Journal of the International Neuropsychological Society (2000), **6**, 649–658.

The functional relevance of affect recognition errors in schizophrenia

JOHN H. POOLE,[1,2] FAITH C. TOBIAS,[2,3] AND SOPHIA VINOGRADOV[1,2]

[1]Center for Neurobiology and Psychiatry, University of California, San Francisco, California
[2]Mental Health Service, Department of Veterans Affairs Medical Center, San Francisco, California
[3]California School of Professional Psychology, Alameda, California

(Received December 14, 1998; Revised May 24, 1999; Accepted July 20, 1999)

Abstract

To evaluate the clinical and ecological validity of affect recognition (AR) measures in a sample of community-dwelling schizophrenic outpatients ($N = 40$), we analyzed the relation of facial and vocal AR to intellectual, symptomatic, and quality-of-life criteria. Facial and vocal AR showed virtually identical patterns of association with these criteria, suggesting that both modalities of AR draw on the same underlying heteromodal capacity. Specifically, AR was correlated with a subset of intellectual abilities (verbal–semantic, executive–attentional), but was unrelated to age, education, or neuroleptic dose. In terms of clinical and ecological criteria, AR errors correlated with more severe psychotic symptoms (positive and disorganized) and with lower quality of life (relationships, community participation, and richness of intrapsychic experience). Even after controlling for subjects' intellectual abilities and illness severity, inaccurate AR was associated with bizarre behaviors (involving sociosexual interactions, clothing, appearance) and with impoverished interpersonal relations. Thus, while difficulty identifying basic affective cues is related to general cognitive and illness-severity factors, it appears to have specific functional implications that do not depend on generalized impairment. Assessment of AR may identify a subgroup of schizophrenic patients who have a central defect in the heteromodal monitoring of emotional-social displays, associated with dysregulation of social behaviors and disruption of interpersonal relations. (*JINS*, 2000, *6*, 649–658.)

Keywords: Neuropsychology, Stimulus discrimination, Prosody, Psychopathology, Heterogeneity

INTRODUCTION

Abundant research has demonstrated that people with schizophrenia have difficulty identifying facial and vocal expressions of emotion (e.g., Archer et al., 1994; Borod et al., 1990, 1993; Feinberg et al., 1986; Schneider et al., 1995; Walker et al., 1984). Several studies have shown that affect recognition (AR) is not influenced by neuroleptics, age, or sex of patients (Diaz et al., 1987; Kline et al., 1992; Salem et al., 1996; Schneider et al., 1995), and that facial AR ability is related to the severity of clinical symptoms and overall cognitive disturbance (Borod et al., 1993; Kerr & Neale, 1993; Mueser et al., 1996). Furthermore, studies on schizophrenic inpatients have suggested that AR may account for difficulties with interpersonal communication and other aspects of social behavior (Mueser et al., 1996; Penn et al., 1996)—although this has not yet been directly evaluated outside the hospital setting. The present study was conducted to evaluate the relevance of AR abilities to the clinical and community functioning of schizophrenia patients.

Many studies have compared the AR ability of schizophrenic *versus* nonschizophrenic groups—an important step in the description of any syndrome. However, to fully understand a heterogeneous illness such as schizophrenia, this must be followed by within-group analyses that address the disorder's diverse clinical presentations (Shallice et al., 1991; Stevens, 1997). Several studies (discussed below) have included such analyses, but, with two exceptions (Bryson et al., 1997; Schneider et al., 1995), these were limited to approximately 20 schizophrenic participants. Such sample sizes only provide adequate power to detect correlations of $r > .50$, rendering attempts to characterize AR's association with other measures inconclusive. Therefore, the present research was undertaken to evaluate the relevance of AR to

Reprint requests to: John Poole, Ph.D., Department of Psychiatry (116C), University of California at San Francisco, 4150 Clement Street, San Francisco, CA 94121. E-mail: poole@itsa.ucsf.edu

https://doi.org/10.1017/S135561770066602X Published online by Cambridge University Press

symptomatic and behavioral criteria of heterogeneous functioning in schizophrenia, utilizing a sample size that provides adequate statistical power.

Evidence Linking AR to Specific Clinical Symptoms

A substantial body of research (reviewed by Buchanan & Carpenter, 1994; Liddle, 1987) suggests that schizophrenia involves at least three relatively independent psychopathologic dimensions: positive symptoms (hallucinations, delusions), negative symptoms (psychomotor retardation, asociality), and disorganized symptoms (formal thought disorder, bizarre behavior). Several studies have examined whether poor AR relates to a particular subset of symptoms. One analysis of 28 schizophrenics found that negative symptoms on the Brief Psychiatric Rating Scale (BPRS) covaried with deficits in emotional and nonemotional facial perception (Mueser et al., 1996), but others found no relation between schizophrenics' BPRS ratings and performance on facial AR tasks (Borod et al., 1993; Salem et al., 1996). However, the BPRS's sensitivity to specific symptoms is low compared to scales that provide comprehensive, operationally defined symptom rating—such as the Scales for Assessment of Positive and Negative Symptoms (SAPS, SANS; Andreasen, 1982; Andreasen & Olson, 1982) or the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987).

One study of 20 schizophrenics (Heimberg et al., 1992), using items from the SAPS, SANS, BPRS, and a brief AR measure (involving two facial emotions), found that poor AR was associated with a composite rating of schizophrenia-specific symptoms (positive, negative, disorganized), but not with nonspecific symptoms (e.g., anxiety, depression, hostility). A study of 40 schizophrenics using the same methods found facial AR associated with global ratings of bizarre behavior, several negative symptoms, and inattentive behavior (Schneider et al., 1995). Using a six-emotion facial AR task and the PANSS, a study of 18 patients (Lewis & Garver, 1995) found trend-level associations of facial AR with total positive and negative symptoms ($p < .10$). Finally, several studies have shown that major depression can also be associated with inaccurate AR (e.g., Borod et al., 1990; Feinberg et al., 1986); therefore, it is important to analyze whether schizophrenics' AR difficulties may be related to mood symptoms. In the present study, we used an extensive semistructured interview to detect both global and item-level associations of clinical symptoms with AR.

