ELECTRODERMAL INDICES OF INFORMATION PROCESSING AND FUNCTIONAL CEREBRAL ASYMMETRY IN SCHIZOPHRENIA. A COMPARISON WITH AFFECTIVE DISORDER

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SUMMARY

Skin conductance measures of the orienting response and tonic arousal were used to test the general hypothesis that certain groups of symptoms occurring in schizophrenia could be understood in terms of anomalies in the stages of perceptual information processing. A review of the literature describing patterns of symptom change during recovery from schizophrenic psychoses led to the identification of relatively discrete groups of symptoms. The delineation of these groups was based on their *prima facie* internal consistency and the tendency for their constituent items to covary with time. It was proposed that one of these symptom groups may be a more or less direct manifestation of some primary or "core" psychotic process of fundamental importance in schizophrenia. Other symptom groups were thought to represent secondary, corrective or compensatory information processing strategies that served to counterbalance those of the primary abnormality.

A model of the orienting response which was developed by Arne Ohman within the framework of attention and information processing theory was modified and incorporated within an information processing model of schizophrenia. When certain components of this model were tested using bilateral skin conductance measurements in a tone habituation paradigm, it was found that acutely psychotic schizophrenic patients had relatively high levels of tonic arousal and showed a pattern of asymmetry in several skin conductance variables which suggested underactivity of left hemisphere functioning relative to that of the right. Using amplitude of the orienting response as the central information processing variable of relevance to the proposed model of schizophrenia, it was found that those symptoms representing the putative primary abnormality in schizophrenia and those representing the secondary or compensatory processes were each related to this orienting response variable in opposite directions in a manner predicted by the proposed model of

schizophrenia. Furthermore, these secondary symptoms, unlike those reflecting the primary disorder, seemed to be associated with reduced tonic arousal and, to a lesser extent, normalization of the lateral asymmetry in skin conductance. That is, they seemed to be associated with increasing activation of left hemisphere functioning relative to that of the right.

In contrast, the findings with respect to patients with depressive illness failed to confirm predictions based on the literature dealing with electrodermal activity in depression. In particular, reduced tonic arousal in depression was not demonstrated. Neither did the direction of skin conductance asymmetry conform to expectation. Finally, there was a positive correlation between tonic arousal levels and severity of psychomotor slowing instead of the predicted negative correlation. This unexpected finding was discussed in the light of other research conducted by the author.

Reference:

Ohman, A. The orienting response, attention, and learning: An information-processing perspective. In H.D. Kimmel, E.H. Van Olst and J.F. Orlebeke (Eds). *The Orienting Reflex in Humans*. Lawrence Erlbaum Associates, Inc., Hillsdale, New Jersey, 1979, pp 443-471.

This thesis contains no material which has been accepted for the award of any degree or diploma in any university, and, to the best of my belief, contains no material previously published or written by another person, except where due reference is made in the text.

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Vaughan J. Carr

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CHAPTER 1

INTRODUCTION

"The most profound distinction in psychic life seems to be that between what is meaningful and *allows empathy* and what in its particular way is *un-understandable*, 'mad' in the literal sense, schizophrenic psychic life ..." (Karl Jaspers)[1].

Here Jaspers was emphasising the significance of non-understanding as a characteristic of schizophrenic experience. Although he was speaking to the issue of *empathic* understanding, incomprehensibility of schizophrenic phenomena has been taken more broadly by many as an inherent quality of this illness. Others have held to the belief that comprehension of the schizophrenic experience is limited more by the tools we have available to understand the condition rather than by any immutable characteristic of schizophrenia itself.

Bleuler and Jung, for example, applied the tools of Freudian psychoanalytic theory to schizophrenia in an effort to understand the illness. This was an important step as it demonstrated that content, if not form, could yield to empathic understanding and this helped to underscore the humanness of the schizophrenic person's experience. Carl Schneider was another whose theory of schizophrenic symptom-complexes was intended to help the schizophrenic experience yield to human comprehension. There have, of course, been others who have attempted to render schizophrenic phenomena comprehensible within some framework or another, but no review of this work will be undertaken here. The point to be made is that no one conceptual frame of reference has attained general acceptability.

