Patient–Environment Relationships in Schizophrenia
Information Processing, Communication Deviance, Autonomic Arousal, and Stressful Life Events

KEITH H. NUECHTERLEIN, MICHAEL J. GOLDSTEIN, JOSEPH VENTURA, MICHAEL E. DAWSON and JERI A. DOANE

The general view that relationships between factors within the patient and those in the environment are important in understanding schizophrenia has been widely accepted and is the basis for vulnerability/stress models of this disorder. However, the specifics of the patient–environment relationships that may be critical for schizophrenia continue to be largely a mystery. At the UCLA Clinical Research Center for the Study of Schizophrenia, we have developed a tentative working model of schizophrenic episodes that emphasises the mediating role of information-processing and autonomic abnormalities in the patient in interaction with stressful circumstances and protective factors in the patient's environment (Nuechterlein & Dawson, 1984a; Liberman, 1986; Dawson & Nuechterlein, 1987; Nuechterlein, 1987). Here we examine two examples of patient–environment relationships that may increase our understanding of such processes in schizophrenia.

The first example involves schizophrenic patients' information processing and the communication patterns of their parents. Abnormalities in attentional functioning and information processing may serve as vulnerability factors for schizophrenia, in the sense that they are found not only in many patients during acute schizophrenic episodes but also in some children and siblings of schizophrenic patients and in schizophrenic patients who are in psychotic remission (Nuechterlein & Dawson, 1984b). Such abnormalities have been found for high-processing-load conditions of the continuous performance test (CPT) and the forced-choice span of apprehension task. Given the strong evidence for genetic factors in schizophrenia (Gottesman & Shields, 1982), one possibility is that these disturbances in information processing are vulnerability factors for schizophrenia that are genetically transmitted within families. The extent of these information-processing deficiencies varies considerably in schizophrenic patients. Although some of the variability is probably related to the clinical state of the patient at the time of assessment (Strauss *et al*, 1987), a range of information-processing performance is present even in clinical remission, with a number of patients showing abnormal functioning while others shown none (Asarnow & MacCrimmon, 1981).

Another line of research has suggested that parents of schizophrenic patients manifest difficulties in maintaining a shared focus of attention when administered a projective psychological test (Singer & Wynne, 1965; Wynne & Singer, 1963). As with the patient data on information processing, a notable variability has been observed in both the form and quantity of these communication difficulties, termed communication deviance (CD) by Wynne & Singer. The communication deviance construct is multi-dimensional (Jones, 1977), with some factors reflecting difficulties in perceptual-cognitive organisation while others reflect unusual patterns of language use. In the initial papers in the mid-1960s, Wynne & Singer suggested that parental communication style was an influence on the off-spring's information-processing style. Thus, Wynne and Singer predicted that when a schizophrenic psychosis developed, the types of information-processing deficits observed would be pathological extensions of a pre-psychotic style that was related to the type of parental communication pattern.

Although the conceptual link between focused attention deficits in schizophrenic patients and communication deviance was suggested in the mid-1960s, the empirical relationship between laboratory measures of patient information-processing deficits and projective test measures of parental CD has only been addressed recently. The evaluation of whether parental communication style relates to variability in severity of information-processing deficits in their schizophrenic offspring is an important first research step whether such transmission is hypothesised to arise from genetic or experiential sources or from a gene–environment interaction.

In the only previous study of relationships between laboratory measures of patients' information processing and parental CD, Wagener *et al* (1986) found that mothers' high scores on one CD factor, Misperceptions, were significantly related to schizophrenic patients' low target detection accuracy

in the span of apprehension and greater false alarms (misidentification of non-targets as targets) on a continuous performance test. On the other hand, the *total* amount of maternal CD did not relate to the offspring's performance. These findings are intriguing because they suggest that serious deficiencies in the perceptual integration of ambiguous stimulus elements in a parent are associated with impaired visual target detection and perceptual misidentifications in their schizophrenic offspring.

The present research attempts to extend the examination of these intergenerational relationships. One limitation of the Wagener *et al* (1986) study is that the sample contained many patients with long histories of schizophrenic illness. Thus, offspring information-processing deficits might have been correlated with parental CD because one influences the other over the years after the onset of schizophrenia or because of a common association with some other effect of illness chronicity. Thus, the present examination of schizophrenic patients and their parents shortly after the schizophrenic illness onset provides a clearer test of a connection between offspring information-processing deficit and parental CD. As in the Wagener *et al* study, the patients were assessed at a clinically stabilised out-patient point, but a larger sample size and standardisation of patient medication dosages in the present study make conditions more favourable for detection of relationships between these domains.

