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Continuous performance test differences among schizophrenic out-patients living in high and low expressed emotion environments

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ABSTRACT

Background. High expressed emotion (EE) in families reliably predicts relapse in schizophrenia leading to the assumption that high EE stresses patients and is the cause of relapse. Attempts at validating the stressful properties of high EE using autonomic skin conductance measures have been inconclusive. Since memory loaded vigilance tasks are sensitive to stress, we used a memory loaded version of the Continuous Performance Test (CPT) to see if test performance would change in the presence and absence of high or low EE relatives. If high EE was stressful, performance should decline in their presence of high EE relatives. If low EE was protective against stress performance should improve in the presence of low EE relatives.

Methods. The CPT was administered to 41 schizophrenic and 51 normal control participants. CPT testing was conducted in the absence, then presence, then absence of high or low EE relatives.

Results. Control participants had significantly greater CPT scores than schizophrenic participants; there was no effect of the relative's presence or absence on CPT performance for either the high or low EE group. Schizophrenic participants from high EE homes demonstrated significantly better, rather than worse, CPT scores than those in low EE homes.

Conclusions. These findings fail to support the notion of high EE as stressor, but show that high EE and low EE patient groups perform a vigilance task significantly differently. We propose that patients from low EE groups may be underaroused relative to their high EE counterparts and that this underarousal leads to less than optimal performance on the CPT.

INTRODUCTION

Expressed emotion (Brown & Rutter, 1966) is a construct that has been used for the past 30 years to describe families of psychiatric patients. A high expressed emotion (EE) family has at least one member who, when discussing the patient with an interviewer, makes a large number of critical comments about the patient, and/or demonstrates a marked degree of emotional over-involvement (e.g. overprotectiveness or self-sacrifice) in the patient's life. Studies ranging from England (Brown *et al*. 1972) to Los Angeles (Vaughn *et al*. 1984) to Denmark and India (Leff *et al*. 1987), have all produced remarkably similar findings about the association between high levels of expressed emotion in key relatives and relapse in schizophrenic patients who live at home. In the British studies, for example, the rate of rehospitalization or the return of florid symptoms within 9 months of hospital discharge is significantly greater when schizophrenic patients leave hospital to live in high EE homes (relapse rate 51%) than in low-EE homes (relapse rate 13%) (Brown *et al*. 1972; Vaughn & Leff, 1976). In 1990, Parker & Hadzi-Pavlovic published an aggregate analysis of the 12 published EE and schizophrenia studies available at the time and concluded that the risk of relapse within 9 months of discharge was 3·7 times greater among schizophrenia patients

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living in high EE homes than among those in low EE homes. A more recent meta-analysis of 27 EE studies concluded that the effect size for EE predicting relapse was a highly significant $r = 0{\cdot}30$ (Buzlaff & Hooley, 1998). While the magnitude and replicability of this empirical relationship are impressive, the interpretation of this correlational finding must be made with caution.

One attractive explanation for the EE-relapse association, consistent with the influential vulnerability-stress model of schizophrenia (Nuechterlein and Dawson, 1984*a*), is that a high EE environment is a stressful environment, which overloads the schizophrenic patient's limited information-processing capabilities, resulting in clinical relapse. The implication that high EE is a stressor that causes relapse has promoted the idea that high EE relatives should be encouraged, even 'taught', to act more like low EE family members in order to discourage relapse in the schizophrenic relative. To that end, psychoeducational interventions have been developed and have proven to be somewhat successful in reducing parental EE and/or in reducing relapse rates (Anderson *et al.* 1980; Berkowitz *et al.* 1981; Falloon *et al.* 1981; Leff & Vaughn, 1981; Leff *et al.* 1982). Despite their apparent success, there is still no direct evidence, however, that these lower relapse rates are attributable solely to a change in family EE and a reduction in the stress levels experienced by patients: these studies have not ruled out that 'family interventions' may have influenced the patients directly.

If, indeed, high EE is a stressor that pushes schizophrenic patients over the edge into relapse, then that stress ought to be measurable. As a stressor, high EE should have the same consequences as other stressors. Specifically, since stress is known to increase general arousal, then those living in high EE environments should demonstrate greater arousal levels than those living in low EE environments.

In order to operationalize arousal, EE researchers have used variables including heart rate, blood pressure and skin conductance level. Following the seminal work of Tarrier *et al.* (Tarrier *et al.* 1979; Tarrier, 1989) the most common variable used by EE researchers to measure arousal in the context of studying EE is the frequency of non-specific skin conductance responses (NS-SCRs). To maximize EE cues, Tarrier *et al.* measured NS-SCRs in the patient's home, in the absence and then in the presence of a high or low EE relative. This absent–present paradigm has been used to compare arousal levels for high EE and low EE patient groups both in remission (Tarrier *et al.* 1979) and in acutely psychotic states (Sturgeon *et al.* 1984; Tarrier *et al.* 1988). Relative to measures like skin conductance levels, the NS-SCR measure is particularly suited for this paradigm, because theoretically it can detect relatively transient changes in arousal.

