at risk for schizophrenia, (c) the role of motivation in the performance deficit, and (d) the impact of stimulus-input versus response-output processes.

The search for a vulnerable subgroup within the high-risk sample follows from observations that only 10% to 15% of children born to one schizophrenic parent will later develop schizophrenic disorder and that both monogenic and polygenic theories of transmission predict a truly high degree of vulnerability to schizophrenia only in some offspring of a schizophrenic parent. Furthermore, not all adult schizophrenic patients perform poorly on the CPT (Orzack & Kornetsky, 1966, 1971), so one would not necessarily expect CPT deficits to occur in families of all schizophrenic patients. Thus, group mean comparisons are likely to have particularly low power to detect true differences between children of a schizophrenic parent and comparison children that are due to precursors of schizophrenia or indicators of vulnerability characterizing only a subgroup. To adapt the form of the data analysis to this situation, I emphasized the isolation of a significantly larger subgroup of deviant responders among children of schizophrenic mothers relative to comparison groups, in addition to traditional analyses of group mean effects.

To evaluate the specificity of any vigilance performance deficits among children of a schizophrenic parent to increased risk for schizophrenic disorder, a maternal psychopathology and a personal psychopathology group were included to supplement comparisons with normal peers. Children born to mothers with nonpsychotic forms of psychiatric disorder were included to examine any generalized effects of maternal psychiatric disturbance on children's vigilance performance and test behavior. The disorders in these index mothers were selected for being clearly differentiated from schizophrenic and "schizophrenic spectrum" disorders (Rosenthal, 1975, 1978).

Because attentional disturbance has been central to recent theories regarding childhood hyperactivity (Douglas, 1972, 1980; Porges & Smith, 1980; Ross, 1976), even to the extent that the diagnosis has been retitled "attention deficit disorder with hyperactivity" (American Psychiatric Association, 1980), hyperactive children are an especially relevant psychopathological comparison group in studies of attentional disorder among children at risk for schizophrenia. While follow-up studies of longer duration are needed to clarify final outcome, existing follow-up data do not indicate a high incidence of later psychosis (Borland & Heckman, 1976; Mendelson, Johnson, & Stewart, 1971; Minde, et al., 1971; Weiss, Hechtman, Perlman, Hopkins, & Wener, 1979; Weiss, Minde, Werry, Douglas, & Nemeth, 1971), except possibly for atypical and extremely severe, hospitalized cases of hyperactivity (Menkes, Rowe, & Menkes, 1967). Furthermore, schizophrenic disorder has not been found to occur at an elevated rate among adult relatives of hyperactive children (Cantwell, 1972; Morrison & Stewart, 1971; Stewart, de Blois, & Cummings, 1980). Thus, it should prove useful to attempt discrimination of attentional

and information-processing disorder among hyperactive children and among some children born to schizophrenic mothers. This study represents the first attempt to compare these two groups directly.

On conventional CPT versions with a target stimulus consisting of a single letter (Klorman, Salzman, Pass, Borgstedt, & Dainer, 1979) or a fixed two-letter sequence (Sykes, Douglas, & Morgenstern, 1973), hyperactive children have obtained fewer hits and more false alarms than normal children. Similar findings for hits have been obtained with a more broadly defined "minimal brain dysfunction" group (Kupietz, 1976). More rapid CPT performance deterioration over time has also been demonstrated relative to normal children (Sykes et al., 1973; Kupietz, 1976). These previous studies have not employed signal detection analyses of perceptual sensitivity (d') and response criterion (β) components of vigilance performance.

Based on past research and theoretical considerations, I hypothesized that a disproportionately large subgroup of children born to schizophrenic mothers would have impaired overall perceptual sensitivity in vigilance tasks and that this effect would be evident in low d', low hit rate, and high false alarm rate. Hyperactive children were hypothesized to display both decreased perceptual sensitivity (d') and decreased response criterion (β), the latter expectation being based on the frequent characterization of these children as impulsive (Douglas, 1972). I expected children of nonpsychotic, psychiatrically disordered mothers to be comparable to their peers (Marcus, 1972; Rolf, 1972).

The primacy of perceptual and attentional deficits as opposed to motivational deficits in schizophrenic disorders has been frequently debated (Hunt & Cofer, 1944; Nuechterlein, 1977a; Salzinger, 1973). The current research dealt with the role of motivation in three ways. First, ratings of cooperation and goal orientation were completed and examined in relationship to CPT performance. Second, the CPT analyses were completed with signal detection theory indexes of performance whenever possible. The conventional CPT variables, errors of omission and errors of commission, do not allow the separation of basic perceptual and attentional processes from cognitive and motivational factors that affect willingness to respond in a given direction. Signal detection theory transformations of the raw scores allow derivation of an index of sensitivity (d'), which reflects the underlying effectiveness of discriminating signal stimuli from noise stimuli, and a separate index of response criterion (β), which indicates the amount of perceptual evidence required to meet the subject's criterion for responding "signal" (Green & Swets, 1966; McNicol, 1972; Swets, 1973). The relative freedom of the sensitivity index from motivational effects has been supported empirically (Swets & Sewall, 1963).

A third strategy for exploring the role of motivation and effort was the examination of reactivity to reward and punishment. This method has frequently been used in the investigation of motivational influences on adult schizophrenic performance (Garmezy, 1966; Nuechterlein, 1977a), including performance on the CPT (Latz & Kornetsky, 1965). The reaction time study of Marcus (1972) suggested that a deficit among children of schizophrenic mothers was present even in an incentive condition. The present study examined vigilance performance under conditions of social reward for correct responses (hits) and social punishment for incorrect responses (false alarms) in order to evaluate further the stability of the performance deficit among offspring of schizophrenic mothers and to separate any incentive feedback influences into effects on perceptual sensitivity (d') and response criterion (β).

Certain theories of schizophrenic cognition have emphasized deficiencies either in the initial stimulus-input stages of information processing (McGhie, 1970; McGhie & Chapman, 1961) or in later response-selection stages (Broen & Storms, 1967). The attempt to isolate particularly deficient information-processing stages or levels in schizophrenia has continued using contemporary methods (Oltmanns, 1978; Saccuzzo, Hirt, & Spencer, 1974; Wishner, Stein, & Peastrel, 1978). Among the methods used to examine stimulus-encoding processes is stimulus degradation, whereas response selection and organization processes have been studied

through the manipulation of response type and frequency (Massaro, 1975; Sternberg, 1967, 1969). Although typically associated with reaction time tasks, manipulations of stimulus degradation and of response type and frequency were introduced into the vigilance paradigm in the present study in an exploratory attempt to isolate any differential deficit in vigilance among children of schizophrenic mothers as a function of stimulus-input versus response-output factors.

Method

Subjects

Subjects were selected for seven groups, of which three were defined by maternal or personal psychopathology, three were matched comparison groups, and one was a larger, representatively stratified, normal comparison group. The first three groups contained children born to schizophrenic mothers, children born to nonpsychotic, psychiatrically disordered mothers, and hyperactive children. A matched comparison group was formed for each of these three groups. The stratified comparison group was selected by representative sampling from the classrooms of the first three groups. Subjects were in Grades 4–9 in the public school system and were between 9 and 16 years of age at time of testing.

The first two groups, offspring of schizophrenic mothers and offspring of nonpsychotic, psychiatrically disordered mothers, were selected through a review of 1,331 female psychiatric intakes during 1971 through 1975 at two large public psychiatric hospitals serving a large midwestern city. All female cases with DSM-II (*Diagnostic and Statistical Manual of Mental Disorders*, 2nd ed.; American Psychiatric Association, 1968) discharge diagnoses of schizophrenia (295), paranoid state (297), other psychoses (298), anxiety neurosis (300.0), or depressive neurosis (300.4) were reviewed in order to locate patients with schizophrenic disorder or with psychiatric disorder that was clearly outside the schizophrenia spectrum. Patients with organic brain syndrome, alcoholism, or mental retardation (IQ < 70) were excluded. Cases were also excluded if they had no children in the 9- to 16-year old range or if their children were not attending the city public school system.

All of the remaining prospective index mothers (n = 72) were submitted to diagnostic review by three independent diagnostic judges (Norman Garmezy, Vernon T. Devine, and the author). Each judge read all of the hospital records and independently completed ratings of 48 psychiatric symptoms for each case, using the Case Record Rating Scale (Strauss & Harder, Note 1). Each of the judges then independently assigned two sets of diagnoses, employing the research classification system developed by Kety, Rosenthal, Wender, Schulsinger, and colleagues (Kety, Rosenthal, Wender, & Schulsinger, 1968; Kety, Rosenthal, Wender, Schulsinger, & Jacobsen, 1978; Rieder, Rosenthal, Wender, & Blumental, 1975) and the standard nomenclature of the DSM-II. Of the 24 cases that were included as schizophrenic index cases, unanimous first-choise diagnoses of schizophrenia were received by 21 cases using the Kety, Rosenthal, Wender, and Schulsinger categories for certain schizophrenia and by 22 cases using the DSM-II diagnosis of schizophrenia. In the remaining cases, two of the three judges assigned a first-choice diagnosis of schizophrenia and the third judge listed schizophrenia as a possible diagnosis.

Current diagnostic standards are moving to a narrower definition of schizophrenic disorder, and a controversy over the nosological placement of schizoaffective conditions is underway (Rosenthal, Rosenthal, Stallone, Dunner, & Fieve, 1980; Tsuang, 1979; Tsuang & Dempsey, 1979). Schizotypal personality disorder has been designated as a separate diagnosis in DSM-III (3rd ed., American Psychiatric Association, 1980), less severe than schizophrenia but genetically related (Kendler, Gruenberg, & Strauss, 1981). Therefore, the schizophrenic index mothers were also recently reclassified using the Research Diagnostic Criteria (RDC) developed by Spitzer, Endicott, and Robins (1978). Two independent raters (William S. Edell and the author) rated the RDC symptomatic criteria using the Case Record Rating Scale data. This review indicated that the initial schizophrenic index group contained 13 cases with RDC schizophrenia, 8 cases with RDC schizoaffective disorder, and 3 cases with multiple RDC schizotypal features (meeting DSM-III criteria for schizotypal personality disorder). This alternative diagnostic classification is used here to examine the implications for major findings of a narrowing of the diagnosis of schizophrenia.

The selection criteria for nonpsychotic, psychiatrically disordered index mothers were designed to rule out the presence of schizophrenia and of schizophrenia spectrum disorder (Rieder et al., 1975; Rosenthal, 1975, 1978). Included cases had no first-choice diagnoses of certain or possible schizophrenia or of schizoid or paranoid personality disorder in the Kety et al. (1968) system nor any first-choice DSM-II diagnoses of schizophrenia. Grouping the 20 index cases by consensus DSM-II diagnosis (assigned by at least two of three judges), we found that 10 had depressive neurosis, 4 adjustment reaction with depressed mood, 3 personality disorder, 2 anxiety neurosis, and 1 psychophysiological disorder.

This sample selection process is summarized in Table 1. Further group descriptive information is presented in Figure 1 in the form of mean Minnesota Multiphasic Personality Inventory (MMPI) profiles for all patients with available data. Despite the loss of information due to averaging, the mean profile type (842) of the schizophrenic index mothers is one associated with a schizophrenic diagnosis, at least by DSM-II standards (Marks, Seeman, & Haller, 1974) and is strikingly similar to that obtained for the schizophrenic index group of Hanson, Gottesman, and Heston (1976). In contrast, the mean profile type (247) of the nonpsychotic, psychiatrically disordered index mothers has been associated chiefly with psychoneurosis and personality disorder in past actuarial research (Marks, Seeman, & Haller, 1974).