Another example of a relationship between schizophrenic patients and their environments that may clarify an important mediating process in schizophrenia involves the triggering of high autonomic arousal levels by stressful life events. High levels of environmental stress in the form of familial tension (Leff & Vaughn, 1985; Nuechterlein *et al*, 1986*b*) or discrete life events (Brown & Birley, 1968; Ventura *et al*, 1986*a,b*) are hypothesised to interact with vulnerability factors to increase the likelihood of schizophrenic psychotic relapse. Electrodermal hyperreactivity has been associated with poor short-term prognosis in acute schizophrenic patients (Frith *et al*, 1979; Zahn *et al*, 1981). Furthermore, Tarrier *et al* (1979) found that schizophrenic patients, after experiencing a recent independent life event, had significantly higher tonic levels of skin conductance and a greater frequency of spontaneous activity than they did during a period in which no such events occurred. This autonomic arousal difference was evident only when a key relative was present in the testing room. Tarrier *et al* (1979) concluded that autonomic arousal increases significantly in response to environmental stressors such as discrete life events,

at least when tested in the presence of a key relative. The present data extend this finding of sensitivity of autonomic arousal to life events to recent-onset schizophrenic patients on standardised medication who are in a laboratory situation not involving presence of a relative.

Patients' information-processing abnormalities and parental CD

Method

Subjects

The schizophrenic patients and their families are participants in an on-going longitudinal study, Developmental Processes in Schizophrenic Disorders (PI: Keith Nuechterlein), that is examining the early course of schizophrenic disorders. Communication deviance data are gathered from the parents by a research team directed by Michael Goldstein, in a collaborative project. These analyses involve the first 40 schizophrenic patients with CPT and span of apprehension data at a standardised-medication out-patient assessment for whom CD data were available for at least the biological mother.

These patients were required to have the following characteristics: (1) a diagnosis of schizophrenia or of schizoaffective disorder, mainly schizophrenic, by Research Diagnostic Criteria; (2) a recent onset of the psychosis, with an active psychotic period lasting at least 2 weeks and a first psychotic episode not longer than 2 years before project contact; (3) aged 16–45 years; and (4) Anglo-American or acculturated Asian or Hispanic. Patients were excluded for known organic central nervous system disorder, significant and habitual drug or alcohol abuse, mental retardation, or impaired visual acuity.

The 35 male and five female patients had a mean age of 22.5 years (s.d. = 3.2) at project entry and a mean educational level of 12.0 years (s.d. = 1.8). Thirty-seven patients were Caucasian and three were acculturated Hispanic. The recency of illness onset for this sample is evident in the mean onset age of 21.4 years (s.d. = 3.2) and the mean total length of illness, including prodromal symptoms, of 12.1 months (s.d. = 11.7).

Information-processing measures of patients

Two CPT versions and a forced-choice span of apprehension task were administered to each patient at the UCLA Aftercare Clinic during a clinically stabilised period 2–3 months after hospital discharge when a fixed dosage of 12.5 mg fluphenazine (Prolixin) decanoate every 2 weeks had been established. As detailed elsewhere (Nuechterlein *et al*, 1986*a*), the CPT versions employed are visual vigilance tasks in which the patient monitors a quasirandom series of single digits as they appear one per second for 40 ms each, over an 8- or 11-minute period. The patient is asked to press a button each time that a "0" appears. In addition to the demand for sustained alertness, one CPT version

creates a high perceptual analysis burden by degrading the numerals through blurring and superimposing a random visual mask. The other CPT version imposes a short-term memory burden by requiring that the patient respond to the numeral ''7'' only if it is preceded by a ''3''. Signal detection theory indices of d' (sensitivity) and the natural log of beta (lη β or response criterion) were derived. The d' index represents the degree to which the subject can discriminate target from non-target stimuli. The lη β index represents the amount of supporting perceptual evidence that the subject demands before responding that a stimulus is a target, with high lη β values indicating a cautious response style. Children with a schizophrenic parent, particularly a subgroup, have been found to have impaired d' on CPT versions with high momentary processing loads (Nuechterlein, 1983; Rutschmann et al, 1977, 1986).