Evidence Linking AR to Adaptive Behaviors

Ultimately, the decision whether to include tests of AR in an assessment battery will depend on their ecological and incremental validity. Do such tests add anything to our understanding of patients' adaptive functioning in the world, beyond what would be expected from their overall level of cognitive and symptomatic impairment? In a study of 28 schizophrenic inpatients, poor performance both on facial AR and on nonemotional facial recognition tasks predicted ward-behavior ratings of reduced social contact and poor appearance/hygiene; however, only facial AR was significantly related to poor nonverbal conversation skills during a structured role-play (Mueser et al., 1996). Similarly, in a study of 26 extended-care inpatients, poor facial AR was associated with reduced social competence, social interest, and hygiene, even after controlling for other cognitive abilities (Penn et al., 1996). The present study sought to extend these findings by evaluating the quality of life of community-dwelling schizophrenia patients in relation to AR abilities, while controlling for cognitive and symptomatic indices of illness severity.

Heteromodal Assessment of AR

Most studies of AR in schizophrenia have focused on visual perception of facial affect. Since real-world perception of others' emotions is typically a multisensory process, a specific affect perception defect cannot be inferred without heteromodal testing (e.g., vocal and facial AR). This is particularly important because studies of patients with acute brain injuries have shown modality-specific impairments of AR, indicating that visual and auditory AR abilities can be dissociated from one another (Bowers & Heilman, 1984; Rapscak et al., 1989). Two such cross-modal studies have been performed on schizophrenics and both found the accuracy of affect judgments to be significantly correlated across visual and auditory modalities (Borod et al., 1990; Kerr & Neale, 1993). However, to our knowledge, no study has examined whether AR impairments in each sensory modality have distinct effects on actual functioning. Thus, we used a combination of facial and prosodic perceptual tasks to evaluate heteromodal AR in schizophrenia, and to test whether the functional implications of AR deficits in each sensory modality are similar or distinct.

Relation of AR to General Cognitive Abilities

In numerous studies, groups of schizophrenic subjects typically have shown a decrement of 10 to 15 IQ points from estimates of premorbid potential (Aylward et al., 1984; Bilder et al., 1992). Thus, it is essential that any analysis of AR control for general intelligence and related processes such as verbal comprehension, visuospatial reasoning, and attentional control. Indeed, several studies have demonstrated cognitive deficits in schizophrenia that are comparable in severity to AR difficulties (Kerr & Neale, 1993; Salem et al., 1996) or correlated with inaccurate AR (Corrigan et al., 1995; Penn et al., 1996; Schneider et al., 1995). Therefore, we evaluated the association of AR with intellectual and perceptual abilities, and tested whether correlations of AR with symptomatic and behavioral criteria simply reflect generalized cognitive decline.

Goals of the Study

With the above considerations in mind, we posed three questions:

1. Do facial and vocal AR show evidence of tapping a single cognitive dimension in schizophrenia (i.e., the same pattern of convergent and discriminant associations with intellectual and perceptual functions)?

2. Is AR correlated with specific clinical symptoms, even after controlling for general cognitive and clinical indices of illness severity?

3. Does AR ability account for quality of life in the community, beyond what would be expected from more general cognitive and symptomatic predictors?

METHODS

Research Participants

Forty schizophrenic patients (31 male, 9 female) were recruited from the Psychiatric Outpatient Service of the San Francisco Veterans Affairs Medical Center, from California Pacific Medical Center, and from contacts in the community—with a goal of maximizing the sample's heterogeneity, in terms of illness severity and symptom profile. Consensus diagnosis of schizophrenia or mainly schizophrenic schizoaffective disorder was made by two research psychiatrists based on the Structured Clinical Interview for DSM–IV (SCID–IV; First et al., 1995), the SADS criteria for mainly schizophrenic schizoaffective disorder, and a medical chart review. All participants gave written informed consent after the experimental procedures had been fully explained. All were clinically stable at the time of testing (no hospitalization in the last three months, and no change in medication dosage in the last 30 days). Exclusion criteria included: nonnative speakers of English, history of neurological or systemic disease, history of substance dependence (other than nicotine) or current substance abuse (based on the SCID–IV and clinical record review); approximately 25% of potential participants were excluded by these criteria. Participants were 25 Whites, 12 African Americans, and 3 "Others," with an age range of 24 to 63 years ($M \pm SD = 41 \pm 9$), education of 3 to 17 years (13 ± 3), and WAIS–R IQ of 75 to 121 (94 ± 10). Subtype diagnoses were 15 undifferentiated, 13 paranoid, 5 disorganized, 3 residual, and 4 schizoaffective. Participants' Global Assessment of Functioning for the past 12 months (DSM–IV, Axis V) ranged from mildly symptomatic to prominently psychotic (GAF = 65 to 25; $mdn = 45$, *seriously dysfunctional*). Thirty-eight were on neuroleptic medication (50 to 1600 cpz·mg·eq/day; $mdn = 300$); 2 patients were currently unmedicated and clinically stable but had at least residual symptoms of schizophrenia.

Affect Recognition Tasks

Participants were administered two AR tests, from which a composite index of AR was calculated. The AR measures were Facial Affect Recognition (FAR) and Vocal Affect Recognition (VAR). FAR stimuli were 42 facial photographs from a commonly used series by Ekman and Friesen (1976), portraying seven emotions (*happy*, *sad*, *angry*, *afraid*, *surprised*, *disgusted*, and *neutral*) with six examples of each emotion (three male, three female). The photos were presented in booklet form (10 × 15 cm), along with a separate card listing the seven emotional labels. Participants were instructed to choose the label that best described the emotion on each face, proceeding at their own pace (no time limit imposed). The VAR stimuli, from the Florida Affect Battery (Bowers et al., 1991), were 20 audio-recorded sentences of emotionally neutral content (e.g., "The chairs are made of wood") and prosodic intonation portraying five emotions (*happy*, *sad*, *angry*, *afraid*, *neutral*) with four examples of each emotion (by one female actor). The sentences were presented through headphones (volume adjusted to each participant's preference), along with a card listing the five emotional labels. Participants were instructed to attend to the intonation rather than the content of each sentence. Each sentence was played only once, after which participants made their choice (no time limit). Mean accuracies for Facial Affect Recognition (FAR = 69% ± 13) and Vocal Affect Recognition (VAR = 80% ± 16) were comparable to those previously reported for schizophrenics tested with the same or similar stimulus sets (Borod et al., 1993; Lewis & Garver 1995). The internal-consistency reliability (Cronbach's α) of each index was acceptable (FAR $\alpha = .78$; VAR $\alpha = .85$). The composite AR index was calculated as the mean of FAR and VAR z scores; the mean intercorrelation of all 64 AR items was used to estimate the reliability of this index, which was high (Cronbach's $\alpha = .87$).