The implicit assumption in using a relative absent *v.* relative present paradigm is that if high EE is a stressor and low EE a protector from stress then compared to their low EE counterparts, patients living in a high EE environment should show higher stress levels even in the absence of high EE family members (ambient stress). In addition, specific relatives who are rated as high in EE should evoke increases in arousal by their very presence (situational stress), while protective, low EE relatives should be capable of situationally decreasing the arousal levels of stressed patients.

In the original Tarrier *et al.* (1979) study, it was found that high ($N = 11$) and low EE groups ($N = 10$) did not differ when they were alone with the experimenter, but the two groups began to show differences upon the entrance of the high or low EE relatives. Specifically, those in the high EE group maintained constant levels of NS-SCRs, while the low EE group showed a significant decrease in the frequency of NS-SCRs. When the same patients were tested 9 and 18 months later, no differences between high and low EE groups emerged. Tarrier *et al.* suggested that the novelty of the first testing situation was akin to a significant life event and served to sensitize patients to the presence of high and low EE relatives.

A large scale (High EE group $N = 65$; Low EE group $N = 24$) replication of this study was conducted by Tarrier *et al.* (1988). NS-SCRs were recorded at one minute epochs, for both the 15 min relative absent, and 15 min relative present sessions. Tarrier analysed his data using both change scores, which measure only the direction of change but not magnitude, and a Wilcoxin matched pairs test, which takes into account direction and magnitude of change.

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Using the latter, more reliable measure, Tarrier *et al*. precisely replicated the results of the earlier study. They showed that, overall, the high EE group had significantly higher NS-SCRs than the low EE group. As in the 1979 study, there were no statistically significant differences between high EE and low EE patient groups in the relative absent condition but significant differences in the relative present condition. As in the previous study, these interactive effects appeared to be due to the high EE group maintaining relatively constant NS-SCRs across relative-absent to relative-present conditions, while the low EE group showed steady reductions that become significant during the relative-present condition. A close scrutiny of the data in the Tarrier *et al*. (1988) study indicates that the low EE group begins to separate from the high EE group before the entrance of the relative. In each of the final 8 min of the relative absent session, the low EE group had lower NS-SCRs than the High EE group (the binomial probability of this happening by chance is $P = 0{\cdot}003$).

Not all studies have revealed evidence of situational stress effects. Sturgeon *et al*. (1984) tested acutely psychotic patients and found that, regardless of the presence or absence of relatives, patients from high EE homes showed significantly greater NS-SCR levels. Importantly, there were no increases in NS-SCRs in the presence of high EE relatives; in fact, NS-SCRs decreased for both high and low EE groups in the relative present condition. These results may suggest that at least for psychotic individuals, EE level may be more related to tonic levels of hyperarousal than to a response to those around him or her.

One measure of skin conductance thought to reflect such tonic levels of hyperarousal is the general skin conductance level SCL. In the large scale study of Tarrier *et al*. (1988), subjects in the high EE group showed significantly higher SCL levels than those in the low EE group during both the relative absent and relative present conditions. No differences in SCL levels were found in the Tarrier *et al*. (1979) study of remitted patients, although this study used smaller numbers of subjects and had long delays between EE assessment and SCL recordings.

As can be gleaned from the differing results reported above, one problem with using any form of skin conductance measure to demonstrate the stress-inducing properties of high EE is one of replicability. These replicability problems exist both between studies, and within studies in which the same patients are retested. In an attempt to reconcile these discrepancies, Tarrier & Turpin (1992) have echoed the sentiments expressed in Tarrier *et al*.'s original study that 'the first occasion of testing was similar to a life event and sensitized patients to the EE status of their relatives' (p. 6).

This contention highlights another crucial problem in NS-SCR studies. If patients are more sensitive to the EE status of their relatives on the first occasion of testing, one would predict that NS-SCRs would decrease in the presence of a low EE relative and increase in the presence of high EE relatives. While such decreases in low EE groups have been noted (Tarrier *et al*. 1979, 1988), with the exception of a study following a single schizophrenic patient (Tarrier & Barrowclough, 1987), increases in NS-SCRs in the presence of a high EE relative have never been found using conservative statistical measures. One possibility, however, is that autonomic activity measures the net effects of two opposing forces: stress and adaptation. Accordingly, both high and low EE groups habituate to stress, but only the low EE group shows decreases in NS-SCRs because in the high EE group habituation is counteracted by increases in stress due to the presence of the high EE relative. If such were the case, however, one might predict that among the high EE group, there should at least be a temporary spike in NS-SCRs upon the initial entry of the high EE relative – a spike that would be absent for the low EE group. This inability to demonstrate such situational increases in stress must be considered surprising given the oft-cited finding that schizophrenics demonstrate autonomic hyper-responses to aversive stimuli (Dawson & Nuechterlein, 1984).