The forced-choice span of apprehension consists of 70 ms presentations of letter arrays with either 1, 3, 5, or 10 letters and, for each array, requiring the patient to say whether the letter T or F is present. Half of the arrays contain a T and half an F. Non-target letters are placed randomly in other positions of a 4×4 matrix. Unlike the CPTs, the experimenter does not initiate a stimulus presentation unless the subject appears ready. Detection accuracy for the largest array has been found to be the most sensitive index of deficit in schizophrenic patients and their children (Asarnow et al, 1977; Asarnow & MacCrimmon, 1981).

The performance on the three information-processing tasks was summarised through calculation of two factor scores, based on the results of a principal components analysis completed on all schizophrenic patients participating in the project. The first rotated factor, Tachistoscopic Signal Discrimination, represents a common visual signal/noise discrimination factor across the three tasks, with loadings from the target discrimination accuracy in the largest span of apprehension array and the d' level for each of the CPT tasks. The second rotated factor represents a dimension of Response Caution in responding to stimuli as targets, with loadings from the lη β levels within each CPT as well as an index of increases in cautious responding over time.

Communication deviance evaluation of parents

The CD scores were derived from stories elicited from the patients' parents in response to Thematic Apperception Test (TAT) cards. The patient and his or her parents completed a family interaction session designed by Drs Michael Goldstein and Jeri Doane 5–6 weeks after the patient's hospital discharge. Each parent was asked in an individual session to tell stories to pictures in a seven-card version of the TAT. Communication deviance was scored from verbatim transcripts of audiotapes of these TAT stories without knowledge of the patient's information-processing performance or the patient's diagnosis (Jones, 1977).

The form of CD was examined by computation of six factor scores from the 27 CD categories based on the factor analysis of Jones (1977). Factor 1, Contorted, Peculiar Language, represents speech that is fragmented and long-winded with use of unusual negative phrasing, odd words, and peculiar reasoning. Factor 2, Misperceptions, involves

distorted perception of elements on the TAT cards and uncertainty about percepts, as well as tangential replies. Factor 3, Flighty Anxiousness, consists of an anxious, flighty response style that includes jumping from one idea to another, interruptions within sentences, and inquiring about task directions. Factor 4, Overpersonalised Closure Problems, represents loss of personal distance from the task such that personalised responses disrupt the story or contribute to difficulty in ending the story. Factor 5, Faulty Intellectualisation, involves a peculiar, overly abstract, symbolic, intellectualised approach to the task. Finally, Factor 6, ''Failure to Integrate'' Closure Problems, is characterised by ignoring perceptual elements of the TAT pictures, lack of integration of elements, and story endings that are left hanging.

Results

For this summary report, we used the two factor scores from the three patient information-processing tasks to evaluate relationships with parental CD factor scores. Our hypotheses focused on the Tachistoscopic Signal Discrimination factor, because this perceptual factor summarises the components of performance that are sensitive to deficits in schizophrenic patients and their children. In contrast, because the indices contributing to the Response Caution dimension were not deviant among children of schizophrenic parents in two previous studies (Ruschmann et al, 1977; Nuechterlein, 1983), we hypothesised that parental CD factors would be independent of this dimension. Thus, the Response Caution factor was used to evaluate the discriminant validity of relationships between CD and information-processing deficits that are relevant to schizophrenia.

We hypothesised that only three parental CD factor scores would show relationships to the patients' Tachistoscopic Signal Discrimination scores. Due to its emphasis on perceptual accuracy as well as to the recent significant relationships reported by Wagener et al (1986), we hypothesised that parental CD factor 2, Misperceptions, would correlate positively with the patients' Tachistoscopic Signal Discrimination factor. A correlation between CD Factor 1, Contorted, Peculiar Language, and patients' Tachistoscopic Signal Discrimination scores was predicted because this CD factor combines codes that come closest to a subtle, subclinical form of thought disorder. Finally, a correlation with factor 6, ''Failure to Integrate'' Closure Problems, was hypothesised because Jones (1977) had found it, when combined with Factor 2, to discriminate families with schizophrenic children from other families. We will focus on relationships between the biological mothers and the patients in this report because only 18 of the biological fathers of these 40 patients completed the TAT assessment.