To avoid the statistical problem of nonindependent sampling, only one child of each index mother was included in the study sample in the few cases in which more than one child was available in the appropriate age range. No criterion of family intactness was employed, in order to avoid this source of possible sample selection bias (Mednick, 1978). Of the index mothers selected for

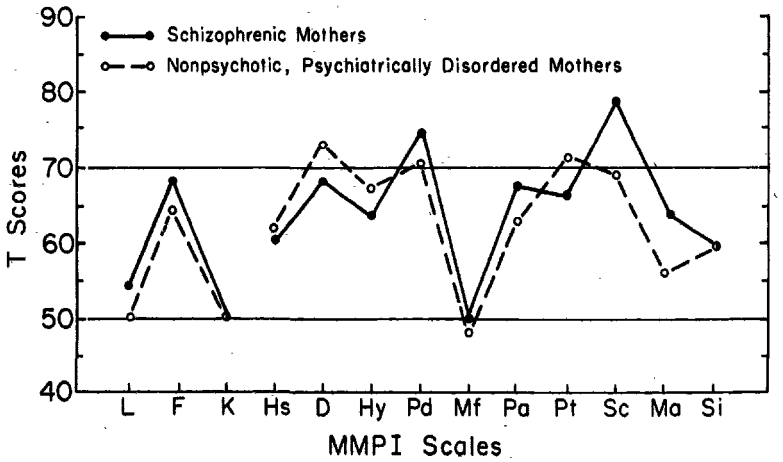

Figure 1. Mean Minnesota Multiphasic Personality Inventory (MMPI) profiles for all index mothers with available test scores ($n = 17$ for schizophrenic mothers; $n = 16$ for nonpsychotic, psychiatrically disordered mothers).

inclusion, only two mothers (one in the schizophrenic disorder and one in the nonpsychotic psychiatric disorder category) refused to allow their children's participation in the study.

Hyperactive children were selected from cases referred to two child guidance clinics. Exclusion criteria were (a) IQ < 75 (b) convincing evidence of neurological disorder (c) severe physical illness or chronic physical handicap (d) current psychoactive medication (e) major psychiatric illness in a parent (f) age outside the 9- to 16-year-old range and (g) school enrollment outside the city public schools. Cases receiving psychoactive medication were excluded due to the known effect of some medications on CPT performance (Kornetsky, 1972; Sykes, Douglas, & Morgenstern, 1972).

Diagnostic criteria for hyperactivity employed the results of recent factor analyses of child outpatient psychiatric symptomatology (Nuechterlein, Soli, Garmezy, Devine, & Schaefer, 1981; Soli, Nuechterlein, Garmezy, Devine, & Schaefer, 1981). All 138 cases that passed the screening criteria were submitted to case record review by two independent judges who completed the 91-item Achenbach Checklist of symptomatology (Achenbach, 1966; Soli et al., 1981). The lowest interrater agreement on symptoms between pairs of three possible raters was 79.2% by the conservative method of calculating agreement on checked items only (Achenbach, 1966). Factor scores were derived by unit weighting of items and averaging across raters, using the factors described in Soli et al. (1981).

Hyperactive children were operationally defined as those potential subjects who obtained a high score on the Hyperactivity factor (>50% of total possible score) and relatively low scores on the Delinquency and Re-

Table 1
Sample Selection for Children Born to Mothers With Schizophrenia or a Nonpsychotic Psychiatric Disorder

Reason for exclusion at initial chart review	*n*	Disposition of cases submitted to three clinical judges	*n*
No children	496	Moved to private school	10
Children too old	246	Moved out of city	1
Children too young	108	Children not locatable or not accessible	5
Residence outside city	129	Children still too young at end of study	3
Residence not locatable	113	Diagnostic disagreement	3
Children in private school	10	Diagnosis judged nonschizophrenic psychosis	2
Patient too old or too young	53	Diagnosis judged organic brain syndrome	1
Patient alcoholic	20	Insufficient information for diagnosis	1
Patient has organic brain syndrome	5	Refused participation	2
Patient has IQ < 70	4	Included as index schizophrenic mother	24
Chart not available	44	Included as index nonpsychotic, psychiatrically disordered mother	20
Insufficient chart information	31		
Total no. of cases excluded	1,259	Total no. of cases examined	72

belliousness factors (≤33% and 50% of total possible scores, respectively). For females, the Interpersonal Aggression factor was used as the counterpart of the male Rebelliousness factor. This selection of children who showed hyperactive behavior and not predominantly delinquent or rebellious patterns was designed to yield a narrower syndrome than the "externalizing" grouping that had been used in earlier studies of the Minnesota high-risk project (Marcus, 1972; Rolf, 1972, 1976). In order to maintain comparability with the category termed *hyperkinetic reaction* in DSM-II and *attention deficit disorder with hyperactivity* in DSM-III, subjects were required to have clear evidence of two specific Achenbach Checklist symptoms, "restless, hyperactive" and "can't concentrate, distractible, short attention span" (Achenbach, 1966). As a result of this process, 14 hyperactive children were included as subjects. All hyperactive subjects were male because no clear cases of hyperactive females were found in the screening sample.

Each child in the three groups described thus far was individually matched with a comparison child in the same public school classroom on sex, age, peer evaluation level, reading achievement vocabulary and comprehension scores, and socioeconomic status. Peer evaluation level was measured through a 27-role adaptation of Rubenstein, Fisher, and Iker's (1975) version of the Class Play (Bower, 1960). Children in these classrooms were asked to nominate classmates for roles in a hypothetical class play. The rank order of the number and the percentage of negatively toned social role nominations were averaged within classrooms to derive a peer evaluation index of social competence. Since negative evaluation by peers is a predictor of later psychiatric contact (Cowen, Pederson, Babigian, Izzo, & Frost, 1973), apparently without strong diagnostic specificity (Kohlberg, LaCrosse, & Ricks, 1972; Roff, 1970), matching subjects on this variable serves to equate them on predicted global level of adult mental health. Any cognitive deficits among children of schizophrenic mothers relative to peers of the same sociometric level might be more specific to risk for schizophrenia.

Because certain matching variables (e.g., vocabulary and comprehension scores, peer evaluation level) may actually also be influenced by a predisposition to schizophrenic disorder, matching might reduce the likelihood of demonstrating valid relationships between risk for schizophrenia and anomalies of attention and information processing. Moreover, matching on multiple variables may create a "normal" comparison group that is both unrepresentative of its population and systematically mismatched with the target group on other variables (Chapman & Chapman, 1973; Meehl, 1970). Therefore, a larger, representative normal comparison group was also recruited. In order to maximize the extent to which this group was representative of the fourth- to ninth-grade students in classrooms attended by the target children, stratified sampling on peer evaluation level was employed in these classrooms. A group of 67 students was included in the stratified normal comparison group. Because classroom peer evaluation data were collected on students of the same sex as the target child, this procedure maintained sex and grade level proportions in the stratified normal group that were comparable to those in the three target groups as a whole.

All subjects were screened for impairments in vision and hearing. Visual acuity of 20/30 or better, with corrective lenses if necessary, was required for participation in this research. Potential matched or stratified comparison children who had child guidance or psychiatric referral for personality or behavior problems, neurological disorder, or relevant physical handicaps were excluded on the basis of school records review.

Table 2 summarizes the background data for each of the seven subject groups, while Table 3 presents the data

Table 2
Background Data for the Seven Subject Groups

Group	Sex		Age (in yr.)		Vocabulary score[a]			Comprehension score[a]			Socioeconomic status[b]		
	M	F	*M*	*SD*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Children of schizophrenic mothers	14	10	13.1	1.8	45	31	22	49	29	22	4.9	1.2	23
Matched comparison children	14	10	12.8	1.5	47	28	22	50	30	22	4.3	1.5	23
Children of nonpsychotic, psychiatrically disordered mothers	11	9	13.0	1.5	44	24	16	45	29	16	4.6	2.1	19
Matched comparison children	11	9	12.8	1.5	47	27	16	48	27	16	4.3	1.9	19
Hyperactive children	14	0	12.8	1.5	38	20	13	40	25	13	4.4	1.1	13
Matched comparison children	14	0	13.0	1.9	42	23	13	32	25	13	4.9	1.4	13
Stratified normal comparison children	43	24	12.8	1.7	53	27	64	52	29	64	4.7	1.7	63

[a] Vocabulary and comprehension scores are percentiles on the Gates–MacGinitie Reading Achievement Test from school records. *Ns* indicate the number of children for whom data were available.
[b] Using the 7-point Occupation scale from the Amherst modification of Hollingshead's (Note 2) Two-Factor Index of Social Position. High scores represent low socioeconomic status. *Ns* indicate the number of children for whom head of household occupational information was available. Highest known occupation achieved by head of household was scored.

Table 3
Mean Scores and Standard Deviations for Negative Social Appraisal by Peers[a]

Group	*n*	No. of negative nominations[b]		Percentage negative[c]	
		M	*SD*	*M*	*SD*
Children of schizophrenic mothers	24	.07	1.02	62	25
Matched comparison children	24	−.07	.91	58	24
Children of nonpsychotic, psychiatrically disordered mothers	20	.00	.67	70	24
Matched comparison children	20	−.04	.77	61	22
Hyperactive children	14	.64	1.19	80	18
Matched comparison children	14	.36	.93	69	21
Stratified normal comparison children	67	−.08	1.00	51	32

[a] Using the 20 of the 27 roles that had social behavior or personality content.
[b] Scores were standardized within classrooms to allow comparisons across classrooms, because the average number of roles assigned each student varied across classrooms.
[c] Percentage of roles assigned to child that were negatively toned.

for two global sociometric indexes of negative peer appraisal. The goodness of matching is evident in the fact that none of the pairwise *t* tests between a target group and its matched comparison group was statistically significant for age, vocabulary score, comprehension score, socioeconomic status, or peer evaluation indexes. Sex was completely matched for these pairings.

Comparisons among the three target groups and the stratified normal group revealed some differences on these matching variables. The hyperactive children, as might be expected, received more negative peer nominations than the stratified comparison group, $t(79) = 2.38$, $p < .05$, and a higher percentage of their nominations were negative than was the case for the stratified group, $t(79) = 3.33$, $p < .01$, or the children of schizophrenic mothers, $t(36) = 2.46$, $p < .05$. Children of nonpsychotic, psychiatrically disordered mothers also were assigned a higher percentage of negative roles than the stratified comparison children, $t(85) = 2.41$, $p < .05$. Sex of subject was significantly different for the all-male hyperactive group in comparison to the stratified normal group, $\chi^2(1) = 7.13$, $p < .01$, the children of schizophrenic mothers, $\chi^2(1) = 7.92$, $p < .01$, and the children of nonpsychotic, psychiatrically disordered mothers, $\chi^2(1) = 8.57$, $p < .01$. No other significant differences in sex, age, vocabulary score, comprehension score, two global peer evaluation indexes, or highest household socioeconomic status were present among target groups and stratified normal comparison children.[1]

Apparatus

The versions of the CPT were administered by presenting visual stimuli on a 20.5 × 20.5 cm rear projection screen by means of a Kodak 650H carousel projector. An Alphax shutter (Wollensak No. 1) modified with a solenoid to allow electrical activation and mounted on the Kodak 3-inch lens was automatically triggered by a Hunter timer at the beginning of each 1.42-sec slide cycle. The translucent plastic screen was mounted on the front of a gray wooden cabinet and located 72 cm from the front of the projector housing. The actual slide image was 10.6 cm high and 6.8 cm wide.

The subject's responses were made by pressing a handheld microswitch button. Any response to a slide subsequent to the first 200 msec after its onset and prior to the onset of the following slide was automatically registered as a response to that slide. Because the actual stimuli for responses in the first 200 msec were probably the previous slides, these responses were counted separately as late responses.

The slides for each CPT condition were contained in an 81-slide carousel (80 plus 1 zero-position slide). For the first condition, the slides were pictures of standard playing-card faces, as Erlenmeyer-Kimling and Cornblatt (1978) employed. Like they did, I included all spades and clubs from 2 through 10. In 10 slide positions, the playing-card face was identical to that of the previous slide, marking a target (signal) trial. In another 10 positions, the card face was the same as the previous one in number but not in suit, designating a nontarget (noise) trial. The remaining slides differed in number (and sometimes also in suit) from the previous slide and were regarded as filler trials. The quasi-random order of the slides was identical to that used in Erlenmeyer-Kimling and Cornblatt's (1978) first session.