A stable measure of stress

Many of the problems outlined above may stem from the use of NS-SCRs to measure situational arousal levels. As Tarrier & Turpin (1992) note, NS-SCRs (as well as skin conductance levels and heart rate) are affected not only by stressors but by factors unrelated to stress such as speech and movement. To circumvent this lack of

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specificity we selected a more stable measure to effect a construct validation of high EE as a stressor.

The impetus for selecting this measure came from studies concerning information processing capabilities of persons with schizophrenia. Such studies have repeatedly shown performance deficits on tests requiring the allocation of large amounts of cognitive resources (studies reviewed by Nuechterlein & Dawson, 1984*a*). Such high processing load tasks can discriminate schizophrenia patients from controls because schizophrenia patients have (in vulnerability–stress model terms) a reduced amount of available processing resources (Nuechterlein & Dawson, 1984*b*; Nuechterlein *et al*. 1992). This finding has been so consistent that Nuechterlein and Dawson have included the concept of reduced processing resources as a key vulnerability indicator in their influential vulnerability–stress model.

For psychophysical procedures that require patients to extract signal (target) stimuli from noise (distracting) stimuli, a certain proportion of schizophrenia patients show markedly poor performance relative to controls when the processing load is heightened by increasing the memory load of the task (Nuechterlein & Dawson, 1984*a*; Walker, 1981). One measure illustrating this discriminative ability is the memory-load version of the continuous performance task (CPT). The CPT involves the computer assisted, sequential presentation of target and distracting digits. The subject continuously monitors the display and presses a button whenever a target digit is detected. In the memory load versions of the CPT targets are sequences of numbers. In the 0–5–9 version of the CPT subjects press a button as quickly as possible each time they see the numbers 0–5–9 occur one after another in any order. Based on subjects' correct detections and false alarms the variable A′ can be calculated. A′ is a non-parametric estimate of subjects' signal detection sensitivity levels (Nuechterlein, 1991).

The relationship between A′ and stress can be understood by looking at how A′ performance changes in the presence of environmental stressors such as high decibel white noise. In a review of 24 such studies Handcock (1984) concluded that, when the processing load of the detection task was high, d′ (a parametric version of A′) was reduced in the presence of a stressor. This is especially the case when increases in processing load are effected by imposing demands on short-term memory (Folkhard, 1975; Hamilton *et al*. 1977). Although these studies used healthy subjects, the same relationships appear to hold for schizophrenia patients as well: as patients go from remission to an acute state, increases in stress/arousal are associated with A′ performance decreases for the memory loaded CPT but not for perceptually degraded, non-memory loaded versions of this task (Nuechterlein *et al*. 1992).

This relationship between stressors and signal detection performance may provide a means of testing the hypothesis that high EE is indeed a stressor. Since stressors are known to effect reductions in performance on memory loaded information processing tasks, if high EE relatives serve as stressors, then those who live in such an environment will show reduced signal detection capability compared to patients living with low EE relatives. Thus, by substituting A′ for NS-SCRs in the absent-present paradigm of Tarrier *et al*. one may be better able to show differential effects of high and low EE on ambient and situational stressors.

Because A′ is not susceptible to artefacts like movement and talking, one can predict that this measure will be a more stable and specific variable than the NS-SCR variable. Furthermore, Nuechterlein's laboratory indicates that unlike degraded versions of the CPT, A′ performance on memory load versions of the CPT does not change significantly over short time intervals (K. Nuechterlein, personal communication, 1993). Since this stability in A′ is noted for both normal and schizophrenic subjects, any changes in A′ from the relative-absent to the relative-present condition in the proposed study must be attributable to the stress inducing (or reducing) properties of the relative, rather than to fatigue or practice effects. As an added precaution, however, the absent-present design of Tarrier *et al*. (1979) will be appended to include a second relative-absent condition. This ABA, or absent-present-absent, design will allow fatigue, habituation and/or practice effects to be monitored.

By using a psychophysical measure which is known to be sensitive to stress, but which is a more stable measure than skin conductance, we

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will test the assumption that high expressed emotion is both an ambient and a situational stressor. If high EE represents an ambient stressor, then we would expect to find significantly poorer CPT A′ scores for subjects living in high EE households. And if high EE is a situational stressor, we would expect to see significant decreases in CPT A′ scores during the relative-present condition. Given the nature of schizophrenia, these results may be stronger in the schizophrenic than in the normal control samples.