On the other hand, the trend in biological psychiatry recently has inclined to be one in which 'understandability' has taken very much a second place to attempts at defining schizophrenia in conventional disease terms. With notable exceptions, this has

produced an often thoughtless search for an elusive 'disease marker' and formulation of simplistic disease theories flawed by their predication upon the fallacy of the single cause.

The present study takes as a fundamental premise that an adequate scientific understanding of schizophrenia must be rooted in two sciences simultaneously, neurobiology and psychology, the nature of schizophrenia being a problem of the interface between them. It follows that to understand schizophrenia scientifically requires approaches to this interface from both directions at the same time.

Having broadly defined the problem in those terms, it remains to sketch a theoretical framework within which to approach the problem. A testable theory can be viewed as a set of interrelated questions designed to yield to empirical methods. Thus, theory is in large part determined by the empirical methods or tools that are available to address the questions. In the present instance, available tools included a polygraph capable of measuring electrodermal activity and a certain amount of clinical expertise in measuring psychiatric symptomatology. These two capabilities were combined to develop a conceptual framework focusing on the neurological-psychological interface. This framework was one which attempted to unite schizophrenic symptomatology and electrodermal activity within an information-processing model.

Symptomatology was first organized by reviewing the literature on recovery from schizophrenic psychoses in an attempt to identify particular symptom clusters or dimensions on the basis of symptom covariation over time, which could act as vectors for describing psychopathological states. Having defined these particular symptom dimensions, it was proposed that certain of them represented the outward manifestations

of underlying psychophysiological processes of relevance to schizophrenic pathology.

From the neurobiological viewpoint, electrodermal indices of arousal and the orienting response were reviewed. The literature dealing with the general neurophysiological and psychological aspects of electrodermal activity was examined together with that covering the clinical psychiatric applications of electrodermal measurement.

An information-processing model of the orienting response was adapted in an attempt to combine psychophysiology with schizophrenic symptomatology in a way which, it was hoped, would illuminate that neurobiological-psychological interface where an understanding of the nature of schizophrenia might follow.

CHAPTER 2

SYMPTOMATOLOGY

2.1. THE PROBLEM OF HETEROGENEITY.

Two characteristic features of schizophrenia are daunting to the novice investigator in this field. One is the comparative rarity with which distinctive differences between schizophrenic and control subjects are identified. The other is the regularity with which positive findings, when they do occur, fail to be replicated.[1] In spite of the fact that nearly a century has passed since Kraepelin first defined dementia praecox, the aetiology and pathogenesis of this condition remains as much an enigma as ever .[2]

The problem of diagnostic classification has been one important impediment to the progress of schizophrenia research. The establishment of diagnostic systems employing operational criteria has since enabled diagnoses to be made with satisfactory levels of reliability.[3–5] However, the issue of the validity of such systems of classification remains to be settled.

Another major source of the variability in research findings which has confounded investigations of schizophrenia is the high degree of within-diagnosis heterogeneity. This is one factor which has led some authorities to adopt the view that the schizophrenic syndrome represents a group of disorders.[2,6] Evidence in support of this view is, however, not yet sufficiently convincing. Certainly, the traditional schizophrenia subtypes - paranoid, hebephrenic, catatonic and simple - have not been validated on the basis of descriptive criteria.[7] Other methods of subtyping have been used as a way of reducing within-class heterogeneity and have met with limited but notable successes. By far the majority of these methods have involved dichotomous divisions. Examples include the paranoid/nonparanoid distinction,[8–11]

process/reactive schizophrenia,[12–14] and good prognosis versus poor prognosis.[15,16]

Dichotomies, however, carry with them certain disadvantages. First, the lines of division are inherently arbitrary and, on this basis, are apt to mislead. Second, although dichotomous divisions can be viewed simply as convenient classifications for utilitarian purposes, like nosological entities and categories of clinical state,[17] by imposing artificial limits or boundaries on the phenomena in question they run the risk of distorting them. A method of measurement which, by avoiding the constraints of the categorical approach, is likely to be more faithful to the actual phenomena to be represented, is the dimensional method. In contrast to categorical measurement, the latter has the potential to provide a more accurate representation of the phenomena under investigation. It is not that the dimensional approach eliminates altogether the potential for the means of measurement to distort the object of inquiry. Rather, it is argued that the dimensional method provides less distortion of the phenomena being measured than the categorical method.