All other versions of the CPT employed a carousel of 81 slides of the arabic numerals 2 through 9. These numerals were identical in size, placement, and type to those in the upper left-hand corner of the playing-card

[1] When current occupation of head of household rather than highest known occupation of the current or past head of household was employed, the socioeconomic status of children of schizophrenic mothers was rated lower than that of their matched group and tended to be lower than that of the stratified comparison group. Examination of these data suggests that occupational downward drift and divorce made current socioeconomic level unrepresentative of the earlier rearing level among children with schizophrenic mothers.

slides, with a projected size of 10 × 7 mm. The target numeral 5 occurred 20 times and nontarget numerals occurred 61 times in quasi-random order in the carousel. The target 5 numerals were randomly assigned to four positions within each sequence of 16 trials. The number of times each nontarget numeral appeared immediately preceding a 5 was balanced as fully as possible. Numerals were not allowed to appear twice in a row, minimizing position learning and confusion with the playing-card CPT.

For some new CPT versions that were developed in this study, a random pattern of "visual noise" was superimposed on the images from the slides. This visual noise mask was created by placing directly on the rear side of the screen a Xerox transparency consisting of the typed character + appearing randomly in 75% of the possible locations in each computer-generated printout line.

Headphones with circumaural padding were employed to shield the subject from extraneous noise.

Procedure

The CPT assessment session was completed at the school to avoid the possible anxiety-provoking effect of bringing the subjects to a university laboratory. To protect the target children from any negative expectations that might be raised in teachers, peers, or themselves, the target status of the children was not revealed within the school system.

The testing included six versions of the CPT and the standard version of the Porteus Maze Test (Porteus, 1950) and completion by the experimenter of 14 behaviorally anchored rating scales for personality and motivational characteristics. An interstimulus interval of 1.42 sec was common to all six CPT versions, as was the 3-foot (.91 m) distance from the screen to the eye of the subject. Throughout the CPT testing, the experimenter monitored the subject's eye orientation to ensure continuous visual contact with the screen. On the rare occasions when subjects glanced away, they were immediately reminded to continue focusing on the screen. The CPT versions are described in the following paragraphs in the order in which they were presented in the experimental session.

Playing-card CPT. This version of the CPT basically replicated the condition employed by Erlenmeyer-Kimling and Cornblatt (1978) and Rutschmann et al. (1977). Playing-card face stimuli were presented one at a time for durations of 650 msec at the fixed interstimulus interval. The subjects were asked to respond with a button press each time the playing card presented was identical to the previous one. Forty practice trials were administered to ensure that subjects understood the task requirements, followed by 323 experimental trials.

Conventional numeral CPT. To examine directly the performance of children born to schizophrenic mothers on a CPT version that was more typical of previous research with adult chronic schizophrenics and acute remitted schizophrenics (Asarnow & MacCrimmon, 1978; Kornetsky, 1972; Kornetsky & Orzack, 1978; Wohlberg & Kornetsky, 1973), the second condition employed arabic numeral stimuli from 2 through 9 displayed very briefly one at a time. Pilot work with normal children suggested that the age-related performance difference between late elementary school (Grades 4–6) and junior high school (Grades 7–9) children could be eliminated in this and subsequent versions by using exposure times of 50 msec and 40 msec for these two groups, respectively. Since elimination of this normal developmental performance difference equates the discriminating power of the task more closely across the age range employed, these exposure times were employed for the conventional numeral CPT and the four CPT conditions that followed it.

The subject's task was to press the button each time a 5 appeared. Each subject was administered 30 practice and 243 experimental trials. Each block of 81 trials contained 20 target trials and 61 nontarget trials. This version used a shorter exposure time and a somewhat higher target-to-nontarget ratio than the CPT used by Orzack and Kornetsky (1966, 1971) with chronic schizophrenic patients, in an attempt to decrease target detections and increase false alarms, respectively (Mackworth, 1970).

Degraded stimulus CPT. The conventional CPT used here and in previous research on schizophrenia and hyperactivity yields very low error rates, limiting measurement sensitivity and barring the calculation of reliable signal detection indexes. In order to improve sensitivity to subtle deficits and to benefit from the theoretical power of signal detection analysis of attentional and perceptual processes (Broadbent, 1971; Davies & Parasuraman, 1982; Mackworth, 1970; Swets & Kristofferson, 1970), a new CPT version was developed. Task difficulty level was increased by stimulus degradation, resulting in the weak signal situation recommended by Swets and Kristofferson (1970) for more sensitive analysis of vigilance performance. The Kodak 3-inch lens barrel was withdrawn 2 inches (5.08 cm) into the projector housing to result in substantial blurring of the relatively small numeral stimuli. The degree of blurring achieved can be indexed by the increased power of lens required to focus the object at the same screen distance, which in this case was .18 diopters. The random pattern of + characters was also used as a partial simultaneous visual noise mask. The recognition of the numerals required extraction of the degraded features of the figure from the perceptually more salient mask background, which degrades the signal by sensory integration (Felsten & Wasserman, 1980). Thus, in addition to more optimal task difficulty level, this degraded stimulus CPT creates a particular burden for the early stimulus-encoding and analysis aspects of information processing (Felsten & Wasserman, 1980; Sternberg, 1967, 1969).

Pilot testing in which individual children were asked to alter response criterion levels in successive periods of testing yielded receiver operating characteristic (ROC) curves with slopes near a value of one when plotted on double probability scales. Thus, the assumptions of normal distributions and of equal variance of the effects of signal and noise appear to be approximated, so d' and β indexes were used to represent the independent sensitivity and response criterion components of performance (Green & Swets, 1966; McNicol, 1972).

This degraded-stimulus CPT employed the same response demand (press to each 5) and exposure times as the prior conventional CPT condition. After 30 practice trials, an 11.5-minute series of 486 experimental trials was administered.

Porteus Maze Test. The Porteus mazes (Porteus, 1950) were administered in the standard fashion, providing a change to a subject-paced task that was challenging and intrinsically interesting.

Feedback on hits during degraded stimulus CPT. In the hits-feedback condition, each correct press (hit) was immediately followed by a single ring from a bell. Subjects were urged to use this "correct" bell to try even harder to respond to each 5. The degraded stimulus CPT version, rather than the conventional numeral CPT, was employed to ensure sufficient room for improvement, differing from the previous condition only in that 243 experimental trials were administered.

Feedback on false alarms during degraded stimulus CPT. In this condition, an aversive buzzer immediately followed each incorrect button press (false alarm). Subjects were instructed that this buzzer meant that their response was wrong and that they should use this feedback to try harder to respond to each target 5. Again, 243 experimental trials were administered. This condition was counterbalanced for order with the hits-feedback condition within each subject group.

Response reversal CPT. The final CPT condition reversed the well-learned response to the number 5. Subjects were instructed to press the button to each numeral other than 5. This CPT condition was designed to increase task difficulty level by burdening the response-selection and response-organization components of information processing (Massaro, 1975; Sternberg, 1969). The proportion of trials requiring button presses was high, and inhibition of competing responses to the previously relevant stimulus was now required. The numeral stimuli were presented in clear focus without the visual noise pattern and were identical to those of the conventional numeral CPT condition. Thus, the conventional and response-reversal CPT conditions differed in response requirements but were equated on stimulus-input factors. After 30 practice trials, 243 experimental trials were administered.

Behavioral ratings. At the end of the session, the experimenter rated the subject's personality and motivational characteristics as observed during the session. The 14 behaviorally anchored rating scales had been designed for the Collaborative Study of Cerebral Palsy, Mental Retardation, and Other Neurological and Sensory Disorders of Infancy and Childhood (Niswander & Gordon, 1972) and had been employed in a previous study of younger offspring of schizophrenic parents (Hanson, Gottesman, & Heston, 1976).

Results

Data Reduction

As noted earlier, the most critical examination of the data for the children born to schizophrenic mothers involves isolation of extreme-scoring subgroups. In order to avoid excessive Type I error, a principal-components analysis was performed to develop a small set of summarizing dimensions. Principal components analysis also allows an examination of the interrelationships among the scores from the CPT tasks and the rating scales and serves to stabilize the scales of measurement by compounding similar indexes (Gnanadesikan, 1977).

For the CPT conditions, hit and false alarm probabilities were obtained, and d' (sensitivity, or discriminability of signal and noise) and the natural log (ln) of β (response criterion) were calculated. For purposes of comparison to the results of Rutschmann et al. (1977), frequency distributions of the effects of signal and noise were assumed to be normal and of equal variance for each condition. Due to the very low rates of misses and false alarms, reliable signal detection indexes could not be derived for the conventional numeral CPT condition. In the rare cases in which a perfect hit or false alarm score was obtained in other conditions, a small constant correction (equal to one half response) was made in the final score for the condition to allow signal detection indexes to be estimated, as suggested by McNicol (1972).

The correlations between d' and ln β from each condition were examined for each group to check the signal detection theory assumption of independence. All correlations varied around zero and did not differ significantly from zero in any group, with the exception of the response-reversal condition. In five of seven groups, a significant negative correlation was obtained for this condition, probably because the high response rate demanded by this task favored a low response criterion. The general independence of d' and ln β indexes and the similarity of correlations across groups support the appropriateness of signal detection theory analyses for these groups.

The d' and ln β scores from 5 CPT conditions, the 14 rating scale scores, and the global averaged index of negative peer appraisal were submitted to principal-components analysis with direct quartimin rotation using the BMDP series P4M program (Dixon & Brown, 1979). The peer appraisal index was included as a marker variable for general low social competence, while the conventional numeral CPT scores were omitted from this analysis due to the inability to obtain reliable d' and ln β values. The highly representative stratified normal group was

Table 4
Loadings on Oblique Factors Derived From Continuous Performance Test, Behavior Rating, and Peer Evaluation Variables

Variable	Loading
Factor 1: Emotionality	
Emotional reactivity	.89
Activity level	.77
Dependency	.74
Friendliness with examiner	.56
Free style of communication	.55
Self-confidence	−.52
Negative peer evaluation	.45
Emotionality after frustration	.44
Passivity	−.36
Factor 2: *d'*	
d' degraded stimulus	.88
d' feedback on hits	.85
d' feedback on false alarms	.85
d' playing cards	.55
d' response reversal	.44
Attention span (rated)	.34
Factor 3: Task Orientation	
Goal orientation	.83
Cooperation	.77
Agreeability	.71
Emotionality after frustration	.55
Attention span (rated)	.45
Passivity	.37
Impulsivity	−.33
Factor 4: Fearful Inhibition	
Fearfulness	.89
Self-confidence	−.73
Friendliness with examiner	−.55
Free style of communication	−.43
d' response reversal	.37
Passivity	.35
Factor 5: β	
Ln β feedback on false alarms	.72
Ln β feedback on hits	.61
Ln β degraded stimulus	.61
Ln β response reversal	.59
Impulsivity	−.45
d' response reversal	−.44
Ln β playing cards	.42

used as the subject base for this analysis to avoid any contamination of the principal component results by atypical or psychopathological scores within the target groups or the less representative matched control groups. This procedure allows the best estimation of the percentile cutoff points for extreme factor scores within the normal population.[2]

This analysis yielded five factors with eigenvalues greater than 1.5, which together accounted for 59% of the total variance. These five factors accounted for 20.7%, 12.4% 10.4%, 8.4%, and 7.1% of the total variance, respectively. Three additional factors with eigenvalues greater than 1.0 were not included in further analyses because their item content could not be clearly labeled, and they individually accounted for no more than 5% of the total variance. The variables with loadings stronger than .30 on the first five rotated factors are presented in Table 4.

The first factor, Emotionality, obtained loadings greater than .30 from several behavioral rating scales reflecting characteristics such as high emotional reactivity, high activity level, high need for attention, immediate warmth with the examiner, and a free style of communication. The second factor, *d'*, obtained loadings from each of the five *d'* scores from individual CPT conditions as well as from a rating of attention span. The major loadings on the third factor reflect ratings of positive focused motivation, suggesting the label Task Orientation. Fearfulness, lack of self-confidence, shyness with the examiner, and limited verbal communication characterize the content of the fourth factor, Fearful Inhibition. Finally, the fifth factor obtained substantial loadings from the response criterion (ln β) indexes from each of the five CPT versions as well as a negative loading from the rating of Impulsivity, suggesting a dimension of caution in responding that was labeled simply β.