Other Cognitive Tasks

To assess general intellectual and feature-discrimination abilities, we administered a short form of the Wechsler Adult Intelligence Scale–Revised (WAIS–R), plus two nonemotional perceptual tasks frequently used in prior AR studies. WAIS–R subtests were Information, Similarities, Picture Completion, Block Design, Digit Span, and Digit Symbol. Subtests were selected to (1) optimize administration time, (2) include equal numbers of Verbal and Performance tests, (3) tap three factors: Verbal Comprehension (Information, Similarities), Perceptual Organization (Picture Completion, Block Design), and Sustained Attention (Digit Span, Digit Symbol). In prior studies, the WAIS–R attentional factor's composition has varied somewhat across samples; however, in large psychiatric samples (reviewed by Leckliter et al., 1986) Digit Span and Digit Symbol have loaded on this factor and have the advantage of tapping both the Verbal and the Performance domains. WAIS–R factor score es-

https://doi.org/10.1017/S135561770066602X Published online by Cambridge University Press

timates consisted of mean age-adjusted standard scores for each dyad of subtests. In addition, Digit Span Forward and Digit Span Backward were analyzed separately, since these tap different cognitive processes (Lezak, 1995).

The two nonemotional perceptual tasks assessed participants' ability to discriminate among facial and prosodic stimuli that are affectively neutral (i.e., lacking overt emotional content). The neutral facial task was the Facial Recognition Test, Short Form (Benton et al., 1978), which requires participants to select photographs of a target person from an array of six simultaneously presented choices. The test consists of 27 items, which progress in difficulty by addition of shadows and shifting the apparent angle of view. The neutral prosodic task was the Non-Emotional Prosody Discrimination subtest of the Florida Affect Battery (Bowers et al., 1991), consisting of 16 pairs of audio-recorded sentences. Each pair has identical content (e.g., "The shoes are in the closet") presented with either declarative or interrogative prosody. Half of the pairs had the same prosody; half had different prosody. Participants were given a cue card listing their choices (*same*, *different*) and were instructed to attend to the intonation rather than the content of sentences. Each sentence was played only once, after which participants made their choice.

To control for general cognitive factors that may influence AR, an index of "Nonemotional Cognition" was derived. This consisted of mean *z* scores for those subtests from the WAIS–R, Non-Emotional Faces, and Non-Emotional Prosody that were significantly correlated with AR (Information, Similarities, Digit Span Backward, Digit Symbol, Non-Emotional Prosody; see Results). The internal-consistency reliability of this Nonemotional Cognition index was acceptable ($\alpha = .77$).

Clinical Symptom Rating

All symptom ratings were made blind to test results. Following a separate 1-h semistructured interview, two of the authors made separate and then consensus ratings on the 30-item PANSS, supplemented with 10 items from the Comprehensive Assessment of Symptoms and History (CASH; Andreasen et al., 1992). Based on prior analyses of symptom factors in schizophrenia (Buchanan & Carpenter, 1994; Kay & Sevy, 1990), items of this Extended PANSS (PANSS–E) were categorized in six symptom subscales ([c] indicates CASH items): *Positive* (hallucinations, delusions, grandiosity, suspiciousness, unusual thoughts), *Negative* (blunted affect, motor retardation, lack of spontaneous conversation, passive social withdrawal, emotional withdrawal, poor rapport, avolition), *Disorganized* (conceptual disorganization, incoherence[c], poverty of speech content[c], inappropriate affect[c], bizarre clothing and appearance[c], bizarre social and sexual behaviors[c], ritualistic stereotyped behavior[c]), *Excited* (excitement, racing thoughts[c], euphoric mood[c], tension, hostility, poor impulse control), *Depressed–Anxious* (depression, loss of energy[c], guilt, anxiety, somatic concern), and *Cognitive* (inattention, disorientation, poor abstract thinking, stereotyped thinking, deficient judgment and insight, preoccupation)—with the remaining items categorized as *Other* (poor grooming/hygiene[c], mannerisms and posturing, active social avoidance, uncooperativeness). Psychometric properties of the PANSS–E are to be presented elsewhere (Poole & Vinogradov, 2000). In brief, internal-consistency reliabilities were moderately high and comparable for the Positive, Negative, Disorganized, and Cognitive scales ($\alpha = .80, .79, .86, .80$, respectively). Reliability was lower for the Excited and Depressed–Anxious scales ($\alpha = .59$ and $.47$), reflecting the restricted range of these symptoms in our sample (none had more than moderately severe mood symptoms)—but was adequate for the purposes of this study.

Quality of Life Rating

During a 40-min interview and consensus ratings by two of the authors (blind to test results), the Quality of Life Scale (QLS; Heinrichs et al., 1984) was administered to 37 of the patients. QLS items are divided into four subscales (Heinrichs et al., 1984): *Interpersonal Relations* (family, friends, sexual), *Vocation* (work or other instrumental role functions), *Intrapsychic Foundations* (e.g., curiosity, sense of purpose, hedonic experiences), and *Community Participation* (engagement in common activities, use of common objects). Internal-consistency reliabilities were high for the first three subscales ($\alpha = .90, .88, .85$, respectively). The fourth subscale, which is composed of two items, had lower but acceptable reliability ($\alpha = .62$).

Data Transformations

Three patients were not given the QLS, and three cognitive measures had single missing values (VAR, Non-Emotional Faces, WAIS–R Block Design). Missing values were replaced by sample means, so that $n = 40$ for all tests—a conservative approach that avoids the biasing effect of dropping participants, but tends to reduce slightly the magnitude of correlations (only slight changes occurred when these variables were reanalyzed without mean substitution). Neuroleptic dose had a large positive skew which was successfully normalized prior to all analyses by square-root transformation; all other variables were normally distributed (skewness and kurtosis < 1.0, with no extreme outlier values).

Inferential Procedures

To control Type I error while maintaining acceptable statistical power, protected significance tests were conducted hierarchically as follows. First, two overall tests of significance were performed on AR's multiple correlation with (1) all cognitive measures and (2) all interview-based ratings. Second, AR's correlations with global indices were tested (FSIQ, PANSS–E Total, QLS Total), followed by analyses of subscales (three WAIS–R, six PANSS-E, four QLS). Third, to help interpret the global and subscale correlations, AR's association with individual items (seven WAIS–R, 40 PANSS–E, 21 QLS) was also examined. Finally, we tested for significant differences among correlation coefficients, using a multivariate *r*-to-*z* procedure: that is, the chi-squared homogeneity test, adjusted for nonindependence of measures (Meng et al., 1992). This latter adjustment is necessary whenever one contrasts correlation coefficients obtained on the same subjects.