A relatively recent example of the dimensional approach of considerable heuristic importance in dealing with heterogeneity in schizophrenia is the positive-negative symptom distinction or type I versus type II syndromes of Crow.[18–20] Although the type I-type II distinction has been interpreted to represent two aetiologically distinct subtypes of schizophrenia and attempts have been made to squeeze the concept into the mould of an either/or dichotomy, Crow has been at pains to correct these misinterpretations.[21] He has emphasised that the concept represents what may be two distinct pathological *processes,* each related to a particular constellation of symptoms, positive and negative.[21] Andreasen has thoroughly reviewed and operationalized the symptoms which comprise the positive-negative dimensions and has

tested their reliability.[22–25]

Inspection of Table 2.1.1 which summarizes Andreasen's[26,27] scales for measuring positive and negative symptoms reveals that the group of negative symptoms does seem, conceptually at least, to be *prima facie* a relatively homogeneous dimension. Most symptoms are those of loss, reduction, diminution or inhibition of psychological/psychosocial processes. Possible exceptions include inappropriate affect and poverty of content of speech. On the other hand, the list of positive symptoms seems to be much more heterogeneous by comparison. Hallucinations of various types are combined with delusions. Certain Schneiderian first rank symptoms which have something of the quality of both hallucinations and delusions but are not clearly either (e.g. thought broadcasting) are included as well. All are lumped together with items of positive formal thought disorder, including some manic-like features, and alterations in behaviour. Some of the latter are psychotically bizarre or disorganized while others are more simply those of aggressiveness or agitation.

This manner of grouping positive symptoms is a remnant of Jackson's hierarchical model of mental functions in which positive symptoms of "insanity" were said to represent the "release" of "lower" mental functions caused by the "dissolution" of "higher" functions.[28] However, the Jacksonian theory is without empirical support and is so global in nature that its equal applicability to epilepsy, psychosis and other abnormalities of behaviour reveals the relative weakness of its explanatory power.

Table 2.1.1

Scales for the Assessment of Negative and Positive Symptoms*

Negative Symptoms

1. Affective flattening or blunting
   - Unchanging facial expression
   - Decreased spontaneous movements
   - Paucity of expressive gestures
   - Poor eye contact
   - Affective nonresponsivity
   - Inappropriate affect
   - Lack of vocal inflections
2. Alogia
   - Poverty of speech
   - Poverty of content of speech
   - Blocking
   - Increased latency of response
3. Avolition - Apathy
   - Poor grooming and hygiene
   - Impersistence at work or school
   - Physical anergia
4. Anhedonia-Asociality
   - Reduced recreational interests and activities
   - Reduced sexual interest and activity
   - Reduced ability to feel intimacy and closeness
   - Restricted relationships with friends and peers
5. Attention
   - Social inattentivenes
   - Inattentiveness during mental state testing

Positive Symptoms

1. Hallucinations
   - Auditory
   - Voices commenting
   - Voices conversing
   - Somatic or tactile
   - Olfactory
   - Visual
2. Delusions
   - Persecutory
   - Jealous
   - Sin or guilt
   - Grandiose
   - Religious
   - Somatic
   - Reference
   - Being controlled
   - Mind reading
   - Thought broadcasting
   - Thought insertion
   - Thought withdrawal
3. Bizarre behaviour
   - Clothing & appearance
   - Social and sexual
   - Aggressive and agitated
   - Repetitive or stereotyped
4. Positive formal thought disorder
   - Derailment
   - Tangentiality
   - Incoherence
   - Illogicality
   - Circumstantiality
   - Pressure of speech
   - Distractable speech
   - Clanging

*Summarised from SANS and SAPS ©Nancy Andreasen, 1984[26,27]

Although the empirical support[21,25,29] for the positive-negative or type I-type II distinction suggests that the grouping of seemingly disparate phenomena under the rubric of positive symptoms is not without some validity, the variety of symptoms within that dimension is sufficiently lacking in *prima facie* homogeneity in comparison to the group of negative symptoms that it deserves to be regarded with rather more skepticism than the latter.

A further problem with the positive-negative distinction is that this system for measuring symptoms in schizophrenia is by no means comprehensive. A wide range of symptoms is experienced by schizophrenic patients apart from those that fit within this model. Symptoms of anxiety are commonplace for instance, as are those of depression[30-32] and a number of neurotic phenomena[33] such as obsessions, compulsions, hypochondriasis and so forth. A symptom rating scale that is to deal thoroughly with schizophrenic heterogeneity should also provide for measurement of these phenomena.