METHOD

Participants

Demographic characteristics of the final schizophrenic and normal control samples are presented in Table 1. Inclusion criteria included age (between 19 and 50 years) and living with at least one relative. Exclusion criteria included uncorrected vision or hearing problem, organic disorder, current substance abuse and current relapse. The schizophrenic sample for this study consisted of 41 DSM-III-R schizophrenic outpatients recruited from four hospitals in the Montreal area: two general and two psychiatric hospitals. A diagnosis of paranoid schizophrenia was given to 23 of the 41 patients, the others being diagnosed with either undifferentiated (12), residual (5), or disorganized type (1). There were 30 male and 11 female subjects. Only five schizophrenic subjects had ever been married. The PANSS scores indicate that this sample was, on average, only moderately symptomatic. Half of the patients were living in two-parent homes while nearly another third lived in single-parent households; the remaining schizophrenic subjects lived in marital or sibling households. Of the 41 relatives who participated in the CPT experiments, 35 were female.

The 51 subjects in the final normal control sample were recruited through newspaper advertisements. Control subjects were within the same age range as the schizophrenia sample. There were 23 male and 28 female subjects. These subjects denied current substance abuse. None of the control subjects were full-time students, nor were they working full time. Only five control subjects had ever been married. Nine of the relatives who participated in the CPT experiment were male.

The schizophrenic sample was somewhat older and less well educated than the control group, and while nearly 50% of the schizophrenic sample's households were classified within the two highest Hollingshead socio-economic status groups more than 83% of the control households were so classified.

Materials

Patient diagnoses were validated using the Structured Clinical Interview for DSM-III-R (SCID) (Spitzer *et al.* 1988). Normal control subjects were screened for all Axis I and Axis II diagnoses using the computerized Mini-SCID and Auto-SCID (First *et al.* 1996*a*, *b*). These programmes are based on the full SCID, but save time by advancing to the next section prematurely if either a probable diagnosis can be made on current responses, or if the subject will not meet diagnostic criteria even if remaining items are all positive.

Patients were interviewed with the Positive and Negative Syndrome Scale (PANSS) (Kay *et al.* 1987) to determine the severity of psychiatric symptoms. The 30 PANSS items provide summary scores for positive symptoms (7 items), negative symptoms (7 items), and general symptoms (16 items).

All available relatives were interviewed with the abbreviated version (Mueser *et al.* 1992) of the Camberwell Family Interview (CFI) (Brown & Rutter, 1966; Vaughn & Leff, 1976) to assess their level of EE. Each relative spent approximately 45 min discussing the subject with a trained interviewer/rater. Mueser and colleagues' abbreviated version of the CFI is identical to the Vaughn & Leff CFI except that questions about symptoms, chores, and finances are eliminated; sections on psychiatric history, current (or most recent) episode, family quarrels and tensions, nagging, relationship between relative and patient, and the relative's attitude towards the illness, are all retained. In our adaptation of the interview for use with normal control subjects, questions on psychiatric history were replaced with questions on the subject's developmental history with reference to schooling, friendships, and adjustment. The semi-structured interview was tape-recorded and later coded along five different scales, three of which were used to determine whether an individual relative was rated high or low EE.

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Table 1. *Demographic characteristics of* 41 *schizophrenic and* 51 *normal control subjects*

Variable	Schizophrenic Mean (S.D.)	Control Mean (S.D.)
Subject's age (years)	30·68 (7·36)	26·35 (4·89)
Subject's education (years)	11·41 (2·68)	14·22 (2·80)
Previous hospitalizations	2·98 (2·81)	NA
PANSS		
Total symptom score	51·9 (14·36)	NA
Positive symptom score	13·3 (6·54)	NA
Negative symptom score	12·12 (4·41)	NA
General symptom score	26·48 (6·76)	NA
Relative's age	53·83 (12·54)	49·92 (12·72)
Relative's education (years)	11·00 (3·84)	13·33 (3·15)
	Schizophrenic %	Control %
Sex of subject (males)	73·2	45·1
Sex of relative (males)	14·6	17·6
Subject's marital status (married)*	12·2	9·8
Family type		
Two-parent home	51·2	39·2
Single-parent home	29·2	45·1
Sibling home	4·8	5·9
Marital home	14·6	9·8
Hollingshead Work Status Category		
I Professional	2·4	0
II Lesser professional	0	5·9
III Administrative personnel	0	15·7
IV Clerical/sales	12·2	23·5
V Skilled manual employees	4·9	7·8
VI Semi-skilled/machinists	7·3	11·8
VII Unskilled employees	73·2	35·3
Two-Factor Hollingshead Score for Household		
I Upper class	9·8	25·5
II Upper middle class	39·0	56·9
III Middle class	29·3	5·9
IV Lower middle class	9·8	2·0
V Lower class	7·3	9·8

* Married or cohabiting.
NA, Not applicable.