Significance and Power Criteria

For evaluating AR's correlations with symptomatic and quality-of-life measures, we decided one-tailed significance tests would provide the most accurate estimates of Type-I error rates. This is because only a unidirectional alternative to the null hypothesis appeared rational (i.e., that cognitive deficits are associated with worse, not improved, functioning)—as well as being consistent with prior AR studies. A conventional criterion of statistical significance ($\alpha = .05$) was used; however any trends approaching significance ($p < .10$) were also reported, to allow readers to consider possible Type-II errors. With $N = 40$ and $\alpha = .05$ (one-tailed), this study had over 70% power to detect correlations of at least .35 (Kraemer & Thiemann, 1987).

RESULTS

Preliminary Analysis: Intellectual Correlates of AR

AR did not covary significantly with education, age, sex, or neuroleptic dose (all *p*s > .10). In an overall significance test, the multivariate relation of the two affect recognition measures (FAR, VAR) to the nine nonemotional cognitive measures (WAIS–R subscores, Non-Emotional Prosody, Non-Emotional Faces) was evaluated by canonical correlation analysis. This indicated that the two sets of measures covaried via a single significant canonical function [$R(18,56) = .69$, $p = .04$]. Variables that loaded highly ($r > .50$) on the canonical variates included both FAR and VAR, as well as five of the cognitive measures (Non-Emotional Prosody, Digit Symbol, Similarities, Information, Digit Span Backward). Next, we contrasted FAR and VAR's correlations with the nine nonemotional cognitive measures (multivariate contrast, adjusted for nonindependence of measures; Meng et al., 1992); the two sets of correlations were virtually identical, with no significant differences between FAR and VAR's correlation matrices [$\chi^2(9) = 8.425$, $p = .5$]. These analyses indicated that affect recognition acted as a single cognitive entity across auditory and visual modalities; therefore, all subsequent analyses focused on AR (the composite of FAR and VAR).

AR correlated significantly with WAIS–R Full Scale IQ ($r = .44$, $p = .002$). However, there were significant differences among the nine nonemotional cognitive measures' correlations with AR (multivariate homogeneity test, adjusted for nonindependence of measures [$\chi^2(8) = 15.803$, $p = .045$]); these differences were accounted for as follows: AR correlated significantly with two WAIS–R factors, Verbal Comprehension and Sustained Attention (Table 1), including the following subtests, Digit Symbol, Similarities, Information, Digit Span Backward (rs = .46 to .30, ps < .03). Block Design approached significance ($r = .25$, $p = .07$). Picture Completion and Digit Span Forward were unrelated to AR (rs < .10). AR also correlated significantly with Non-Emotional Prosody, but not Non-Emotional Faces; this is consistent with the above findings, since Non-Emotional Prosody correlated highly with WAIS–R Sustained Attention ($r = .59$, $p < .001$) and Verbal Comprehension ($r = .44$, $p = .002$), while Non-Emotional Faces did not.

Table 1. Relation of AR to general cognitive abilities

Cognitive ability	r_{AR} (Pearson correlation)
Intellectual factors (WAIS–R)	
Verbal Comprehension	.45**
Sustained Attention	.45**
Perceptual Organization	.18
Feature discrimination	
Non-Emotional Prosody	.57**
Non-Emotional Faces	.08

**$p < .01$ (one-tailed).

AR's Correlations With Symptoms and Quality of Life

In an overall significance test on the relation of AR to interview-based ratings, AR was significantly correlated with the six PANSS–E and four QLS subscales [$R(10,29) = .69$, $p = .01$]. When we contrasted FAR and VAR's correlations with the interview-based ratings, FAR and VAR showed a virtually identical pattern of correlations with these 10 subscales (multivariate contrast for nonindependent measures [$\chi^2(10) = 4.757$, $p = .9$]). This again supported the use of a single AR index combining auditory and visual modalities.

AR correlated significantly with PANSS–E Total ($r = -.44$, $p = .002$). However, the six PANSS–E subscales differed significantly in their correlations with AR (homogeneity test for nonindependent measures [$\chi^2(5) = 14.504$, $p = .01$]): Disorganized, Cognitive, and Positive Symptoms were significantly correlated with AR—but Negative, Excited, and Depressed–Anxious Symptoms were not (Table 2).

Likewise, AR correlated significantly with QLS Total ($r = .36$, $p = .02$). However, the four QLS subscales differed significantly in their correlations with AR (homogeneity test for nonindependent measures [$\chi^2(3) = 8.68$, $p = .03$]): Interpersonal Relations, Intrapsychic Foundations, and Community Participation were significantly correlated with AR—but Vocation was not (Table 2).

Table 2. Relation of AR to symptom severity and quality of life

Interview subscale	r_{AR} (Pearson correlation)
Symptoms (PANSS–E)	
Disorganized symptoms	−.46**
Positive symptoms	−.44**
Cognitive symptoms	−.40**
Negative symptoms	−.23
Excited symptoms	−.19
Depressed/anxious symptoms	.19
Quality of life (QLS)	
Community participation	.39**
Intrapsychic foundations	.37*
Interpersonal relations	.35*
Vocation	.03

** $p < .01$, * $p < .05$ (one-tailed).

Table 3. Interview items specifically associated with AR (controlling for global intellectual and clinical impairment)

Interview item	$r_{partial}$
PANSS–E items	
Bizarre social & sexual behaviors (D)	−.34*
Bizarre clothing & appearance (D)	−.34*
Euphoric mood (E)	−.33*
Poor impulse control (E)	−.27
Inattentive behavior (C)	−.26
Hallucinations (P)	−.25
Poor grooming & hygiene (O)	−.21
Quality of Life items	
Household relations (IR)	.35*
Social activity (IR)	.34*
Acquaintances (IR)	.28
Commonplace activities (CP)	.27
Sexual relations (IR)	.25
Curiosity (IF)	.24

Partial correlations of AR with PANSS–E and QLS items, controlling for adjusted PANSS–E Total score and Nonemotional Cognition: * $p < .05$ (one-tailed). To allow consideration of possible Type-II errors, all PANSS–E and QLS items with rs $>.20$ ($p < .10$) are listed, in order of descending magnitude. Subscale assignment of items on PANSS–E is indicated: (D) Disorganized, (P) Positive, (C) Cognitive, (E) Excited, (O) Other. Subscale assignment on QLS is indicated: (IR) Interpersonal Relations, (CP) Community Participation, (IF) Intrapsychic Foundations.