These oblique factors have very low intercorrelations. The highest correlation ($r = .23$, $p > .05$) occurs between the *d'* and Task Orientation factors, indicating relatively little common variance between the perceptual sensitivity and motivation factors. As would be expected from signal detection theory, the *d'* and β factors are independent ($r = -.04$).

[2] Supplementary analyses showed that using the entire subject sample for the principal components analysis yielded five rotated factors that were very similar to those derived from the stratified comparison group, indicating that the factors did generalize to the whole sample.

A varimax rotation of the factors was completed to examine the stability of the rotated factors. The same five factors were found, with only minor changes in the levels of factor loadings.

Examination of d' and β Factor Scores

Factor scores for all subjects on the oblique factors were obtained by multiplying the standard scores for the original variables by factor score coefficients. Since accurate factor scores could be computed only for subjects with complete data, two stratified comparison subjects who had not been administered the response-reversal condition of the CPT were omitted from these analyses. For the purpose of examining the number of extreme-scoring subjects in each group, cutpoints were established to isolate the extreme 10% of each tail of the theoretical factor score distributions. The 10% figure was chosen to represent clearly atypical cases while still isolating sufficient numbers for reasonable data analysis. The cutting scores of −1.28 and +1.28 represent the 10th and 90th percentile scores, respectively, for the smoothed normal distribution of the stratified comparison group, the best available estimate of the parallel population percentile scores.

The frequencies of cases obtaining extremely low and extremely high scores on the *d'* and β factors are presented in Table 5. Using the stratified comparison group as the first normal reference point because of its highly representative nature, the hypothesis that the children of schizophrenic mothers would contain an excess of extreme-scoring children was tested by comparison of frequencies using Fisher's exact test. As hypothesized, a significant excess of children born to schizophrenic mothers (7 of 24, or 29%) as compared to stratified normal children (6 of 65, or 9%) obtained extremely low *d'* factor scores ($p = .03$, Fisher's exact test). The breakdown of the initial schizophrenic index group by narrower diagnostic criteria results in relatively small variations in the percentage of extremely low *d'* factor scores across children of RDC schizophrenic, RDC schizoaffective, and DSM-III schizotypal personality disorder mothers. Children of RDC schizophrenic mothers included an excess of extremely low *d'* cases (31%, $p = .05$) relative

Table 5
Percentages and Frequencies of Children Obtaining Extremely Low or High d' or β Factor Scores

		d'				β			
		Low		High		Low		High	
Group	*n*	%	*f*	%	*f*	%	*f*	%	*f*
Stratified normal children	65	9	6	12	8	8	5	12	8
Children of all schizophrenic mothers[a]	24	29	7**	4	1	4	1	8	2
Children of RDC schizophrenic mothers	13	31	4*	8	1	8	1	8	1
Children of RDC schizoaffective mothers	8	25	2	0	0	0	0	13	1
Children of DSM-III schizotypal personality disorder mothers	3	33	1	0	0	0	0	0	0
Matched comparison children	24	8	2	8	2	4	1	13	3
Children of nonpsychotic, psychiatrically disordered mothers	20	10	2	5	1	0	0	0	0
Matched comparison children	20	10	2	15	3	5	1	10	2
Hyperactive children	14	14	2	0	0	29	4*	0	0
Matched comparison children	14	0	0	0	0	7	1	14	2

Note. RDC = Research Diagnostic Criteria. DSM–III = *Diagnostic and Statistical Manual of Mental Disorders*, 3rd edition.
[a] Diagnosis based on Kety, Rosenthal, Wender, and Schulsinger (1968) schizophrenia criteria.
* $p = .05$, compared to the frequency for the stratified normal group.
** $p = .03$, compared to the frequency for the stratified normal group; $p = .07$, compared to the matched group.

to the stratified normal group. Combining RDC schizophrenic and schizotypal personality disorders into a schizophrenic spectrum without the inclusion of schizoaffective disorder results in an identical excess of low d' cases (31%, $p = .04$). The slightly lower frequency among children of RDC schizoaffective mothers (2 of 8, or 25%) is not significantly different from that among children of RDC schizophrenic and schizotypal personality disorder mothers and is in the same range. Thus, the breakdown of maternal index cases by diagnoses narrower than the Kety, Rosenthal, Wender, and Schulsinger (1968) schizophrenia category does not lead to differential rates of low d' cases among this sample of children. Larger sample sizes would be necessary to address this issue more fully.

Fisher's exact test was also computed to evaluate the generalizability of this increase in low d' children among children of schizophrenic mothers to comparisons with the children matched individually on background and personal characteristics to target children in the same classrooms. The children of schizophrenic mothers again tend to include a disproportionately high number of low d' scorers, with 7 of 24 as compared to 2 of 24 matched comparison children falling below -1.28 (Figure 2), but in this case the difference only approaches statistical significance ($p = .07$). It is noteworthy that the actual difference in percentage of low d' scorers is virtually the same as that in the previous comparison with the stratified normal group, but the smaller sample size of matched comparison children leads to a higher probability level.

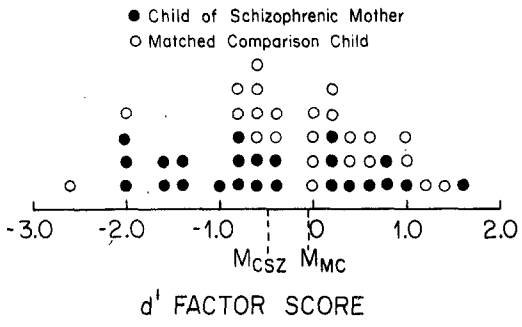

Figure 2. Distribution of d' factor scores for children of schizophrenic mothers and matched comparison children (M_{CSZ} = mean of children of schizophrenic mothers; M_{MC} = mean of matched comparison children).

While the extreme-score analyses are viewed as the most appropriate strategy for examination of possible antecedents of schizophrenia among the children of schizophrenic mothers, the presence of a disproportionate number of atypical scorers may be sufficient to produce group mean differences. One-way analyses of covariance were computed for the three target groups and the stratified comparison group, using sex as a covariate. A planned comparison was employed to examine the principal contrast of interest, children of schizophrenic mothers vs. stratified comparison children, to maximize the power to detect the expected subtle difference in means. As hypothesized, the children born to schizophrenic mothers had a significantly lower mean d' factor score than the stratified normal children, $t(118) = -2.25$, $p < .05$, see Table 6. Using the narrower diagnostic breakdown, the children of RDC schizophrenic and schizotypal personality disorder mothers show the hypothesized significantly lower mean d' compared to the stratified normal children, $t(116) = -1.76$, $p < .05$; $t(116) = -2.38$, $p < .05$, respectively, one-tailed tests. However, the children of schizoaffective mothers do not (see Table 6).

In separate paired t-test analyses of d' and β factor score differences between the children of schizophrenic mothers and their matched comparison group, the children born to schizophrenic mothers again obtained significantly lower mean d' factor scores as hypothesized, $t(23) = -2.03$, $p < .05$, one-tailed test. Lower mean d' factor scores also characterized children of RDC schizophrenic mothers, $t(12) = -2.14$, $p < .01$ (one-tailed), as well as the combination of children of RDC schizophrenic mothers and of schizotypal personality disorder mothers, $t(15) = -2.64$, $p < .01$ (one-tailed), relative to matched comparison children in the narrower diagnostic classification.

Parallel analyses comparing the children of nonpsychotic, psychiatrically disordered mothers and the hyperactive children to stratified and matched comparison children were completed. For mean differences among the children of schizophrenic mothers, children of nonpsychotic, psychiatrically disordered mothers, hyperactive children, and stratified normal children, pairwise comparisons were evaluated by Newman-Keuls analysis if the

Table 6
Mean Factor Scores for the Target Groups and Stratified Normal Group (Adjusted for Sex)

Group	Factor				
	d'	β	Task Orientation	Emotionality	Fearful Inhibition
Stratified normal children	−.01	−.01	.00	.00	−.01
Children of all schizophrenic mothers[a]	−.52*	.03	.04	.33	.10
Children of RDC schizophrenic mothers	−.52*	−.01	−.10	.60	.29
Children of RDC schizoaffective mothers	−.22	.30	.34	−.14	−.22
Children of DSM-III schizotypal personality disorder mothers	−1.36*	−.54	−.13	.39	.11
Children of nonpsychotic, psychiatrically disordered mothers	−.32	−.10	−.30	.10	.46
Hyperactive children	−.35	−.67*	−.70	1.43**	−.67*

Note. RDC = Research Diagnostic Criteria. DSM-III = *Diagnostic and Statistical Manual of Mental Disorders,* 3rd edition.
[a] Diagnosis based on the Kety, Rosenthal, Wender, and Schulsinger (1968) schizophrenia criteria.
* $p < .05$, compared to the stratified normal children.
** $p < .01$, compared to the stratified normal children.

overall F value was significant after the sum of squares due to the planned comparison of offspring of schizophrenic mothers and stratified normal children was removed (Hays, 1973; Kirk, 1968). The remaining effect of group was not significant for d' factor scores, $F(2, 118) = 0.47$ but was significant for β, $F(2, 118) = 3.24$, $p < .05$.

As expected, children born to nonpsychotic, psychiatrically disordered mothers do not differ significantly from stratified or matched normal children on the d' and β factor scores in extreme-score or mean analyses. The hyperactive group, on the other hand, contains a surplus of children having extremely low β factor scores relative to the stratified normal group ($p = 0.5$, Fisher's exact test). Hyperactive children also obtain lower mean β factor scores than the stratified normal group ($p < .05$) and the matched group, $t(13) = -2.70$, $p < .05$ (one-tailed test), as hypothesized. Hyperactive children do not differ significantly from either normal comparison group in analyses of d' factor scores.

As argued elsewhere (Nuechterlein, 1982), tests of mean differences between children of schizophrenic mothers and other children with parental or personal psychopathology are likely to be insensitive tests of the specificity of a deficit to the development of schizophrenic disorders, because only a fraction of the offspring of a schizophrenic parent later develop the disorder or even have a high level of genetic vulnerability. The children of schizophrenic mothers did tend to have a higher frequency of extremely low d' factor scores (7 of 24) than the children of nonpsychotic psychiatric patients (2 of 20), but this difference did not reach statistical significance ($p = .115$) despite the fact that the latter frequency is at the normal population base rate (10%). Thus, larger samples would be necessary to establish that the indicated differential rate of low d' cases among offspring of schizophrenic mothers is reliably higher than that found among offspring of nonpsychotic, psychiatrically disordered mothers. A similar constraint applies to the more unexpected directional trend toward a greater frequency of extremely low d' cases among offspring of schizophrenic mothers relative to hyperactive children.

The hyperactive group, for which mean analyses are likely to be more powerful because every case was selected for personal psychopathology, obtained a significantly lower mean β factor score than either of the groups with maternal psychopathology ($p < .05$, Newman-Keuls). The hyperactive group also included more extremely low β cases than either the children of schizophrenic

mothers ($p = .05$) or the children of nonpsychotic, psychiatrically disordered mothers ($p = .02$).

Examination of Task Orientation, Emotionality, and Fearful Inhibition Factor Scores

Analyses for Task Orientation, Emotionality, and Fearful Inhibition paralleled those for the d' and β factors. Extreme-score analyses (see Table 7) found no significant excess of deviant cases for these motivational and personality factors among the children of the initial index schizophrenic mothers, but the narrower diagnostic breakdown reveals that children of RDC schizophrenic mothers are significantly more likely to obtain high Fearful Inhibition scores than are the stratified normal children ($p = .05$, Fisher's exact test) or the hyperactive children ($p = .02$). No significant mean differences were found between offspring of schizophrenics and the stratified or matched comparison children (see Table 6).