It was with the aim of not foundering on the rocks of schizophrenia variability that the first step in the present research was to find an adequate method for taking into account the notorious clinical heterogeneity of this disorder. This aim was also combined with an important assumption, namely, that the symptomatic manifestations of schizophrenia are neither random nor meaningless phenomena. Rather, it was assumed that they signify important underlying processes which are fundamental to either the basic cerebral dysfunction that is schizophrenia or to the compensatory or regulatory mechanisms which are brought into play in response to that basic dysfunction.

The means chosen to locate a suitable method for dealing with the

heterogeneity of symptoms in schizophrenia was first to review the descriptive literature on recovery from schizophrenic psychoses. It was believed that by examining the differential rates of symptom remission, the methods that other investigators have chosen to characterize this process, and the way in which certain symptoms cluster together over time, a useful method of dealing with or, more precisely, organising symptom variability would be derived. Behind this approach was the expectation that in knowing more about how a schizophrenic psychosis was 'dismantled' one would gain insight into how it was 'constructed' in the first place.

2.2 PATTERNS OF RECOVERY FROM SCHIZOPHRENIC PSYCHOSIS

The following review has been confined to the symptom manifestations of recovery, supplemented by relevant data from related investigations. The literature is considered under three main headings: the continuum or dimensional model, the categorical model, and post-psychotic depression. The latter subject demanded a heading of its own as it has been a subject of controversy and misunderstanding in previous years. The review of each of these areas is followed by a synthesis of the material.

2.2.1 The Continuum Model

Changes in symptomatology in this section are conceptualized as occurring on a severity continuum for each discrete symptom or symptom cluster.

One of the first comprehensive dimensional studies of change over time was

Table 2.2.1.1

Table 2.2.1.1 | Summary of factor analytic studies of recovery from schizophrenic psychosis.

Overall et al[34]	Astrachan et al[36]	Dencker et al[37]	Wittenborn[38]
1. Psychoticism Irrelevant responses Inconsistency of thoughts and feelings Disorientation Speech elements illogically and inconsistently connected Speaking to self Perplexity	5. Turbulent Chaotic interpersonal relations Bizarre thinking Derealization Negativism Concreteness Mutism		
		1. Schizophrenic Splitting Delusions Conceptual disorganization Paranoia Suspiciousness	
2. Paranoidism Tension Suspicions of influence, persecution, and reference Hostility, resentment, bitterness Anxiety over aggressive impulses Apprehension	2. Schizophrenia Grandiosity Speech disorganization Inappropriate behavior Inappropriate affect Looseness of associations Suspicion-persecution Delusions, unspecified		1. Schizophrenic Depressive retardation Schizophrenic excitement Compulsive-obsessive Intellectual impairment
	4. Hallucinations and delusions Hallucinations (auditory, visual) Delusions, depressive		
4. General retardation Slowed motor reactions Reduced amount and loudness of speech Blocked speech Controlled, restrained, inhibited Reduced emotional responsiveness	3. Motor retardation Retarded/lack of emotion Reduced motor activity Stereotyped motor activity	2. Contact disturbance Retardation Psychomotor retardation Reduced affective intensity Motor retardation Verbal contact disturbances	
		3. Psychomotor Psychomotor activity Agitation Uncooperativeness Tension Lack of insight	2. Manic Manic state Psychotic belligerence Dominance Ideas of grandeur

Table 2.2.1.1 Summary of factor analytic studies of recovery from schizophrenic psychosis.

Overall et al[34]	Astrachan et al[36]	Dencker et al[37]	Wittenborn[38]
3. Guilt-conversion Feelings of sinfulness and guilt Degree to which physical complaints not based on organic factors Use of physical symptoms as defense mechanism Concern over health	1. Neurotic Multiple somatic symptons Insomnia Can't take care of things Agitation-excitement Suicide-self-mutilation Somatic concerns Anxiety Depression	4. Neurotic Depressive mood Depression Depression mood Anxiety Anxiety, psychic	
5. Depression Feelings of inadequacy Depression Suicidal impulses			
6. Anxiety and tension Tension Hostility, resentment, bitterness Anxiety over aggressive impulses Apprehension			
RATING SCALES			
Multidimensional Scale of Rating Psychiatric Patients (MSRPP)	New Haven Schizophrenia Index (NHSI); Gurin Mental Status Index (MSI); Psychiatric Evaluation Form (PEF).	Brief Psychiatric Rating Scale (BPRS); Hamilton Rating Scale for Depression (HRSD), Zung Self-Rating Scale for Depression (ZSRSD); S-Scale of Jensson and Martens	Wittenborn Psychiatric Rating Scale (WPRS)