Item-Level Analysis

AR's correlations were significant (or approached significance) with most items composing the three PANSS–E and three QLS subscales that covaried significantly with AR—as well as with four PANSS–E items not on these scales (passive social withdrawal, poor grooming–hygiene, euphoric mood, poor impulse control (rs $= -.42$ to $-.26$, ps $< .05$). However, we considered a more stringent criterion of item-level correlation appropriate and potentially more informative—namely, to identify items that were specifically correlated with AR, even after removing the general effects of intellectual deficits and overall illness severity.

Therefore, partial correlations were computed, controlling for Nonemotional Cognition (the nonemotional cognitive correlates of AR) and the adjusted PANSS–E Total score (sum of all PANSS–E subscales not containing the item being analyzed). As summarized in Table 3, AR showed significant partial correlations with three PANSS–E items (bizarre social and sexual behaviors, bizarre clothing and appearance, euphoric mood) and two QLS items (household relations, social activity). Thus, with the apparent exception of one item (euphoria), AR was most specifically associated with impairment in several social behaviors, independent of general intellectual and illness severity indicators.

Exploratory Analyses and Model Building

To construct a preliminary, parsimonious model of AR's unique and conjoint covariation with PANSS–E subscales, QLS subscales, and Nonemotional Cognition, a series of hierarchical regressions and a principal components analysis were conducted.

The regression analyses indicated the following:

1. After partialing out the effect of Nonemotional Cognition, AR was no longer significantly correlated with PANSS–E Positive or Cognitive Symptoms (ps $> .10$); therefore these two symptoms were dropped from the final model.
2. After partialing Nonemotional Cognition, AR still covaried significantly with PANSS–E Disorganized Symptoms and QLS Interpersonal Relations ($r_{partials} = -.28$ and .30, ps $< .04$); therefore these two variables were retained in the final model.
3. Disorganized Symptoms and Interpersonal Relations were uncorrelated with each other, and both measures covaried uniquely with AR [$r_{partials} = -.43$ and .30, respectively, ps $< .03$; multiple $R(2,37) = .53$, $p = .001$].

To summarize, Nonemotional Cognition, Disorganized Symptoms, and Interpersonal Relations all shared significant, unique covariance with AR, while none of these measures showed significant unique covariation with one another. This pattern suggests that AR, or a closely related process, may play a mediating role among these indices.

Rather than assuming that AR is the mediating process, we tested whether a single latent variable (i.e., an unobserved factor) may account for the correlations among these four measures. Principal components analysis conducted on AR, Nonemotional Cognition, Disorganized Symptoms, and Interpersonal Relations yielded a single factor (meeting scree-test and eigenvalue >1 criteria), which accounted for 53% of the variance in these measures . All four variables had loadings above .40 on this component (see Figure 1 for

https://doi.org/10.1017/S135561770066602X Published online by Cambridge University Press

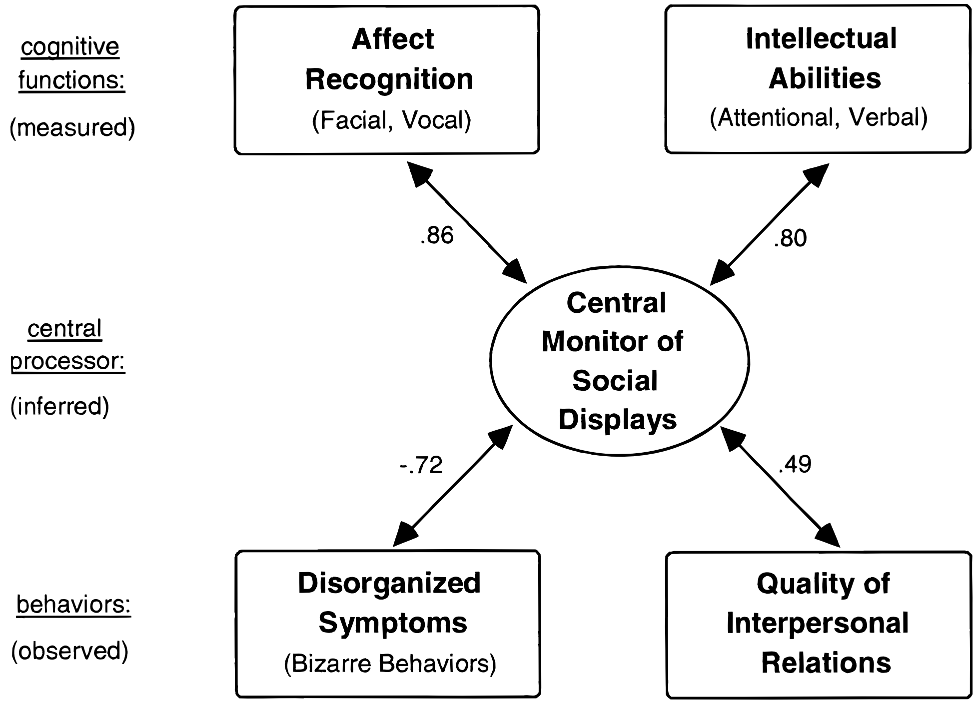

Fig. 1. Proposed model linking specific cognitive and behavioral impairments in schizophrenia to the status of a central social-display monitor that evaluates and regulates social cues generated by others and by oneself. Numbers are correlation coefficients (principal component loadings).

values). Furthermore, after partialing out the effects of this component, no correlations among the four measures even approached significance (all $ps > 0.7$). These analyses are consistent with a model in which a single underlying factor mediates among the four observed measures.

DISCUSSION

Scope and Limitations of the Study

The present research is one of the largest analyses to date of affect recognition in schizophrenia; it is the first to analyze the relation of heteromodal AR (facial and prosodic affect recognition) to the clinical and community functioning of schizophrenic outpatients. To determine whether the present findings are specific to schizophrenia or more broadly characterize psychotic illness, this within-group analysis of AR should be extended to other psychiatric disorders with psychotic features. Since only 9 participants were female, the generalizability of these findings to both sexes still needs to be evaluated. Finally, our cognitive battery was intended to assess and control for AR's relation to general intellectual abilities, not to evaluate all neuropsychological domains relevant to schizophrenia. Thus, a comprehensive evaluation of heteromodal AR's relation to other cognitive processes will require further study. Nonetheless, the present analyses provided clear answers for the three questions posed in this study.