As predicted, high maternal scores on the Misperceptions factor were found to be significantly associated with low Tachistoscopic Signal Discrimination factor scores among the patients ($r = -0.34$, $P < 0.05$). As shown in Table I, patients' low Tachistoscopic Signal Discrimination factor scores are also significantly related to high maternal scores on the Contorted, Peculiar Language factor

TABLE I
Correlations of schizophrenic patients' out-patient information-processing performance with their mothers' communication deviance (n = 40)

Communication deviance factor	Tachistoscopic Signal Discrimination	Response Caution factor
1. Contorted, peculiar language	− 0.40*	0.08
2. Misperceptions	− 0.34*	− 0.19
3. Flighty anxiousness	− 0.04	0.14
4. Overpersonalised closure problems	0.05	− 0.08
5. Faulty overintellectualisation	− 0.03	0.27
6. "Failure to Integrate" Closure Problems	0.02	− 0.03

*$P < 0.05$

($r = − 0.40$, $P < 0.05$). The lack of correlation of this patient information-processing factor with CD Factor 6 was unexpected. On the other hand, the independence of the patients' Tachistoscopic Signal Discrimination factor scores from CD Factors 4 and 5 as well the lack of significant correlation of the Response Caution factor scores with the CD factors are as predicted.

Discussion

The modest strength of the significant relationships between schizophrenic patients' perceptual discrimination scores and maternal CD seems appropriate when the markedly different measurement situations are considered. The CPTs and span of apprehension are administered in a cognitive laboratory and involve visual letter and digit discriminations for which high-level verbal, linguistic factors would not be expected to play a large role. By contrast, the CD ratings are based on a verbal sample gathered in an interpersonal situation in response to stimuli with much richer symbolic potential. From this perspective, even modest correlations among these measures are noteworthy.

The appropriateness of the strength of the correlations is even clearer when the intergenerational nature of the comparison is considered. A trait transmitted genetically via a single gene would not be expected to show a correlation higher than 0.50 between the midparent value (mean of the two parents) and the offspring value. Although midparent values could not be used here due to the absence of CD data for many biological fathers, similar constraints on expected correlational strength apply. An environmental transmission hypothesis for the relationship between parental CD and offspring information-processing difficulties would also presumably involve assumptions regarding moderating variables that would limit expected intergenerational correlation. Thus, the observed significant correlations encourage additional examination of intergenerational transmission of perceptual and cognitive processes that are likely to underlie performance on both the laboratory tasks and the verbal interpretations of the TAT pictures.

The association of the patients' Tachistoscopic Signal Discrimination with mothers' CD Factor 2, Misperceptions, is consistent with the relationships with maternal Factor 2 reported by Wagener *et al* (1986), thereby eliminating the possibility that this relationship results from schizophrenic illness chronicity. The extension of the relationship of patients' visual information processing to mothers' CD Factor 1, Contorted, Peculiar Language, is an important one, as this factor includes linguistic distortions that might represent subclinical forms of formal thought disorder; CD Factor 2 on the other hand, includes primarily perceptual errors and uncertainties.

The relationships found in the current data could arise from at least three separate processes. First, genetic transmission of perceptual and cognitive abnormalities could account for the findings. Second, environmental transmission from parents to offspring could play a role. Third, environmental transmission from offspring to parents could be involved. Of course, some combination of these processes is quite possible and perhaps likely. The present data suggest that intriguing relationships are present, but are neutral with regard to their origin.

Patients' autonomic arousal and stressful life events

The association of patients' autonomic arousal to recent stressful life events represents a patient–environment relationship that more clearly reflects the impact of environmental factors on potential mediating processes within schizophrenic patients. Examination of this relationship has been presented initially by Ventura *et al* (1986*a*) at the American Psychological Association convention. Electrodermal activity was measured as the index of autonomic arousal under the direction of Michael Dawson while life events interviews were supervised by Joseph Ventura.

Method

Subjects

For this analysis, we examined 21 patients from the same on-going longitudinal study, including every patient whose

monthly Life Events Interview was conducted on the day of the first out-patient, standardised-medication, electro-dermal test session or within ± 7 days of that test session.