(Table adapted from Carr, V.J. Recovery from Schizophrenia: A review of patterns of psychosis. *Schizophrenia Bulletin, 9,* 95-121, 1983).

conducted by Overall *et al.*[34] They analyzed symptom data on 120 chronic schizophrenic patients in an investigation of the efficacy of chlorpromazine compared to reserpine and placebo after chlorpromazine withdrawal. Ratings were collected before the study began and, again, after 3 and 6 months in the study. Factor analysis identified six independent change factors that represented "basic dimensions of change" (Table 2.2.1.1.) The first of these was labeled "psychoticism" and was postulated to represent the "primary psychotic process" of mental disorganization. The second change factor was "paranoidism", which was believed to reflect a distortion of organized thought processes possibly involving a delusional system. The third factor, "guilt-conversion", appeared to involve a neurotic process unrelated to the "primary psychotic process." Factor 4 was described as "general retardation" and factor 5, "depression". Factor 5 seemed to represent a mood component independent of the retardation and somatic complaint dimensions. The final change factor, "anxiety and tension", covered neurotic symptom items unrelated to the distortion of thought processes involved in the second factor. These change factors were reported by the authors to be similar in many respects to several of those identified by Lorr who, using the same rating scale, analyzed data gathered from a more heterogeneous sample in which between-patient rather than within-patient variance was examined.[35] Overall *et al* also indicated that each patient could be characterized temporally in terms of these functionally independent processes or dimensions.[34] Some support for these findings comes from three later sources.

Astrachan *et al* reported interviews with 132 schizophrenic patients 2 to 3 years after hospitalization.[36] Three symptom rating scales were used. Subjecting these data to factor analysis yielded five factors (Table 2.2.1.1). The first was called a

"neurotic" factor. The second, labeled the "schizophrenia" factor, contained items which appear to reflect a process of psychotic disorganization accompanied by paranoia. The third and fourth factors were "motor retardation" and "hallucinations and delusions", respectively. A final factor was called "turbulent". Factor 5 seems to reflect the psychotic disorganization process but, in contrast to factor 2, without delusions or paranoia. Comparisons with the study of Overall *et al*, which was an investigation of symptom *change* in chronic schizophrenics, must be made with caution as the Astrachan *et al* study was not strictly an investigation of change but an analysis of symptom data at a followup point 2-3 years after hospitalization.[34,36]

Dencker *et al* reported an investigation of a group of schizophrenic outpatients studied repeatedly over 3 years of treatment with depot neuroleptics.[37] Factor analysis of all symptom ratings over this time yielded four factors accounting for 60 percent of the variance (Table 2.2.1.1). The first, a "schizophrenic" factor, is similar to the "schizophrenia" factor in Astrachan *et al* [36] which reflected psychotic disorganization in association with paranoia and roughly corresponds in the study of Overall *et al* to two factors - "psychoticism" and "paranoidism".[34,36] Factor 2, called "contact disturbance", resembles the "general retardation" factor of Overall *et al*.[34] Factor 3, the "psychomotor" factor, could be interpreted as a hypomanic-like dimension with agitation. The final factor was labeled "neurotic" and contained items of depression and anxiety. In some ways it is similar to the first factor of Astrachan *et al* which was also labeled "neurotic", although it contained somatic complaint items in addition to those of anxiety and depression.[36] This last factor of Dencker *et al* also contains items similar to factors 5 ("depression") and 6 ("anxiety and tension") of Overall *et al*.[34,37] An

interesting aspect of the study of Dencker *et al* was the analysis of change in these symptom factors during the first year of treatment.[37] During this time, symptom reduction in the third, hypomanic-like factor ("psychomotor") was less notable than that obtained for the other three factors, which declined fairly smoothly. Factor 4 ("neurotic") showed an interesting transitory peak at the 6-month point, possibly indicating the postpsychotic depression to be discussed later.