Intellectual Correlates of AR

The study confirmed prior reports that AR is associated with general, "nonemotional" cognitive abilities (Kerr & Neale, 1993; Penn et al., 1996). Specifically, our analyses suggest that both vocal and facial AR may depend on aspects of verbal comprehension, such as semantic memory and abstract reasoning (Information and Similarities tests), and on executive–attentional abilities required for rapid mental manipulation of sequential symbolic input (Digits Backward and Digit Symbol). Furthermore, this pattern was corroborated by independent ratings of behavior during the PANSS–E interview, in which poor AR was associated with signs of stereotyped thinking and inattention.

Facial and vocal AR were not related to simple attention span (Digits Forward), nor to visuospatial abilities (Perceptual Organization) or nonemotional face recognition. Some prior studies found that nonemotional face recognition covaried with facial AR in schizophrenia (Kerr & Neale, 1993), while another study did not (Borod et al., 1990). This indicates that a generalized face-perception deficit is not a robust component of AR problems in this disorder.

These findings parallel those of two recent studies, despite major methodological differences. In one study (Bryson et al., 1997), 63 schizophrenic outpatients attempted to identify six emotional states portrayed by actors in audiovisual recordings of social vignettes. Accuracy on this task was associated with better performance on attentional and

https://doi.org/10.1017/S135561770066602X Published online by Cambridge University Press

executive measures (Digit Span, Digit Symbol, Continuous Performance Task, Wisconsin Card Sort) and better short-term recall. As in the present study, these correlations did not depend on global indices of illness severity. The second study (Corrigan et al., 1995) found that schizophrenics' ability to identify social cues improved significantly following cognitive training to enhance vigilance and verbal-semantic encoding. Taken together, these studies indicate that executive–attentional and verbal–semantic abilities contribute to the process of identifying social cues, and that rehabilitation efforts aimed at these two cognitive domains may compensate, at least partly, for AR deficits in schizophrenia.

Functional Relevance of AR

The practical significance of AR assessment was evaluated in relation to two sets of criteria: *clinical* (symptom profile) and *ecological* (quality-of-life measures). Clinically, inaccurate AR was associated with two schizophrenia-specific symptom domains, disorganized and positive symptoms—but was not stongly related to negative, depressed, anxious, or excited symptoms. This is consistent with prior studies that found facial AR associated mainly with schizophrenia-specific symptoms (Heimberg et al., 1992; Schneider et al., 1995). The lack of connection with mood symptoms is important, because it demonstrates that AR's associations with cognitive and behavioral features of schizophrenia are not simply a byproduct of altered mood. This finding, however, does not contradict reports of facial AR anomalies in major depression (Borod et al., 1990; Feinberg et al., 1986), since none of our participants had more than moderately severe mood symptoms.

In terms of ecological validity, inaccurate AR was associated with impoverished interpersonal relations, limited community participation, and restricted range of intrapsychic experience. These behavioral and intrapsychic deficits are among the most debilitating long-term sequelae of schizophrenic illness and are sometimes considered a subset of negative symptoms. However, it is important to note that AR was unrelated to flat affect, poverty of speech, or motor slowness. While this concurs with previous findings that facial AR is associated with impaired social relations (Mueser et al., 1996; Penn et al., 1996), it does not support a link with core negative symptoms. Interestingly, a study that compared facial and vocal AR to operationalized measures of expressive facial and prosodic affect (Borod et al., 1990) also found no significant connection between perception of emotions and expression of emotions in schizophrenic patients. Taken together, these analyses suggest that inaccurate AR is related to active disruption of interpersonal relations rather than to psychomotor retardation.

General *Versus* Specific Functional Correlates of AR

When we controlled for verbal–semantic and executive–attentional abilities, several associations with AR were attenuated (namely, the correlations with positive symptoms, impoverished intrapsychic experience, and overall community participation). This suggests that AR's correlations with these symptoms may largely reflect the wide-ranging effects of general intellectual deficits in schizophrenia. In contrast, AR accounted significantly for the quality of interpersonal relations and the severity of bizarrely inappropriate behaviors (involving social and sexual displays, choice of clothing, and appearance)—even after adjusting for intellectual and illness severity ratings. This suggests that impaired AR is specifically linked to the severe disorganization of social behaviors that occurs in a subset of schizophrenic patients. Thus, errors in the interpretation of heteromodal social cues may help account for bizarre, socially disruptive behaviors—a manifestation of schizophrenia that is less well understood from a neurocognitive perspective than other symptoms.

AR also showed a significant association with one symptom that is not specific to schizophrenia: euphoric mood. Since this only emerged in item-level analyses (where the likelihood of Type-I error is higher), it should be interpreted cautiously. However this correlation might parallel a reported association of inaccurate facial AR with "defensive self-enhancement" in schizophrenia (Garfield et al., 1987)—a mechanism for elevating self-image with minimal reality testing or use of external feedback. If replicated, AR's association with euphoria, bizarre social–sexual behaviors, and bizarre appearance/behavior, might all reflect a single defect in the self-monitoring and self-regulation of social behaviors, occurring in a subset of schizophrenic patients.

What Is the Core Defect?

Figure 1 is offered in the spirit of initial hypothesis formation and model building. This model reflects previous research findings that were verified in the present study, as well as new analyses that require replication. First, the present study extended prior findings that AR deficits in schizophrenia covary across sensory modalities, by showing that facial and prosodic AR had virtually identical patterns of association with numerous cognitive, symptomatic, and ecological criteria. This provides convergent and discriminant evidence that these visual and auditory AR impairments reflect the same underlying deficit and have the same functional implications. Therefore, the proposed model treats AR in schizophrenia as a single, heteromodal process.

Second, this study sheds light on an ongoing debate in the literature, whether schizophrenia involves diffuse, generalized impairment or specific cognitive defects. Concurring with several prior studies, our analyses indicated that impaired processing of social information in schizophrenia involves *both* general intellectual deficits (executive–attentional, verbal–semantic) and specific difficulty interpreting social cues (heteromodal AR). These results imply that an accurate characterization of this illness (and its within-group heterogeneity) requires ascertainment of patients' gen-

https://doi.org/10.1017/S135561770066602X Published online by Cambridge University Press

eral cognitive level as well as examination of specific functionally salient capacities, such as affect recognition, to determine whether these are impaired or preserved.