For the sum of squares remaining after the planned comparison of offspring of schizophrenic mothers and stratified normal children, the overall effect of group is significant for Task Orientation, $F(2, 118) = 3.15$, $p < .05$; Emotionality, $F(2, 118) = 9.85$, $p < .01$; and Fearful Inhibition, $F(2, 118) = 4.38$, $p < .05$. Newman-Keuls analyses indicate that the hyperactive children obtain significantly higher Emotionality scores ($p < .01$) and lower Fearful Inhibition scores ($p < .05$) than the stratified normal group or either of the maternal psychopathology groups (Table 6).

The high emotional reactivity of the hyperactive children is also revealed in an excess of extremely high Emotionality score cases (see Table 7) relative to stratified and matched normal children and to children of schizophrenic or nonpsychotic, psychiatrically disordered mothers ($p = .02$ or less in each case, Fisher's exact test). The same high Emotionality level is evident in the paired t-test comparison with the matched group, $t(13) = 4.80$, $p < .001$. Further evidence of the low Fearful Inhibition scores of hyperactive children is present in findings that they are significantly more likely to obtain extremely low scores than are the stratified ($p = .01$) or matched ($p = .02$) comparison children (Table 7).

The children of nonpsychotic, psychiatrically disordered mothers do not differ significantly from either the stratified normal children or the children of schizophrenic mothers in Newman-Keuls analyses of these factors. In addition, the Newman-Keuls procedure indicates no significant pairwise differences between groups in Task Orientation factor scores, although some increase in the frequency of extremely low scores on this motivational factor is present among hyperactive children relative to the stratified normal group ($p = .05$).

Effects of Task Condition

In order to clarify further the nature of the performance deficit among children of schizophrenic mothers, additional analyses examined the effect of task condition on the performance of these children and the large stratified normal comparison group. It was hypothesized that feedback would shift the overall level of scores but that deficits among children of schizophrenic mothers would occur across all motivational feedback conditions. To evaluate the effect of auditory feedback, 2 (group) × 3 (condition: no feedback vs. feedback on hits vs. feedback on false alarms) analyses of covariance were computed with condition as a repeated measure and sex as covariate. To equate the number of experimental trials, only the first half of the no-feedback degraded stimulus condition was considered.

In planned contrasts, a significantly higher false alarm rate (.049 vs. .028) and lower d' (3.24 vs. 3.56) are found for children of schizophrenic mothers as compared to stratified comparison children across the three feedback conditions, $t(86) = 2.37$, $p < .01$, and $t(86) = -1.663$, $p < .05$, one-tailed tests, respectively. For hit rate the means are in the expected direction but not significantly different, (.867 vs. .896), $t(86) = -1.25$, $p < .11$, one-tailed test. As expected, ln β does not differ between groups, and none of the interactions between group and feedback conditions approaches statistical significance, indicating that motivational feedback did not affect the children of schizophrenic mothers differentially.

The overall higher false alarm rate and lower d' of offspring of schizophrenic mothers occur despite significant feedback condition

Table 7
Percentages and Frequencies of Children Obtaining Extremely Low or High Task Orientation, Emotionality, or Fearful Inhibition Factor Scores

		Task Orientation				Emotionality				Fearful Inhibition			
		Low		High		Low		High		Low		High	
Group	*n*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*
Stratified normal children	65	8	5	8	5	9	6	11	7	6	4	14	9
Children of all schizophrenic mothers[a]	24	13	3	13	3	13	3	21	5	13	3	25	6
Children of RDC schizophrenic mothers	13	23	3	15	2	8	1	23	3	8	1	38	5*
Children of RDC schizoaffective mothers	8	0	0	13	1	13	1	13	1	25	2	13	1
Children of DSM-III schizotypal personality disorder mothers	3	0	0	0	0	33	1	33	1	0	0	0	0
Matched comparison children	24	8	2	4	1	0	0	4	1	4	1	13	3
Children of nonpsychotic, psychiatrically disordered mothers	20	15	3	0	0	0	0	10	2	5	1	20	4
Matched comparison children	20	5	1	0	0	10	2	5	1	0	0	10	2
Hyperactive children	14	29	4*	0	0	0	0	64	9***	36	5**	0	0
Matched comparison children	14	21	3	14	2	7	1	14	2	0	0	0	0

Note. RDC = Research Diagnostic Criteria. DSM–III = *Diagnostic and Statistical Manual of Mental Disorders*, 3rd edition.
[a] Diagnosis is based on the Kety, Rosenthal, Wender, and Schulsinger (1968) schizophrenia criteria.
* $p = .05$, compared to the frequency for the stratified normal group.
** $p = .01$, compared to the frequency for the stratified normal group; $p = .02$, compared to the frequency for the matched group.
*** $p = .001$, compared to the frequency for the stratified normal group; $p = .01$, compared to the frequency for the matched group.

main effects, suggesting that the feedback manipulation had an impact on overall level of performance: for false alarms, $F(2, 174) = 13.00$, $p < .001$; for d', $F(2, 174) = 6.02$, $p < .01$. Hit rate was not significantly affected. Newman-Keuls analysis indicates (a) that false alarm rates increase from no-feedback to false-alarms-feedback to hits-feedback conditions ($p < .05$, for each pairwise comparison) and (b) that d' is higher during no-feedback than it is during false-alarms-feedback ($p < .05$) and hits-feedback conditions ($p < .01$). Similarly, the condition effect for $\ln \beta$ is significant, $F(2, 174) = 4.92$, $p < .01$, and Newman-Keuls tests reveal that $\ln \beta$ is lower in the hits-feedback condition than in either of the other conditions ($p < .05$).

Similar analyses were completed to evaluate the effect of varying stimulus encoding and response organization difficulty level. Two 2 (group) × 3 (condition) repeated measures analyses of covariance with sex as covariate and the conventional numeral, degraded-stimulus, and response-reversal conditions as a repeated measure were completed for hit rate and false alarm rate. However, since the Group × Condition interactions that would indicate differential condition effects across groups are not significant, these analyses are not detailed here.

Because comparisons of group means may not reflect the power of the separate conditions to isolate deviant performance of a small subgroup, an outlier analysis was also conducted on the d' score from each condition for which this signal detection index could be derived. Using the 10th percentile among the stratified normal comparison children as the cutting point, the number of children obtaining lower scores was tallied for the children born to schizophrenic mothers and the stratified normal children. This analysis indicates that the degraded-stimulus condition without feedback isolates a disproportionate number of children of schizophrenic mothers (7 of 24, as compared to 6 of 67 stratified normal children, $p = .02$, Fisher's exact test). The d' scores from the two degraded-stimulus conditions with feedback show similar directional trends, but the response-reversal and playing-card conditions do not (2 of 24 and 0 of 24 children born to schizophrenic mothers have d' scores in this range for the response-reversal and playing-card conditions, respectively). An equivalent number of deviant responders are isolated when only the first half of the trials for the degraded-stimulus no-feedback condition are considered to equate number of trials.

For the degraded-stimulus condition without feedback, separate outlier analyses examined the contributions of hit rate and false alarm rate to the detection of deviant performers. Again using the 10th percentile among the stratified normal sample as the cutoff, low hit rate (<.78) is found among a disproportionately large number of children born to schizophrenic mothers (7 of 24, as compared to 6 of 67 stratified normal children, $p = .02$, Fisher's exact test).

Vigilance Decrement Over Time

A decrement in sustained attention is most clearly indicated by a decrease in perceptual sensitivity (d') over time (Davies & Parasuraman, 1982; Parasuraman, in press-a), which is also usually evident in a decrease in hit rate and a more moderate decrease or lack of change in false alarm rate. To examine time-liked vigilance decrements, 2 (group) × 3 (time periods) analyses of covariance were computed for the degraded-stimulus condition performance of the children of schizophrenic mothers and the stratified normal children, using sex as a covariate and periods as a repeated measure. The condition without feedback was examined because of its duration and its independent ability to isolate an excess of extremely low-scoring offspring of schizophrenic mothers. Each time period represents 230 sec (3.83 minutes) of task time. Orthogonal decomposition was employed to separate linear and quadratic changes over time. As shown in Figure 3, the hit rate is significantly lower for children born to schizophrenic mothers than for the stratified normal children, $t(88) = -1.67$, $p < .05$, one-tailed test. Hit rate also shows a linear decrease over periods, $F(1, 89) = 24.89$, $p < .0001$, steeper, but not significantly so, for children of schizophrenic mothers as compared to the stratified normal children (Group × Linear-Time-Effect interaction), $F(1, 89) = 3.08$, $p = .08$. False alarm rate fails to distinguish the groups significantly, $t(88) = 1.22$, $p < .12$ (one-tailed test), and yields no significant time effects. The d' index

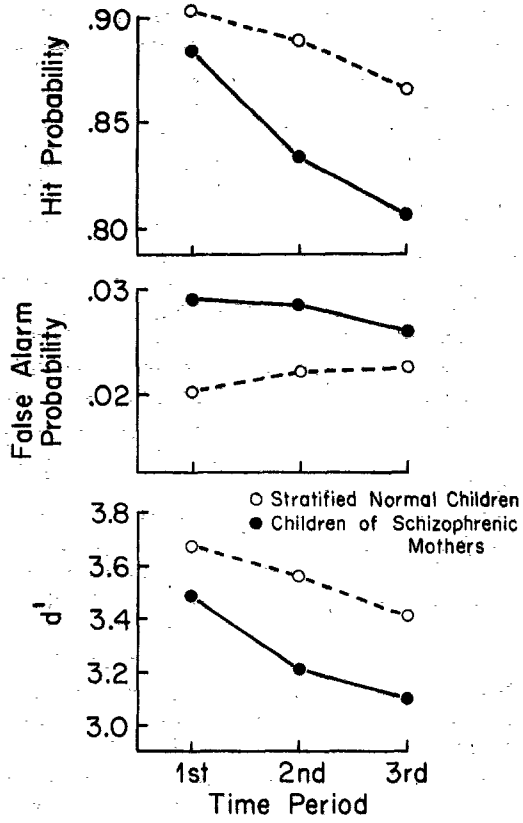

Figure 3. Changes in hit probability, false alarm probability, and d' over time periods of the degraded-stimulus continuous performance test for children of schizophrenic mothers and stratified normal children (each time period equals 230 sec).

also tends to be lower for the children of schizophrenic mothers, $t(88) = -1.62$, $p < .06$ (one-tailed test), and decreases linearly over time, $F(1, 89) = 14.06$, $p < .001$, but the linear decrease does not occur differentially across groups, $F(1, 89) = 0.54$, $p > .40$. Ln β increases linearly over periods, $F(1, 89) = 5.15$, $p < .05$, but this period effect is not significantly different across the children of schizophrenic mothers and stratified normal children, nor do these groups differ in ln β.[3]

Supplementary analyses indicate no differential time decrements in the performance of the low d' subgroup of children born to schizophrenic mothers, but rather a lower hit rate, higher false alarm rate, and lower d' across the three time periods. Ln β for the low d' subgroup does not differ significantly from that of the remaining children of schizophrenic mothers.

Vigilance decrements over time were also examined for hyperactive children, the other group showing performance differences relative to normal comparison children in the initial analysis of factor scores. Including only male stratified normal children ($n = 43$) to control for sex effects, 2 (group) × 3 (time period) analyses of variance were computed. The Group × Linear-Time-Effect interaction is significant for ln β, $F(1, 55) = 4.82$, $p < .05$. Hyperactive children show a steeper increase in ln β over the three time periods (.42 to .94 to 1.10) than do the stratified normal children (1.19 to 1.10 to 1.27). Simple main effects indicate that hyperactive children are significantly less cautious than stratified normal children in their response criterion for the first period, $F(1, 165) = 6.14$, $p < .05$. The two groups do not differ significantly in ln β in the last two periods due to the rapid increase in response criterion among the hyperactive children.