The first of these scales is Critical Comments (CC), which is a frequency count of statements criticizing the patient, that go beyond simple descriptions of undesirable behaviour. The second scale, Emotional Over-Involvement (EOI), is evidence of exaggerated emotional response, self-sacrifice, intrusiveness or overprotection. It is rated on a six-point scale from 'None' (zero) to 'Marked' (5). A third scale, Hostility, reflects the presence of a generalized critical attitude towards the patient and/or a frank rejection of the patient. Hostility ratings range from zero to three. In Meuser's study of the abbreviated CFI, both Pearson and intra-class correlations between the original and abbreviated CFIs were $> 0{\cdot}90$ for the critical comments and emotional overinvolvement scales.

Relatives of schizophrenic and normal control participants were rated 'high' in EE if they obtained a score above the cut-off point on any of the three key CFI scales. Comparing classifications of relatives into high or low criticism categories using the two versions, Mueser *et al.* found the best concordance using a cut-off of 5 CCs: among the 59 relatives assessed, the 5 CC cut-off resulted in one false positive and one false negative (sensitivity of 93% and specificity of 98%). Concordance between the two versions for classification into high and low EOI categories was 100% when using the traditional EOI cut-off of 3. Based on these results, the current study operationalized high EE as $\geqslant 5$ CCs, a rating of $\geqslant 3$ on EOI, or a rating of $\geqslant 1$ on hostility.

The 0–5–9 Continuous Performance Task (CPT) comprised 640 experimental trials con-

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sisting of 80 targets (the digits 0–5–9 in any order) and 560 non-target trials. Non-target trials consisted of numbers that were not included in the memory set, or high-similarity distracters in which two of the three numbers comprising a target were presented followed by a non-target number (e.g. 0–5–8). A session was composed of 8 blocks of 80 trials. Ten targets and 10 high similarity distracters were presented on each block. Blocks 1, 3, 5 and 7 contained auditory distracters in the form of numbers being played over the computer's speaker. Even numbered blocks were presented using the same timing but no sound was emitted.

Each trial began with an auditory presentation (or silence) played for 254 ms. Numbers were recorded and played using the Sound Edit Pro program. Following the playing of the sounds there was a blank interval of 200 ms, followed by a visually presented digit for 67 ms. Digits were black numbers presented in 24 point Geneva font against a white background. Subjects were given a 1000 ms window within which to respond to visually presented stimuli. If no response was made, the program presented the next trial. Thus, digits were presented at a rate of 1 digit every 1454 ms. This memory loaded version of the CPT was programmed using Psychlab, (Gum & Bub, 1990), and presented on a Macintosh PowerBook 170 laptop computer.

Procedures

The research protocol and consent forms were all approved by the Research Ethics Boards of the hospitals from which patients were recruited. Potential schizophrenic subjects were introduced to the clinical interviewer by his or her psychiatrist or principal therapist during a routine clinic visit. The interviewer described the patient's involvement in the study, the involvement of his or her relatives, answered questions and verified the patient's understanding of the study before requesting the patient's signature on the informed consent form. Relatives were contacted by phone by one of the family interviewers to obtain verbal consent. Once consent of relatives was obtained, patients were interviewed with the SCID and the PANSS in their own homes.

Potential normal control subjects who responded to the newspaper advertisement by leaving a message on a telephone answering machine were contacted by phone by a clinical interviewer. Following an eligibility check and the verbal consent of the relative(s), the Mini-SCID and Auto-SCID were administered.

All relatives were scheduled for the CFI once the subject had passed diagnostic screening and most were interviewed in their own homes; when two relatives were included, they were met by different interviewers at the same time.

At this point, experimental sessions were scheduled in the participant's home. Participants were seated comfortably a constant distance in front of the laptop computer. The instructions for performing the memory-load version of the CPT were presented on the screen in a self-paced manner. Subjects read that they would see a series of numbers presented on the computer screen and that on some trials they would also hear numbers presented over the computer's speaker. They were then presented with a number of examples of the sequentially presented numbers and auditory distractors. Then they were instructed to ignore what they heard and to focus on pressing a key (up arrow) as quickly as possible whenever they saw the numbers 0–5–9 in sequence. They were informed that they were to press the key for any combination of these three numbers (e.g. 0–9–5, 5–0–9, 9–0–5, etc). Subjects read that they were to try to press the key as quickly as possible but at the same time to try not to make any errors.

Subjects were then presented with 20 practice trials. At the end of the practice trials subjects were asked if they had any questions. If the questions could not be answered by the experimenter to the satisfaction of the subject then the instructions and practice session were run again.