Third, regarding symptoms and quality of life, the present findings suggest that disorganized behaviors and disrupted interpersonal relations in schizophrenia are different manifestations of a single neurocognitive defect. We hypothesize that this defect involves the central monitoring and regulation of social displays—both *extroceptively* (i.e., recognizing others' social cues and the pragmatic aspects of interpersonal interaction) and *introceptively* (utilizing feedback on the status and adaptive impact of one's own appearance, behavior, and social presentation).

A logical progression in developing this model will be to replicate this study with the addition of a comprehensive neuropsychological battery (in essence, adding greater detail to Figure 1). This will help to further characterize neurocognitive components of this putative defect. Furthermore, the current AR literature consists almost exclusively of cross-sectional correlation analyses, which cannot specify causal relations among the model's components (i.e., the direction of arrows in Figure 1). Longitudinal and intervention studies should clarify AR's causal links with other aspects of schizophrenia, and help identify processes that exacerbate or mitigate the social–functional consequences of this illness.

Where Is the Defect?

Is there evidence for the existence of a single central module that normally monitors and regulates social interactions? Electrophysiological, metabolic, and lesion studies (reviewed by Blonders et al., 1991; Deakin et al., 1991; Tucker et al., 1995) have demonstrated that two main cerebral regions play a direct role in these processes: the right temporoparietal cortex and the basolateral circuit (connecting limbic, anterior temporal, and prefrontal structures). Both of these systems participate in the *perception* of social signals, including facial and vocal affect. However, the basolateral circuit is also crucial in the active *regulation* of social behaviors and social–emotional experience (Kling & Brothers, 1992; Tucker et al., 1995). In the present sample, the differential correlation of AR with executive–attentional and verbal–semantic abilities (and not with visuospatial perceptual measures) would appear to implicate the basolateral circuit rather than the right-posterior temporoparietal cortex. The specific association of AR with distinctly behavioral signs (bizarre behaviors and deficient social engagement) also supports this conclusion (Tucker, 1993).

The basolateral circuit is central both to heteromodal affect recognition and to self-regulation of social behaviors such as grooming, affiliation, and aggression. In animal and human studies, disturbances in limbic components of this circuit have been linked to social–emotional agnosia and inappropriate social behaviors, which bear a striking resemblance to the disorganized syndrome in schizophrenia (Aggleton, 1993; Beauregard & Bachevalier, 1996; Deakin et al., 1991; Kling & Brothers, 1992; Luchins, 1990). We are currently conducting imaging studies to determine whether AR tasks can provide a window on the status of this fundamental neurocognitive system in schizophrenic patients.

ACKNOWLEDGMENTS

Preliminary results of this study were presented at the Annual Meeting of the International Neuropsychological Society (February 6, 1997, Orlando, Florida). Portions were included in the second author's doctoral dissertation. This research was supported by NIMH Grant MH52906-01A1 to S.V. and by a Department of Veterans Affairs Health Service Research and Development Grant to S.V. and J.H.P. The authors are particularly grateful to Jason Willis-Shore and Anne Fischer for their excellent assistance with consensus symptom ratings and data base management. We also sincerely thank Allison McInnis for conducting SCIDs and participating in consensus diagnoses.

REFERENCES

Aggleton, J.P. (1993). The contribution of the amygdala to normal and abnormal emotional states. *Trends in Neurosciences*, *16*, 328–333.

Andreasen, N.C. (1982). Negative symptoms in schizophrenia: Definition and reliability. *Archives of General Psychiatry*, *39*, 784–788.

Andreasen, N.C., Flaum, M.C., & Arndt, S. (1992). The Comprehensive Assessment of Symptoms and History (CASH): An instrument for assessing diagnosis and psychopathology. *Archives of General Psychiatry*, *49*, 615–623.

Andreasen, N.C. & Olsen, S. (1982). Negative versus positive schizophrenia: Definition and validation. *Archives of General Psychiatry*, *39*, 789–794.

Archer, J., Hay, D.C., & Young, A.W. (1994). Movement, face processing, and schizophrenia: Evidence of a differential deficit in expression analysis. *British Journal of Clinical Psychology*, *33*, 517–528.

Aylward, E., Walker, E., & Bettes, B. (1984). Intelligence in schizophrenia: Meta-analysis of the research. *Schizophrenia Bulletin*, *10*, 430–459.

Beauregard, M. & Bachevalier, J. (1996). Neonatal insult to the hippocampal region and schizophrenia: A review and a putative animal model. *Canadian Journal of Psychiatry*, *41*, 446–456.

Benton, A., VanAllen, M., Hamsher, K., & Levin, H. (1978). *Test of Facial Recognition manual*. Iowa City, IA: Benton Laboratory of Neuropsychology.

Bilder, R.M., Lipschutz-Broch, L., Reiter, G., & Geisler, S.H. (1992). Intellectual deficits in first-episode schizophrenia: Evidence for progressive deterioration. *Schizophrenia Bulletin*, *18*, 437–448.

Blonders, L., Bowers, D., & Heilman, K. (1991). The role of the right hemisphere in emotional communication. *Brain*, *114*, 1115–1127.

Borod, J.C., Martin, C.C., Alpert, M., Brozgold, A., & Welkowitz, J. (1993). Perception of facial emotion in schizophrenic and right brain-damaged patients. *Journal of Nervous and Mental Disease*, *181*, 494–502.

Borod, J.C., Welkowitz, J., Alpert, M., Brozgold, A.Z., Martin, C., Peselow, E., & Diller, L. (1990). Parameters of emotional processing in neuropsychiatric disorders: Conceptual issues and a battery of tests. *Journal of Communication Disorders*, *23*, 247–271.

Bowers, D., Blonder, L.X., & Heilman, K.M. (1991). *Florida Affect Battery*. Gainsville, FL: Center for Neuropsychological Studies, University of Florida.

Bowers, D. & Heilman, K.M. (1984). Dissociation between the processing of affective and nonaffective faces: A case study. *Journal of Clinical Neuropsychology*, *6*, 367–379.

Bryson, G., Bell, M., & Lysaker, P. (1997). Affect recognition in schizophrenia: A function of global impairment or a specific cognitive deficit. *Psychiatry Research*, *71*, 105–113.

Buchanan, R.W. & Carpenter, W.T. (1994). Domains of psychopathology: An approach to the reduction of heterogeneity in schizophrenia. *Journal of Nervous and Mental Disease*, *182*, 193–204.