Discussion

A disproportionately *large subgroup* of children born to schizophrenic mothers are found to have very low perceptual sensitivity (d' factor scores) during vigilance, as compared to representatively stratified normal children. Significantly lower *mean* perceptual sensitivity is also evident among children of schizophrenic mothers relative to both stratified and matched classroom comparison children. These differences are present whether maternal index cases are defined by the schizophrenia criteria of Kety et al. (1968), by criteria for either schizotypal personality disorder (DSM-III) or RDC schizophrenia, or by RDC schizophrenia criteria alone.

Children born to mothers with nonpsychotic psychiatric disorders falling outside the schizophrenia spectrum show no vigilance performance deficits. The frequency of low perceptual sensitivity among children of nonpsychotic, psychiatrically disordered

[3] Eliminating the children of RDC schizoaffective mothers from these analyses of decrement over time yields parallel findings. The remaining high-risk children obtained a lower hit rate, $t(80) = -2.06$, $p < .05$, and a lower d', $t(80) = -1.85$, $p < .05$, but not a significantly greater decrement over time than the stratified comparison group.

mothers is at the population base rate. However, larger sample sizes would be necessary to demonstrate that the rate among these children is reliably lower than the rate among children born to schizophrenic mothers.

Hyperactive children, on the other hand, are characterized by lower response criterion (β factor scores) in their vigilance performance compared to stratified normal children, both in mean and extreme subgroup analyses. The mean β factor score of hyperactive children is also significantly lower than that of matched classroom comparison children, children of schizophrenic mothers, and children of nonpsychotic, psychiatrically disordered mothers. The hyperactive children do not show significantly lower perceptual sensitivity than stratified or matched normal children, but they are rated significantly higher than both groups on an Emotionality factor and lower than the stratified normal group on a Fearful Inhibition factor.

Thus, children of schizophrenic mothers, especially a deviant subgroup, display a vigilance performance and behavioral pattern that differs from that exhibited by the hyperactive children. The children of schizophrenic mothers exhibit low d' (and a disproportionately large subgroup of children of RDC schizophrenic mothers show high Fearful Inhibition), whereas the hyperactive children exhibit low β, more Emotionality, and less Fearful Inhibition.

Data from three separate sources suggest that the deficit in perceptual sensitivity (d') during vigilance among some children of schizophrenic mothers is not easily attributable to motivational factors. First, offspring of schizophrenic mothers did not differ from representatively stratified or matched normal comparison children on the Task Orientation factor, an index of focused motivation. Supplementary analyses also indicated that the 7 children of schizophrenic mothers who obtained especially low d' values on the degraded-stimulus CPT did not differ significantly from the remaining 17 offspring on any behavioral rating (including cooperation, goal orientation, and attention span) except agreeability, for which low d' children were rated lower.

A second source of evidence is the β index of response criterion during vigilance. The response criterion index would be raised by lack of involvement and hesitant styles of responding that led to low response frequency. The children of schizophrenic mothers did not differ from stratified or matched comparison children in response criterion (β), nor did extremely low d' children of schizophrenic mothers differ from the remaining offspring of schizophrenic mothers on this measure.

The parallel response to incentive feedback displayed by children of schizophrenic mothers and stratified comparison children provides a third source of evidence arguing against a motivational explanation for lower d' among offspring of schizophrenic mothers. If the d' deficit found among children of schizophrenic mothers was due to motivational factors, one would expect motivational feedback to affect performance of this group more than it does that of representative normal children, but this did not occur. Contingent feedback and general urging to respond to each target affected performance of both groups by increasing the number of false alarms, especially for the hits-feedback condition, in which the rewarding bell-ring following correct responses apparently encouraged additional willingness to initiate other button presses. The d' difference between the children born to schizophrenic mothers and stratified normal children is consistent across the three degraded-stimulus CPT conditions. This consistency of performance deficit across incentive conditions adds strength to the earlier finding of Marcus (1972) using a reaction time paradigm. While overall slowed reaction time could reflect higher response criterion values (Nuechterlein, 1977b), the signal detection analysis in the current study allows a response criterion source of deficit to be ruled out.

Multiple versions of the CPT were used to examine both the commonality of performance across tasks and the impact of certain stimulus and response manipulations. The commonality of d' and ln β across five CPT adaptations is supported by the results of the principal components analysis. Furthermore, the number of hits in the conventional CPT condition is significantly and moderately correlated with hits in the playing-card, response-reversal, and degraded-stimulus CPT versions (.27 to .42 for all 183 subjects), despite the restriction of range of the former

scores. This suggests that results from these CPT adaptations can be related to previous research that employed versions similar to the conventional numeral condition.

Analyses of the ability of each condition to isolate a disproportionately large deviant subgroup of children born to schizophrenic mothers indicated that the degraded-stimulus condition alone could identify such a subgroup as effectively as the *d'* factor score. The playing-card, response-reversal, and conventional CPT conditions could not independently isolate such a disproportionately large poor-scoring subgroup. The correlations of the *d'* scores for the degraded-stimulus CPT conditions with the *d'* factor score (.85, .85, and .83 for the no-feedback, hits-feedback, and false-alarms-feedback conditions, respectively) indicate that this CPT version also provides a good estimate of the *d'* factor obtained in this research.

The current findings extend the previous findings of Rutschmann et al. (1977), Erlenmeyer-Kimling and Cornblatt (1978), and Grunebaum et al. (1974) regarding deficits in CPT performance of children of a schizophrenic parent relative to children of normal parents. The CPT *d'* factor deficit is found among children born to schizophrenic mothers relative to both matched and representatively stratified normal comparison children but not among children born to mothers with psychiatric disorders falling outside the schizophrenia spectrum. Since the maternal psychopathology comparison group in this study consisted of women with nonpsychotic conditions (mostly depressive in nature), additional research will be necessary to determine whether this CPT *d'* deficit is found among children at risk for psychotic conditions other than schizophrenia.

The present results also suggest that some previous negative results regarding CPT performance differences between offspring of schizophrenic mothers and offspring of normal mothers (Asarnow et al., 1977; Grunebaum et al., 1974, for the 6-year-olds) may be due to the use of conventional versions of the CPT with a clearly focused single-letter or single-number target stimulus. These versions require sustained monitoring, but the recognition of single, well-learned, very familiar letters or numbers involves little or no demand on processing capacity, at least among normal individuals (Posner, 1978; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). As in past research that used this conventional version, the current study found that the children of schizophrenic mothers could not be differentiated from comparison children in performance on the conventional numeral CPT condition.

Whether the successful differentiation of children born to schizophrenic mothers and comparison children on more difficult CPT adaptations is linked to demands on specific deficient processes or to increased overall demands on limited processing capacity is not clear at this point. The playing-card CPT that produced group mean *d'* differences between children of a schizophrenic parent and children of normal parents in the study reported by Rutschmann et al. (1977) requires memory of the preceding stimulus in order to detect successive identical stimuli. The degraded-stimulus CPT, on the other hand, requires only immediate detection and recognition of a target stimulus that is presented at a single point in time, thereby eliminating the need for memory of successive stimuli and rehearsal of previous stimuli. The fact that the *d'* levels of the degraded-stimulus CPT condition are higher than those for the playing-card and response-reversal CPT conditions (3.56, 2.33, and 2.72, respectively, for the representatively stratified normal group) suggests that the degraded-stimulus CPT findings for the offspring of schizophrenic mothers are not due to greater overall difficulty level. The degraded-stimulus CPT apparently increases demand on processing resources relative to the conventional numeral condition by burdening early stimulus-encoding and analysis processes. However, additional research is required to determine precisely which task features produce differential deficits in CPT performance among children at risk for later schizophrenia.

Although CPT deficits in clinical populations have usually been assumed to reflect difficulties in sustained attention, few attempts have been made to examine directly whether differential performance decrement over time is actually present. The rapid *d'* decrements in the degraded-stimulus CPT make it particularly suitable for efficient detection of sustained attention deficits across task periods, since longer tasks and memory

for successive stimuli are usually required to obtain d' decrements (Davies & Parasuraman, 1982; Parasuraman, 1979). The data from the current study suggest that low vigilance level differentiates children of schizophrenic mothers from representative normal comparison children but that d' does not decline differentially over time in these children. Only a trend toward a steeper decline in hit rate over time is present.

The indication that d' level deficits across all time periods of the degraded-stimulus CPT account for the overall lower d' of children born to schizophrenic mothers suggests that alterations in arousal level and/or difficulties in rapid extraction of relevant stimulus features in each trial may be involved. Overall level of vigilance, rather than decrement over time, has been found to relate to optimal level of central arousal (Parasuraman, in press-b). Moreover, previous CPT findings with schizophrenic adults have indicated an association of poor CPT performance with less slow-wave sleep and possibly more high frequency (beta 2) EEG activity, which has been interpreted as consistent with earlier psychopharmacologic evidence indicating that central hyperarousal may interfere with CPT performance in schizophrenia (Kornetsky & Mirsky, 1966; Kornetsky & Orzack, 1978).

The possibility that errors or slowness in information processing in each trial, rather than differential decrement over time, account for the lower degraded-stimulus CPT d' levels of some children born to schizophrenic mothers provides a bridge to studies of signal detection and speed of information processing in schizophrenia. Visual and auditory signal recognition in the presence of noise have been found deficient in adult schizophrenic patients (Rappaport, Hopkins, & Hall, 1972; Stilson & Kopell, 1964; Stilson, Kopell, Vandenbergh, & Downs, 1966). Furthermore, in a series of backward masking studies, performance of schizophrenic and schizotypal patients has been shown to be particularly impaired by visual masks, even if stimulus recognition levels have been equated in a condition without a mask (Braff, 1981; Brody, Saccuzzo, & Braff, 1980). These backward masking impairments have been viewed as indications of slow posticonic processing in schizophrenia (Saccuzzo & Braff, 1981; Braff & Saccuzzo, 1981), a deficit that would also be a handicap in a rapidly paced vigilance task requiring relatively difficult stimulus discriminations.

An even closer possible relationship between the backward masking findings and the current degraded-stimulus CPT results is suggested by recent evidence favoring an integration model rather than a processing-interruption model of visual masking (Carlson & Mayzner, 1977; Felsten & Wasserman, 1980; Schultz & Eriksen, 1977). This evidence indicates that, rather than operating through separate mechanisms, concurrent and backward binocular visual masking both involve mainly summation of the sensory information of the target and masking stimulus. The extent of masking interference is dependent not only on the time relationship between the target and mask stimuli but also on their relative energy levels and the nature of their figural overlap (Felsten & Wasserman, 1980; Schultz & Eriksen, 1977). These considerations raise the possibility that the schizophrenia-related impairment being tapped in both concurrent and backward incomplete visual masking could involve lower perceptual sensitivity for weak signals in a relatively strong noise background.

The hyperactive children in the current study, on the other hand, show neither overall perceptual sensitivity (d') deficits nor differential decrement in sensitivity over time. This lack of d' deficit among hyperactive children was unexpected, because previous conventional CPT findings for hyperactive children have included both lower hit and higher false alarm rates (Klorman et al., 1979; Sykes et al., 1973; Sykes, Douglas, Weiss, & Minde, 1971), which would imply lower d' levels. One possible factor is the sample selection procedure employed for hyperactive children in the current study. The hyperactive children were older than those in most previous research and were required to be unmedicated and relatively low in antisocial behavor. These factors may lead to selection of a subgroup of hyperactive children who have no d' deficit.

While further research is desirable to clarify whether perceptual sensitivity (d') level deficits or differential time decrements are present among some hyperactive children, the current results point to the importance

of lower response criterion levels among hyperactive children. The hyperactive children obtained lower β factor scores than either normal comparison group or either maternal psychopathology group. This lower response criterion indicates a tendency to respond as if stimuli are relevant even when only limited sensory evidence supports their relevance. The analysis of degraded-stimulus CPT performance across time periods indicates that this lack of caution in making decisions about stimulus relevance is evident primarily at the beginning of the vigilance task, before any effects of boredom would be expected. The response criterion findings provide further evidence of an impulsive cognitive style among hyperactive children (Douglas, 1972, 1980) and indicate the fruitfulness of separating perceptual sensitivity and response criterion components of vigilance performance in studies of clinical populations.