Following practice, subjects were administered the 640 experimental trials. While subjects were performing the task, the experimenter was evaluating their performance by watching the subjects while holding a mock scoring sheet on a clip board. At the end of the 15-min session the experimenter estimated how many errors subjects had made and indicated their estimates by placing a mark on a line that ran from 0 errors to 100% errors. After the initial session the relative was called into the room and briefly explained the task that would be performed by the subject. Relatives were instructed how to use the evaluation sheets. Evaluation sheets were

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not analysed as the computer kept track of errors, rather, they served only to justify the presence of the relative. Subjects then repeated another block of 640 trials in the presence of their relative.

After the second 15 min session, the relative was asked to leave the room and the experimenter resumed the duty of evaluating the subject. A final block of 640 trials was administered to complete the ABA (relative absent-relative present-relative absent) design. Following the third block of trials, subjects were debriefed and paid $60.00 cdn for their participation.

RESULTS

Ambient stress and EE

A total of 108 subjects were tested. Of these, three patients had to be discarded because they held down the response key during testing – a situation that caused their data to be uninterpretable. A fourth patient was eliminated because his A′ scores were more than 3 standard deviation units away from the mean of all patients in each of the ABA conditions. A further five patients and four controls were eliminated because they ceased testing after only the second session (the B session of the ABA design). One control subject was discarded because, unlike all other patients and controls, he took a 2 h break between the A and B sessions. Finally, data from two patients had to be deleted because, after having agreed to participate, their parents refused the CFI interview.

After eliminating data from these 16 subjects, data from a total of 51 control subjects (36 low EE controls and 15 high EE controls) and 41 patients (24 low EE and 17 high EE) were retained for analyses. Preliminary data screening revealed that patients were much more variable than controls (Box Scheffé test for homogeneity of variance $F(1, 31) = 48{\cdot}56$, $P < 0{\cdot}001$). These differences in variability are reflected in the length of the standard error bars for the control groups (top of Fig. 1) relative to the patient groups (bottom of Fig. 1).

Because of this violation of the homogeneity of variance assumption, which is required for parametric tests, the A′ performance of patients

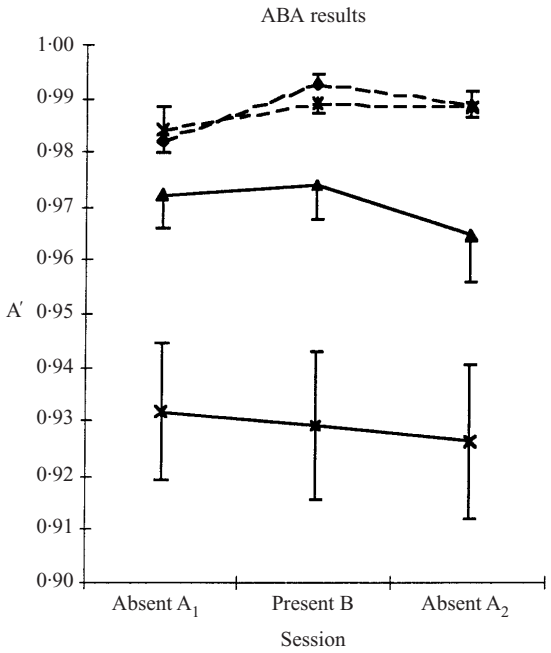


FIG. 1. 0–5–9 CPT A′ scores from 41 schizophrenic and 51 normal control subjects during relative-absent, relative-present, and second relative-absent (ABA) sessions. (◆---◆, High EE control; **X**---**X**, low EE control; ▲——▲, high EE patient; **X**——**X**, low EE patient.)

was compared to controls using the non-parametric Kruskall–Wallace procedure. On all comparisons controls performed significantly better than patients. These comparisons are shown in Table 2.

Although there was heterogeneity of variance among patients and controls, parametric comparisons could be made within these groups. That is, A′ data from patients and controls could be analysed separately using split plot factorial analyses of variance. In these separate analyses EE level (high *v.* low) served as the between-group variable and distracters (present *v.* absent) and presence of the relative (A-present, B-absent, A-present) served as the within-subjects variables.

For patients this analysis yielded a significant main effect of EE level ($F(1, 39) = 4{\cdot}26$, $P < 0{\cdot}05$) attributable to patients in the high EE group (average A′ = 0·968 S.D. = 0·04) performing significantly better than patients belonging to the low EE group (average A′ = 0·929 S.D. = 0·08). No other main effects or interactions were significant. For controls, the analysis of variance

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Table 2. *Means* (*and mean ranks*) *of CPT* 0–5–9 *A′ for* 51 *normal control and* 41 *schizophrenic subjects during three sessions* (*relative present or absent*) *during trials with or without auditory distractors*

	Session					
	A_1: Relative absent		B: Relative present		A_2: Relative absent	
	Dist	No dist	Dist	No dist	Dist	No dist
Controls	0·98 (55·8)	0·98 (55·8)	0·99 (57·3)	0·99 (55·9)	0·99 (54·6)	0·99 (58·3)
Patients	0·94 (34·9)	0·94 (34·9)	0·95 (33·0)	0·94 (34·8)	0·95 (36·5)	0·95 (31·9)
$\chi^2(1)$	13·99	14·06	19·07	14·47	10·57	22·89
P	< 0·001	< 0·001	< 0·001	< 0·001	0·001	< 0·001

Dist, Auditory distractor trials; No dist, trials without auditory distractors.

revealed no significant main effects or interactions. The significant effect of expressed emotion group for patients, but not for controls, can be seen in Fig. 1.