Corrigan, P.T., Hirschbeck, J.N., & Wolfe, M. (1995). Memory and vigilance training to improve social perception in schizophrenia. *Schizophrenia Research*, *17*, 257–265.

Deakin, J.W., Simpson, M.C., Royston, M.C., Slater, P., McKenna, P.J., & Brophy, J. (1991). Social signaling and schizophrenia: The significance of neurochemical and morphological abnormalities of the basolateral circuit. *Schizophrenia Research*, *4*, 357–360.

Diaz, E.G., Fierro, L.C., Menendez, R.G., Perez, A.M., Morejon, M.L., Campos, A.E., Suarez, I.G., & Gonzalez, C.R. (1987). El reconocimiento de la expresion emocional facial por enfermos mentales cronicos [The recognition of facial emotion expression by chronic mental patients]. *Revista del Hospital Psiquiatrico de La Habana*, *28*, 523–535.

Ekman, P. & Friesen, W.V. (1976). *Pictures of facial affect*. Palo Alto, CA: Consulting Psychologists Press.

Feinberg, T.E., Rifkin, A., Schaffer, C., & Walker, E. (1986). Facial discrimination and emotional recognition in schizophrenia and affective disorders. *Archives of General Psychiatry*, *43*, 276–279.

First, M.B., Spitzer, R.L., Gibbon, M., & Williams, J.B.W. (1995). *Structured Clinical Interview for DSM-IV Axis I Disorders* (SCID). New York, NY: Biometrics Research Division, New York State Psychiatric Institute.

Garfield, D.A.S., Rogoff, M.L., & Steinberg, S. (1987). Affect recognition and self-esteem in schizophrenia. *Psychopathology*, *20*, 225–233.

Heimberg, C., Gur, R.E., Erwin, R.J., Shtasel, D.L., & Gur, R.C. (1992). Facial emotion discrimination: III. Behavioral findings in schizophrenia. *Psychiatry Research*, *42*, 253–265.

Heinrichs, D.W., Hanlon, T.E., & Carpenter, W.T. (1984). The Quality of Life Scale: An instrument for rating the schizophrenic deficit syndrome. *Schizophrenia Bulletin*, *10*, 388–398.

Kay, S.R., Fiszbein, A., & Opler, L.A. (1987). The Positive and Negative Syndrome Scale (PANSS) for schizophrenia. *Schizophrenia Bulletin*, *13*, 261–276.

Kay, S.R. & Sevy, S. (1990). Pyramidical model of schizophrenia. *Schizophrenia Bulletin*, *16*, 537–545.

Kerr, S.L. & Neale, J.M. (1993). Emotion perception in schizophrenia: Specific deficit or further evidence of generalized poor performance? *Journal of Abnormal Psychology*, *102*, 312–318.

Kline, J.S., Smith, J.E., & Ellis, H.C. (1992). Paranoid and nonparanoid schizophrenic processing of facially displayed affect. *Journal of Psychiatry Research*, *26*, 169–182.

Kling, A.S. & Brothers, L.A. (1992). The amygdala and social behavior. In J.P. Aggleton (Ed.), *The amygdala: Neurobiological aspects of emotion, memory, and mental dysfunction* (pp. 353–377). New York: Wiley-Liss.

Kraemer, H.C. & Thiemann, S. (1987). *How many subjects? Statistical power analysis in research*. Newbury Park, CA: Sage Publications.

Leckliter, I.N. & Matarazzo, J.D., Silverstein, A.B. (1986). A literature review of factor analytic studies of the WAIS–R. *Journal of Clinical Psychology*, *42*, 332–342.

Lewis, S.F. & Garver, D.L. (1995). Treatment and diagnostic subtype in facial affect recognition in schizophrenia. *Journal of Psychiatric Research*, *29*, 5–11.

Lezak, M.D. (1995). *Neuropsychological assessment* (3rd ed.). New York: Oxford University Press.

Liddle, P.F. (1987). Schizophrenic syndromes, cognitive performance and neurological dysfunction. *Psychological Medicine*, *17*, 49–57.

Luchins, D.J. (1990). A possible role of hippocampal dysfunction in schizophrenic symptomatology. *Biological Psychiatry*, *28*, 87–91.

Meng, X.L., Rosenthal, R., & Rubin, D.B. (1992). Comparing correlated correlation coefficients. *Psychological Bulletin*, *111*, 172–175.

Mueser, K.T., Doonan, R., Penn, D.L., Blanchard, J.L., Bellack, A.S., Nishith, P., & deLeon, J. (1996). Emotion recognition and social competence in chronic schizophrenia. *Journal of Abnormal Psychology*, *105*, 271–275.

Penn, D.L., Spaulding, W., Reed, D., & Sullivan, M. (1996). The relationship of social cognition to ward behavior in chronic schizophrenia. *Schizophrenia Research*, *20*, 327–335.

Poole, J.H. & Vinogradov, S. (2000). *The Positive and Negative Syndrome Scale—Extended: Reliability and validity*. Manuscript submitted for publication.

Rapscak, S., Kasniak, A., & Rubins, A. (1989). Anomia for facial expressions: Evidence for a category specific visual–verbal disconnection. *Neuropsychologia*, *27*, 1031–1041.

Salem, J.E., Kring, A.M., & Kerr, S.L. (1996). More evidence for generalized poor performance in facial emotion perception in schizophrenia. *Journal of Abnormal Psychology*, *105*, 480–483.

Schneider, F., Gur, R.C., Gur, R.E., & Shtasel, D.L. (1995). Emotional processing in schizophrenia: Neurobehavioral probes in relation to psychopathology. *Schizophrenia Research*, *17*, 67–75.

Shallice, T., Burgess, P.W., & Frith, C.D. (1991). Can the neuropsychological case-study approach be applied to schizophrenia? *Psychological Medicine*, *21*, 661–673.

Stevens, J.R. (1997). Enough of pooled averages: Been there, done that. *Biological Psychiatry*, *41*, 633–635.

Tucker, D.M. (1993). Emotional experience and the problem of vertical integration: Discussion of the special section on emotion. *Neuropsychology*, *7*, 500–509.

Tucker, D.M., Luu, P., & Pribram, K.H. (1995). Social and emotional self-regulation. *Annals of the New York Academy of Sciences*, *769*, 213–239.

Walker, E., McGuire, M., & Bettes, B. (1984). Recognition and identification of facial stimuli by schizophrenics and patients with affective disorders. *British Journal of Clinical Psychology*, *23*, 37–44.