The present data, then, support and extend previous indications that low signal detectability in CPT tasks may be a phenotypic indicator of vulnerability to schizophrenic disorder or an early manifestation of disordered processes leading toward schizophrenic psychosis (Hanson, Gottesman, & Meehl, 1977). Previous CPT results have suggested that not only chronic schizophrenic patients (Orzack & Kornetsky, 1966) but also remitted schizophrenic patients (Asarnow & MacCrimmon, 1978; Wohlberg & Kornetsky, 1973) and children of a schizophrenic parent (Erlenmeyer-Kimling & Cornblatt, 1978; Rutschmann et al., 1977) have lower detection rates than normal comparison groups. The incidence of psychiatric disorder in biological relatives has also been found to be higher among schizophrenic patients with poor CPT performance (Orzack & Kornetsky, 1971). The current research indicates that the deficit among 9- to 16-year-old children of schizophrenic mothers, especially a deviant subgroup, is characterized by lower perceptual sensitivity (d') (a) that is not due to transient or observable motivational deficits, (b) that is not present among children of mothers with nonpsychotic, non-schizophrenia-spectrum psychiatric disorders or age-matched hyperactive (but not antisocial) children, and (c) that is evident throughout the vigilance period. A new adaptation of the CPT employing degraded stimuli and a concurrent visual noise mask appears to be useful in detecting this deficit in perceptual sensitivity.

Reference Notes

1. Strauss, J. S., & Harder, D. W. *The Case Record Rating Scale: A method for rating symptom and social function data from case records.* Unpublished manuscript. (Available from J. S. Strauss, Department of Psychiatry, Yale University, New Haven, Conn. 06510).
2. Hollingshead, A. B. *Two-factor index of social position.* Unpublished manuscript, 1957. (Available from A. B. Hollingshead, 1965 Yale Station, New Haven, Conn. 06510).

References

Achenbach, T. M. The classification of children's psychiatric symptoms: A factor analytic study. *Psychological Monographs*, 1966, *80*(7, Whole No. 615).

American Psychiatric Association. *Diagnostic and statistical manual of mental disorders* (2nd ed.). Washington, D.C.: Author, 1968.

American Psychiatric Association. *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, D.C.: Author, 1980.

Asarnow, R. F., & MacCrimmon, D. J. Residual performance deficit in clinically remitted schizophrenics: A marker of schizophrenia? *Journal of Abnormal Psychology*, 1978, *87*, 597–608.

Asarnow, R. F., Steffy, R. A., MacCrimmon, D. J., & Cleghorn, J. M. An attentional assessment of foster children at risk for schizophrenia. *Journal of Abnormal Psychology*, 1977, *86*, 267–275.

Borland, B. L. & Heckman, H. K. Hyperactive boys and their brothers: A 25-year follow-up study. *Archives of General Psychiatry*, 1976, *33*, 669–675.

Bower, E. M. *Early identification of emotionally handicapped children in school.* Springfield, Ill.: Charles C Thomas. 1960.

Braff, D. L. Impaired speed of information processing in nonmedicated schizotypal patients. *Schizophrenia Bulletin*, 1981, *7*, 499–508.

Braff, D. L., & Saccuzzo, D. P. Information processing dysfunction in paranoid schizophrenia: A two-factor deficit. *American Journal of Psychiatry*, 1981, *138*, 1051–1056.

Broadbent, D. E. *Decision and stress.* London: Academic Press, 1971.

Brody, D., Saccuzzo, D. P., & Braff, D. L. Processing of masked and unmasked stimuli in schizophrenia and old age. *Journal of Abnormal Psychology*, 1980, *89*, 617–622.

Broen, W. E., Jr., & Storms, L. H. A theory of response interference in schizophrenia. In B. A. Maher (Ed.), *Progress in experimental personality research* (Vol. 4). New York: Academic Press, 1967.

Cantwell, D. P. Psychiatric illness in the families of hyperactive children. *Archives of General Psychiatry*, 1972, *27*, 414–417.

Carlson, K., & Mayzner, M. S. A reassessment of target-mask interaction in visual backward masking. *Bulletin of the Psychonomic Society*, 1977, *9*, 227–229.

Chapman, L. J., & Chapman, J. P. *Disordered thought in schizophrenia.* New York: Appleton-Century-Crofts, 1973.

Cohler, B. J., Grunebaum, H. U., Weiss, J. L., Gamer, E., & Gallant, D. H. Disturbances of attention among schizophrenic, depressed and well mothers and their children. *Journal of Child Psychology and Psychiatry,* 1977, *18,* 115–135.

Cowen, E. L., Pederson, A., Babigian, H., Izzo, L. D., & Frost, M. A. Long-term follow-up of early detected vulnerable children. *Journal of Consulting and Clinical Psychology,* 1973, *41,* 438–446.

Davies, D. R., & Parasuraman, R. *The psychology of vigilance.* London: Academic Press, 1982.

Dixon, W. J., & Brown, M. B. *BMDP-79: Biomedical computer programs, P-Series.* Berkeley: University of California Press, 1979.

Douglas, V. I. Stop, look and listen: The problem of sustained attention and impulse control in hyperactive and normal children. *Canadian Journal of Behavioral Science,* 1972, *4,* 259–282.

Douglas, V. I. Treatment and training approaches to hyperactivity: Establishing internal or external control. In C. K. Whalen & B. Henker (Eds.), *Hyperactive children: The social ecology of identification and treatment.* New York: Academic Press, 1980.

Erlenmeyer-Kimling, L., & Cornblatt, B. Attentional measures in a study of children at high-risk for schizophrenia. *Journal of Psychiatric Research,* 1978, *14,* 93–98.

Felsten, G., & Wasserman, G. S. Visual masking: Mechanisms and theories. *Psychological Bulletin,* 1980, *88,* 329–353.

Gallant, D. H. Selective and sustained attention in young children of psychotic mothers. (Doctoral dissertation, Boston University, 1972). *Dissertation Abstracts International,* 1972, *33,* 1761B–1762B. (University Microfilms No. 72-25, 275)

Gamer, E., Gallant, D., Grunebaum, H. U., & Cohler, B. J. Children of psychotic mothers: Performance of 3-year-old children on tests of attention. *Archives of General Psychiatry,* 1977, *34,* 592–597.

Garmezy, N. The prediction of performance in schizophrenia. In P. Hoch and J. Zubin (Eds.), *Psychopathology of schizophrenia.* New York: Grune and Stratton, 1966.

Garmezy, N. Children at risk: The search for the antecedents of schizophrenia. Part II: Ongoing research programs, issues, and intervention. *Schizophrenia Bulletin, 1974, 1*(9), 55–125.

Garmezy, N., & Streitman, S. Children at risk: The search for the antecedents of schizophrenia. Part I. Conceptual models and research methods. *Schizophrenia Bulletin,* 1974, *1*(8), 14–90.

Gnanadesikan, R. *Methods for statistical data analysis of multivariate observations.* New York: Wiley, 1977.

Green, D. M., & Swets, J. A. *Signal detection theory and psychophysics.* New York: Wiley, 1966.

Grunebaum, H., Weiss, J. L., Gallant, D., & Cohler, B. J. Attention in young children of psychotic mothers. *American Journal of Psychiatry,* 1974, *131,* 887–891.

Hanson, D. R., Gottesman, I. I., & Heston, L. L. Some possible childhood indicators of adult schizophrenia inferred from children of schizophrenics. *British Journal of Psychiatry,* 1976, *129,* 142–154.

Hanson, D. R., Gottesman, I. I., & Meehl, P. E. Genetic theories and the validation of psychiatric diagnosis: Implications for the study of children of schizophrenics. *Journal of Abnormal Psychology,* 1977, *86,* 575–588.

Harvey, P., Winters, K., Weintraub, S., & Neale, J. M. Distractibility in children vulnerable to psychopathology. *Journal of Abnormal Psychology,* 1981, *90,* 298–304.

Hays, W. L. *Statistics for the social sciences* (2nd ed.). New York: Holt, Rinehart, and Winston, 1973.

Hunt, J. McV., & Cofer, C. N. Psychological deficit. In J. McV. Hunt (Ed.), *Personality and the behavior disorders* (Vol. 2). New York: Ronald Press, 1944.

Jones, F. H. Current methodologies for studying the development of schizophrenia: A critical review. *Journal of Nervous and Mental Disease,* 1973, *157,* 154–178.

Kendler, K. S., Gruenberg, A. M., & Strauss, J. S. An independent analysis of the Copenhagen sample of the Danish Adoption Study of Schizophrenia: I. The relationship between schizotypal personality disorder and schizophrenia. *Archives of General Psychiatry,* 1981, *38,* 982–984.

Kety, S. S., Rosenthal, D., Wender, P. H., & Schulsinger, F. The types and prevalence of mental illness in the biological and adoptive families of adopted schizophrenics. In D. Rosenthal & S. S. Kety (Eds.), *The transmission of schizophrenia.* Oxford, England: Pergamon, 1968.

Kety, S. S., Rosenthal, D., Wender, P. H., Schulsinger, F., & Jacobsen, B. The biologic and adoptive families of adoptive individuals who became schizophrenic: Prevalence of mental illness and other characteristics. In L. C. Wynne, R. L. Cromwell, & S. Matthysse (Eds.), *The nature of schizophrenia: New approaches to research and treatment.* New York: Wiley, 1978.

Kirk, R. E. *Experimental design: Procedures for the behavioral sciences.* Belmont, Calif.: Brooks/Cole, 1968.

Klorman, R., Salzman, L. F., Pass, H. L., Borgstedt, A. D., & Dainer, K. B. Effects of methylphenidate on hyperactive children's evoked responses during passive and active attention. *Psychophysiology,* 1979, *16,* 23–29.

Kohlberg, L., La Crosse, J., & Ricks, D. The predictability of adult mental health from childhood behavior. In B. B. Wolman (Ed.), *Manual of child psychopathology.* New York: McGraw-Hill, 1972.

Kornetsky, C. The use of a simple test of attention as a measure of drug effects in schizophrenic patients. *Psychopharmacologia,* 1972, *24,* 99–106.

Kornetsky, C., & Mirsky, A. F. On certain psychopharmacological and physiological differences between schizophrenics and normal persons. *Psychopharmacologia,* 1966, *8,* 309–318.

Kornetsky, C., & Orzack, M. H. Physiological and behavioral correlates of attention dysfunction in schizophrenic patients. *Journal of Psychiatric Research,* 1978, *14,* 69–79.

Kupietz, S. S. Attentiveness in behaviorally deviant and nondeviant children: I. Auditory vigilance performance. *Perceptual and Motor Skills,* 1976, *43,* 1095–1101.

Latz, A., & Kornetsky, C. The effects of chlorpromazine and secobarbitol under two conditions of reinforcement on the performance of chronic schizophrenic subjects. *Psychopharmacologia,* 1965, *7,* 77–88.

Mackworth, J. F. *Vigilance and attention: A signal detection approach.* Baltimore, Md.: Penguin Books, 1970.

Marcus, L. M. Studies of attention in children vulnerable to psychopathology. (Doctoral dissertation, University of Minnesota, 1972). *Dissertation Abstracts International*, 1973, *33*, 5023-B. (University Microfilm No. 73-10, 606)

Marks, P. A., Seeman, W., & Haller, D. L. *The actuarial use of the MMPI with adolescents and adults.* Baltimore, Md.: Williams & Wilkins, 1974.

Massaro, D. W. *Experimental psychology and information processing.* Chicago, Ill.: Rand-McNally, 1975.

McGhie, A. Attention and perception in schizophrenia. In B. A. Maher (Ed.), *Progress in experimental personality research* (Vol. 5). New York: Academic Press, 1970.

McGhie, A., & Chapman, J. Disorders of attention and perception in early schizophrenia. *British Journal of Medical Psychology*, 1961, *34*, 103–116.

McNicol, D. *A primer of signal detection theory.* London: George Allen & Unwin, 1972.