DISCUSSION

By using a measure that has been shown to be highly sensitive to environmental stress, we were unable to demonstrate that high EE constitutes an immediate situational stressor for either schizophrenic out-patients or normal control young adults from the community. For all four groups (high and low EE, controls and schizophrenic subjects) performance on the 0–5–9 CPT was stable across the three 15-min blocks irrespective of the presence or absence of a relative, suggesting that neither high nor low EE relatives provide either situational stress or protection.

Prior to discussing the important significant differences between the High EE and Low EE groups we will address some points of potential contention in interpreting the results of the current study. One salient difference between this study and studies measuring NS-SCRs in the absence and presence of relatives was that in the latter studies, relatives interacted directly with patients, whereas in the current study relatives sat beside patients and 'evaluated' their performance. The rationale was that if relatives that were highly critical, emotionally over-involved or hostile, were watching and evaluating one's performance on a difficult task, such a situation would likely be as stressful as talking to these relatives. Unfortunately, we have no empirical measure of how the 'evaluation' component of the study was perceived by patients. Thus, it could be argued that the procedures used in the current study might not have been as stressful or stress reducing as a direct interaction with high or low EE relatives. One must note, however, that the current procedure is much more standardized than procedures used in the autonomic studies where possible stress reducing or inducing situations may be entirely dictated by individual differences in the topics of conversation between patients and relatives. Admittedly, however, although the current paradigm is more standardized, it is likely to be less ecologically valid than studies that measure patients and relatives engaged in actual conversations.

In the current study the introduction of auditory distractors had no effect on performance. It was predicted that introducing an auditory distractor would place some demands on patients' limited attentional resources, thereby leading to a decrement in performance. In retrospect, however, because participants were not required to attend to, or in any way manipulate, the information in the auditory channel its distracting properties on the visually presented digits were likely minimal.

Finally, one could argue that the Camberwell Family Interview was developed for the purpose of measuring the dynamics of families containing an ill relative, and is therefore inappropriate for use with control families. We maintain that criticism and emotional over–involvement are not the exclusive domain of families with ill relatives, but rather are concepts that affect the dynamics within any family. That 29 % (15 of 51) of control families contained relatives who were rated as high EE indicates that this instrument

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is sensitive to criticism, emotional overinvolvement and hostility even though the target relative may not have displayed 'pathological' behaviours. Ultimately, the importance of including these control groups, lies in the fact that there were no significant CPT performance differences between High EE and Low EE control group members – a pattern of results that contrasts with that of patients tested using identical procedures.

The most interesting and important finding in this study concerned the differences in CPT performance between High and Low EE groups within the schizophrenia sample – differences that may be relevant to the concept of ambient stress. Although we had suggested *a priori* that if high EE were an ambient stressor then patients in high EE households would perform worse on the CPT than those from low EE households, we found better CPT performance among patients in high EE households.

Different possibilities might be considered to explain this unexpected finding. We might, for example, continue to interpret the review of CPT studies (Handcock, 1984), which indicated that there are performance decrements associated with environmental stressors, as sufficient justification for using performance on memory loaded versions of the CPT to reflect stress levels. From this perspective, it would appear that low EE households engender greater stress in schizophrenia patients than do high EE households, a conclusion that would be difficult to promote. Within a stress paradigm, one simply cannot conclude from our results that high EE stresses patients into a more dysfunctional state: our high EE patients outperform the low EE group in this signal detection task.

The association between EE and CPT scores might also be considered within the context of the Yerkes-Dodson law (Yerkes & Dodson, 1908) which proposes that an inverted U-shaped function exists between level of arousal and performance. If, given the degree of difficulty of a task, an individual is aroused either below or beyond his or her optimal level of arousal, performance will suffer. In our original hypothesis, we imagined that our subjects would be operating at an optimal level of arousal and that the additional stress of having a high EE relative sitting next to them evaluating their performance would push them over the peak and down the descending slope of the inverted U. Our results indicate, however, that high EE is associated with superior CPT performance among our schizophrenic subjects. This suggests the possibility that our schizophrenic young adult subjects tend to be underaroused, and that a high EE environment may increase arousal and, in turn, push them up the ascending portion of the curve towards their optimal performance for this particular task. While the Vulnerability-Stress model has focused attention on the noxious effects of stress on schizophrenia patients, 30 years ago there was great concern that understimulating environments promoted vegetative symptoms in patients. This notion was supported by experimental research of the time (Wing & Freudenberg, 1961). More recently, King & Dixon, 1995, 1996) have shown that lower emotional overinvolvement (EOI) scores in families predict lower social adjustment scores in schizophrenic young adults, supporting the idea that aspects of low EE environments may be understimulating.