Electrodermal and life event assessment procedures

The electrodermal activity used in these analyses was measured from each patient on the same occasion as the CPTs and span of apprehension described earlier, which was 2 to 3 months after the patient had been discharged from the hospital upon being stabilised on 12.5 mg of fluphenazine decanoate every 2 weeks. Electrodermal activity was recorded during 5 minutes of rest and during 15 mild innocuous tones, 12 task-significant tones, and 12 bursts of loud (95–100 db) white noise. The electrodermal activity was measured as skin conductance from the finger tips of the right hand. Following the Tarrier et al (1979) focus on non-specific skin conductance responses, the present analyses examined the mean number of non-specific skin conductance responses (NS-SCRs) per minute averaged across the entire test session.

The Life Events Interview employed in the present research consisted of 111 items, of which 102 were adapted from the Psychiatric Epidemiology Research Interview for Life Events (PERI-LE) developed by Dohrenwend et al (1978). The occurrence of these 111 relatively discrete, objective events was recorded by the interviewer during on-going monthly rating sessions, and a space was provided for reporting any events elicited by the open-ended Brown & Harris (1978) method of interviewing.

Results

Each life event that was reported was rated by a psychologist trained by Brown and Harris in the UK to determine whether it was of sufficient magnitude or associated with sufficient change in role status to be categorised by Brown & Harris (1978) as an event. Ratings were also made to assess the independence of the occurrence of the life event from the patient's symptoms (Brown & Birley, 1968) and from the patient's ability to influence the event.

The patients were split into two groups, based on whether or not they had experienced an independent life event in the 4 weeks prior to the electrodermal test occasion. As shown in Fig. 1, the three patients who had recently experienced an independent life event of the Brown & Harris (1978) type exhibited a higher rate of NS-SCRs than nearly all of the patients who had not experienced such an event. The mean number of NS-SCRs for those who had experienced such a life event was 4.45/min, whereas the mean for those who had not experienced an event was 1.16/min. This difference in number of NS-SCRs between the two groups was statistically significant whether tested with a parametric t-test, $t(19) = 3.53$, $P < 0.003$, or a non-parametric Mann-Whitney U test, $U = 3.00$, $P < 0.02$. Furthermore, it is interesting to note that the one patient with a high rate of NS-SCRs who had not experienced an independent Brown & Harris (1978) type of life event, did in fact experience an independent PERI-LE event during the month which did not qualify as a Brown & Harris (1978) event.

FIG. 1 Distribution of mean number of non-specific skin conductance responses per minute as a function of whether a patient experienced a Brown & Harris (1978) independent life event in the previous month.

To cross-check these findings, we examined the number of NS-SCRs shown by patients who had experienced any independent life event, including those events that were not of sufficient magnitude to be considered Brown & Harris (1978) life events. The six patients who had recently experienced an independent life event were found to have significantly more NS-SCRs than those without such an experience, whether examined with a t-test, $t(19) = 6.17$, $P < 0.003$, or a non-parametric Mann-Whitney U test, $U = 18.00$, $P < 0.04$.

Discussion

These results are consistent with, and extend, previous findings which indicated that the electro-dermal arousal of schizophrenic patients may be sensitive to stressful events such as the presence of a high expressed emotion relative (Sturgeon et al, 1984) or the interaction of independent life events with the presence of a key relative (Tarrier et al, 1979). The study by Ventura et al (1986a) summarised here is the first demonstration of the autonomic arousing effects of independent life events on schizophrenic patients in the absence of inter-action with relatives.

These data are also consistent with our heuristic vulnerability/stress model of schizophrenic episodes (Nuechterlein & Dawson, 1984a; Dawson & Nuechterlein, 1987) which postulates that a state of tonic autonomic hyperarousal results from an inter-action of environmental stressors and personal

vulnerability factors. Previous studies with schizophrenic patients have shown an increase in the frequency of stressful life events just prior to the onset of a schizophrenic episode (Brown & Birley, 1968). Thus, the current data are consistent with the view that an autonomic hyperarousal state may serve as a mediating factor in exacerbating an already deteriorating environment and, unless appropriate intervention occurs, in the development of psychotic symptoms (Dawson & Nuechterlein, 1987).

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Keith H. Nuechterlein, PhD, *Department of Psychiatry*; Michael J. Goldstein, PhD, *Department of Psychology*; Joseph Ventura, MA, *Department of Psychiatry, University of California Los Angeles*; Michael E. Dawson, PhD, *Department of Psychology, University of Southern California*; Jeri A. Doane, PhD, *Department of Psychiatry, Yale University*