Mednick, S. A. Berkson's fallacy and high-risk research. In L. C. Wynne, R. L. Cromwell, & S. Matthysse (Eds.), *The nature of schizophrenia: New approaches to research and treatment.* New York: Wiley, 1978.

Mednick, S. A., & McNeil, F. F. Current methodology in research on the etiology of schizophrenia: Serious difficulties which suggest the use of the high risk group method. *Psychological Bulletin*, 1968, *70*, 681–693.

Meehl, P. E. Nuisance variables and the ex post facto design. In M. Radner & S. Winokur (Eds.), *Minnesota studies in the philosophy of science, IV.* Minneapolis: University of Minnesota Press, 1970.

Mendelson, W., Johnson, N., & Stewart, M. Hyperactive children as teenagers: A follow-up study. *Journal of Nervous and Mental Disease*, 1971, *153*, 272–279.

Menkes, M., Rowe, J., & Menkes, J. A 25-year follow-up study on the hyperkinetic child with minimal brain dysfunction. *Pediatrics*, 1967, *39*, 393–399.

Minde, K., et al. The hyperactive child in elementary school: A 5 year, controlled, follow-up. *Exceptional Children*, 1971, *38*, 215–221.

Morrison, J. R., & Stewart, M. A. A family study of the hyperactive syndrome. *Biological Psychiatry*, 1971, *3*, 189–195.

Neale, J. M. Information processing and vulnerability: High-risk research. In M. J. Goldstein (Ed.), *Preventive intervention in schizophrenia: Are we ready?* (DHHS Pub. No. [ADM]82-1111). Washington, D.C.: U.S. Government Printing Office, 1982.

Niswander, K., & Gordon, M. *The women and their pregnancies.* Philadelphia, Pa.: Saunders, 1972.

Nuechterlein, K. H. Reaction time and attention in schizophrenia: A critical evaluation of the data and theories. *Schizophrenia Bulletin*, 1977, *3*, 373–428. (a)

Nuechterlein, K. H. Refocusing on attentional dysfunctions in schizophrenia. *Schizophrenia Bulletin*, 1977, *3*, 457–469. (b)

Nuechterlein K. H. Specificity of deficits to vulnerability to schizophrenic disorders: Compared to whom, what, and when? In M. J. Goldstein (Ed.), *Preventive intervention in schizophrenia: Are we ready?* (DHHS Pub. No. [ADM]82-1111). Washington, D.C.: U.S. Government Printing Office, 1982.

Nuechterlein, K. H., Soli, S. D., Garmezy, N., Devine, V. T., & Schaefer, S. M. A classification system for research in childhood psychopathology: Part II. Validation research examining converging descriptions from the parent and from the child. In B. A. Maher & W. B. Maher (Eds.), *Progress in experimental personality research* (Vol. 10). New York: Academic Press, 1981.

Oltmanns, T. F. Selective attention in schizophrenic and manic psychoses: The effect of distraction on information processing. *Journal of Abnormal Psychology*, 1978, *87*, 212–225.

Oltmanns, T. F., Weintraub, S., Stone, A. A., & Neale, J. M. Cognitive slippage in children vulnerable to schizophrenia. *Journal of Abnormal Child Psychology*, 1978, *6*, 237–245.

Orzack, M. H., & Kornetsky, C. Attention dysfunction in chronic schizophrenia. *Archives of General Psychiatry*, 1966, *14*, 323–326.

Orzack, M. H., & Kornetsky, C. Environmental and familial predictors of attention behavior in chronic schizophrenics. *Journal of Psychiatric Research*, 1971, *9*, 21–29.

Parasuraman, R. Memory load and event rate control sensitivity decrements in sustained attention. *Science*, 1979, *205*, 924–927.

Parasuraman, R. Forcing sustained attention with fast event rates in vigilance tasks. In D. Sheer (Ed.), *Attention: Theory, brain functions, and clinical applications.* New York: Academic Press, in press. (a)

Parasuraman, R. The psychobiology of sustained attention. In J. S. Warm (Ed.), *Sustained attention in human performance.* London: Wiley, in press. (b)

Parasuraman, R., & Davies, D. R. A taxonomic analysis of vigilance performance. In R. R. Mackie (Ed.), *Vigilance: Theory, operational performance, and physiological correlates.* New York: Plenum, 1977.

Porges, S. W., & Smith, K. M. Defining hyperactivity: Psychophysiological and behavioral strategies. In C. K. Whalen & B. Henker (Eds.), *Hyperactive children: The social ecology of identification and treatment.* New York: Academic Press, 1980.

Porteus, S. D. *The Porteus maze test and intelligence.* Palo Alto, Calif.: Pacific Books, 1950.

Posner, M. I. *Chronometric explorations of mind.* Hillsdale, N.J.: Lawrence Erlbaum, 1978.

Rappaport, M., Hopkins, H. K., & Hall, K. Auditory signal detection in paranoid and nonparanoid schizophrenics. *Archives of General Psychiatry*, 1972, *27*, 747–752.

Rieder, R. O. Children at risk. In L. Bellak (Ed.), *Disorders of the schizophrenic syndrome.* New York: Basic Books, 1979.

Rieder, R. O., Rosenthal, D., Wender, P., & Blumenthal, H. The offspring of schizophrenics: Fetal and neonatal deaths. *Archives of General Psychiatry*, 1975, *32*, 200–211.

Roff, M. Some life history factors in relation to various types of adult maladjustment. In M. Roff & D. F. Ricks (Eds.), *Life history research in psychopathology.* Minneapolis: University of Minnesota Press, 1970.

Rolf, J. E. The academic and social competence of children vulnerable to schizophrenia and other behavioral pathologies. *Journal of Abnormal Psychology*, 1972, *80*, 225–243.

Rolf, J. E. Peer status and the directionality of symp-

tomatic behavior: Prime social indicators of outcome for vulnerable children. *American Journal of Orthopsychiatry*, 1976, *46*, 74-88.

Rosenthal, D. Discussion: The concept of subschizophrenic disorders. In R. R. Fieve, D. Rosenthal, & H. Brill (Eds.), *Genetic research in psychiatry*. Baltimore, Md.: John Hopkins University Press, 1975.

Rosenthal, D. The schizophrenia spectrum disorders: Implications for psychiatric diagnosis. In H. S. Akiskal & W. L. Webb (Eds.), *Psychiatric diagnosis: Exploration of biological predictors*. New York: Spectrum, 1978.

Rosenthal, N. E., Rosenthal, L. N., Stallone, F., Dunner, D. L., & Fieve, R. R. Toward the validation of RDC schizoaffective disorder. *Archives of General Psychiatry*, 1980, *37*, 804-810.

Ross, A. O. *Psychological aspects of learning disabilities and reading disorders*. New York: McGraw-Hill, 1976.

Rosvold, H. E., Mirsky, A., Sarason, I., Bransome, E. D., Jr., and Beck, L. H. A continuous performance test of brain damage. *Journal of Consulting Psychology*, 1956, *20*, 343-350.

Rubenstein, G., Fisher, L., & Iker, H. Peer observation of student behavior in elementary school classrooms. *Developmental Psychology*, 1975, *11*, 867-868.

Rutschmann, J., Cornblatt, B., & Erlenmeyer-Kimling, L. Sustained attention in children at risk for schizophrenia: Report on a continuous performance test. *Archives of General Psychiatry*, 1977, *34*, 571-575.

Saccuzzo, D. P., & Braff, D. L. Early information processing deficit in schizophrenia: New findings using schizophrenic subgroups and manic control subjects. *Archives of General Psychiatry*, 1981, *38*, 175-179.

Saccuzzo, D. P., Hirt, M., & Spencer, T. J. Backward masking as a measure of attention in schizophrenia. *Journal of Abnormal Psychology*, 1974, *83*, 512-522.

Salzinger, K. *Schizophrenia: Behavioral aspects*. New York: Wiley, 1973.

Schneider, W., & Shiffrin, R. M. Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review*, 1977, *84*, 1-66.

Schultz, D. W., & Eriksen, C. W. Do noise masks terminate target processing? *Memory & Cognition*, 1977, *5*, 90-96.

Shiffrin, R. M., & Schneider, W. Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review*, 1977, *84*, 127-190.

Soli, S. D., Nuechterlein, K. H., Garmezy, N., Devine, V. T., & Schaefer, S. A classification system for research in childhood psychopathology: Part I. An empirical approach using factor and cluster analyses and conjunctive decision rules. In B. A. Maher & W. B. Maher (Eds.), *Progress in experimental personality research* (Vol. 10). New York: Academic Press, 1981.

Spitzer, R. L., Endicott, J., & Robins, E. *Research diagnostic criteria (RDC) for a selected group of functional disorders* (3rd ed.). New York: Biometric Research, 1978.

Sternberg, S. Two operations in character recognition: Some evidence from reaction-time measurements. *Perception & Psychophysics*, 1967, *2*, 45-53.

Sternberg, S. Memory scanning: Mental processes revealed by reaction-time experiments. *American Scientist*, 1969, *57*, 421-457.

Stewart, M. A., deBlois, C. S., & Cummings, C. Psychiatric disorder in the parents of hyperactive boys and those with conduct disorder. *Journal of Child Psychology and Psychiatry*, 1980, *21*, 283-292.

Stilson, D. W., & Kopell, B. S. The recognition of visual signals in the presence of visual noise by psychiatric patients. *Journal of Nervous and Mental Disease*, 1964, *139*, 209-221.

Stilson, D. W., Kopell, B. S., Vandenbergh, R., & Downs, M. P. Perceptual recognition in the presence of noise by psychiatric patients. *Journal of Nervous and Mental Disease*, 1966, *142*, 235-247.

Swets, J. A. The relative operating characteristic in psychology. *Science*, 1973, *182*, 990-1000.

Swets, J. A., & Kristofferson, A. B. Attention. In P. H. Mussen & M. R. Rosenzweig (Eds.), *Annual Review of Psychology*. Palo Alto, Calif.: Annual Reviews, 1970.

Swets, J. A., & Sewall, S. T. Invariance of signal detectability over stages of practice and levels of motivation. *Journal of Experimental Psychology*, 1963, *66*, 120-126.

Sykes, D. H., Douglas, V. I., & Morgenstern, G. The effects of methylphenidate (Ritalin) on sustained attention in hyperactive children. *Psychopharmacologia*, 1972, *25*, 262-274.

Sykes, D. H., Douglas, V. I., & Morgenstern, G. Sustained attention in hyperactive children. *Journal of Child Psychology and Psychiatry*, 1973, *44*, 267-273.

Sykes, D. H., Douglas, V. I., Weiss, G., & Minde, K. Attention in hyperactive children and the effect of methylphenidate (Ritalin). *Journal of Child Psychology and Psychiatry*, 1971, *12*, 129-139.

Tsuang, M. T. 'Schizoaffective disorder': Dead or alive? *Archives of General Psychiatry*, 1979, *36*, 633-634.

Tsuang, M. T., & Dempsey, G. M. Long-term outcome of major psychoses: II. Schizoaffective disorder compared with schizophrenia, affective disorders, and a surgical control group. *Archives of General Psychiatry*, 1979, *36*, 1302-1304.

Weiss, G., Hechtman, L., Perlman, T., Hopkins, J., & Wener, A. Hyperactives as young adults: A controlled prospective ten-year follow-up of 75 children. *Archives of General Psychiatry*, 1979, *36*, 675-681.

Weiss, G., Minde, K., Werry, J. S., Douglas V., & Nemeth, E. Studies on the hyperactive child: III. Five-year follow-up. *Archives of General Psychiatry*, 1971, *24*, 409-414.

Wishner, J., Stein, M. K., & Peastrel, A. L. Information processing stages in schizophrenia. *Journal of Psychiatric Research*, 1978, *14*, 35-45.

Wohlberg, G. W., & Kornetsky, C. Sustained attention in remitted schizophrenics. *Archives of General Psychiatry*, 1973, *28*, 533-537.

Received November 20, 1981
Revision received September 17, 1982 ■