The argument that high and low EE environments are associated with different patient outcomes due to their arousal inducing properties relies on the assumption that all schizophrenia patients were created equal, and that nature assigned them randomly to either high or low EE household conditions, with the EE levels being determined by their non-ill relatives. Given the known heterogeneity of this disorder, a more plausible explanation of our results might be that patients in high and low EE households may have been different in some fundamental way long before our CFI interviewers went calling. Patients in low and high EE families may represent subtypes of the disorder, which differ with respect to inherent baseline levels of autonomic arousal. From this perspective, patients from high EE households are higher on the ascending portion of the Yerkes-Dodson curve not because their environment is more stimulating, but because of the particular nature of their illness. This would also be consistent with emerging evidence that patients in high EE families have different, more provocative subclinical symptom profiles than those in low EE families (Rosenfarb *et al.* 1995; Woo, *et al.* 1997), and that the relatives are high in EE as a reaction to those symptoms (King, 1998).

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That schizophrenia patients from high EE families may have a different form of the disorder is also supported by the very psychophysiological studies that attempted to demonstrate the stress-producing properties of high EE. The data from Tarrier's 1988 study using the largest number of subjects ($N = 89$), for example, suggests that patients from high EE homes tend to have high levels of NS-SCRs in both the absence and presence of their high EE relatives, whereas patients from the low EE group show lower levels of NS-SCRs in the presence of their low EE relatives. The fact that the low EE group starts to deviate from the high EE group well before the entrance of the low EE relative, may suggest that both groups are responding with relatively high levels of NS-SCRs in response to the general experimental situation – electrode placements, meeting an experimenter from the hospital, etc. Unlike the high EE group whose NS-SCRs do not change over the 30 min of testing, the low EE group gradually begins to habituate to this novel situation. Thus, what may differentiate the High and Low EE groups is the ability to habituate to the experimental situation rather than anything to do with the presence or absence of the EE relative *per se*. Thus, rather than sensitizing patients to the EE status of their relatives, the first episode of testing may simply serve to momentarily equate patients from high and low EE groups, who otherwise differ in tonic levels of arousal.

Support for this interpretation comes from the studies of groups of patients who were in an acute psychotic state. In these studies, no changes in NS-SCRs were noted upon entrance of the relative, but rather, huge overall group differences were noted with those in the High EE group showing greater NS-SCR levels than those in the Low EE group. Thus, across all studies, the most consistent finding is overall group differences between high and low EE groups, with changes in NS-SCR levels upon entrance of the EE relative being less reliable. Such a pattern of NS-SCR data suggests that rather than reacting to the presence of high and low EE relatives, patients in the High and Low EE groups differ in terms of their levels of tonic arousal. This autonomic hyperarousal among high EEs suggested by the NS-SCR data and by the results of the present study, may be associated with genetic risk for schizophrenia as demonstrated in a study by Hollister *et al.* 1994).

In summary, while recognizing the need for replicating our counterintuitive findings, we propose that the higher CPT scores obtained by patients in the High EE group reflect trait differences in the patients themselves rather than in their environments. In order to support the notion of high EE increasing ambient stress and, in turn, increasing arousal, we would have expected to see evidence of situational stress effects as well. These were noticeably absent in the results of the A–B–A analyses, however.

Family relationships are complex. Although the earliest interpretations of the association between high EE and relapse were useful for the development of interventions geared at improving communication and problems skills within families (Falloon *et al.* 1981) and, ultimately, in reducing the sense of burden often felt by caregivers, the unidirectional model of high EE as a noxious stimulus causing poor outcome may not fit most families. Brown himself posited a number of different causal models that could account for the EE-relapse association (Brown & White, 1992). Our findings that suggest that high EOI is associated with better social adjustment (King & Dixon, 1995, 1996), that maternal CCs do not predict relapse while those from fathers do (King & Dixon, 1999), and the recent findings from longitudinal studies suggesting that EE is an effect, not a cause, of severe symptomatology in patients (King, 1999) all reflect the complex dynamics at work within families. The results from these other papers, which used a different but similar sample of schizophrenic young adults and their families, are consistent with those of the current unsuccessful attempt to demonstrate noxious effects of high EE.

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