Finally, Wittenborn rated the symptoms of 75 schizophrenic men on five occasions over a period of 2 years in an investigation of the effects of niacin used as a supplement to the "usual" treatment of schizophrenia.[38] On admission, the patients' scores on the symptom clusters of anxiety, depressive retardation, schizophrenic excitement, paranoia, and compulsive-obsessive features were much higher than on the remaining clusters. The greatest diminution of all of these symptoms occurred in the first 6 months of treatment, with a more gradual decline thereafter. After 6 months, the only significant change occurred for anxiety and compulsive-obsessive features. However, depressive retardation persisted at a higher level than all other symptom clusters, with a trend toward incrementation from the 6th to the 18th month. The latter is similar to the phenomenon reported by Dencker *et al*, which could be interpreted as representing postpsychotic depression.[37] In all symptom clusters, the later the symptoms were rated, the greater was their predictive power for the next 6-month period, a finding which reflects stability or persistence of symptom clusters. Factor analysis of the symptom scores at each assessment point generated two factors (Table 2.2.1.1). Factor 1, "schizophrenic", was defined by high loadings on a wide variety of symptoms. It is difficult to know what to make of this factor, as it appears to be composed of seemingly unrelated, diverse elements. Factor 2 was defined by

symptoms of "manic" type. The mean pretreatment score for the "schizophrenic" factor was higher than for the "manic" factor, and the former tended to decline more than the latter over the 2-year study period. This finding is somewhat similar to that of Dencker *et al* for their hypomanic-like "psychomotor" factor.[37] In spite of this more marked decline, the "schizophrenic" factor appeared to be more stable than the "manic" factor at 12 months and later, thus reflecting a "more fixed disposition" than the "manic" factor, which showed greater fluctuations over time.

Thus, several studies employing factor analytic techniques have identified groups of symptoms that could represent important dimensions of symptom change in schizophrenic individuals. However, the use of factor analysis in longitudinal studies in which within-patient variance is examined could be criticized on the grounds that the assumption of independent observations that underlies the factor analytic method is invalid in research designs involving repeated measures within individuals. The study of Astrachan *et al* is exempt from this criticism though.[36] What such studies may actually be demonstrating is the stability of certain groups of symptoms over time, thus reflecting relatively enduring characteristics or traits rather than legitimate dimensions of change that are state-dependent. Nevertheless, with reference to Table 2.2.1.1 some approximate cross-comparisons of the factors identified by the studies here reviewed can be made with caution. Although there is considerable overlap and some inconsistencies are present, three factors are well represented across studies. A psychosis dimension, which may be separated into disorganization or turmoil and paranoia subdimensions, is a relatively consistent finding. Retardation is identified as a separate dimension in three of the four studies and dysphoria as represented by neurotic anxiety and depressive symptoms is identified in a similar proportion. A somatic

symptom dimension and a manic-like dimension are identified in only half of the studies. Even these relatively small degrees of comparability are interesting in view of the fact that the several investigations involved wide differences in sample type and size, clinical setting, measuring instruments employed, and stated research aims.

Goldberg *et al,* using data from the National Institute of Mental Health's multihospital collaborative study of phenothiazine treatment, reported differential symptom reduction over 26 weeks in both placebo- and phenothiazine-treated patients.[39] The symptom measure used was the Inpatient Multidimensional Psychiatric Scale (IMPS). They found that all 14 of their IMPS symptom factors declined markedly in the first 5 weeks of treatment in all patients but that over subsequent weeks two distinct patterns emerged. One group of symptoms declined no further after the 5th week, while the other group continued to decline between the 5th and 13th weeks but plateaued thereafter. In the first group, four of the seven symptom factors were labeled "withdrawal" because of their similarity to the withdrawal items on the Venables-O'Connor scale.[40,41] Likewise, three of the seven symptom factors in the second group were labeled "paranoid" on the basis of the same scale. However, this interpretation may be misleading. It can be seen in Table 2.2.1.2 that the symptom factors in the first group, with the exception of the guilt factor, could reasonably be categorized as a combination of retardation/apathy and psychotic disorganization dimensions rather than simply "withdrawal". Similarly, in the second symptom group, only two factors (delusions of grandeur, ideas of persecution) are strictly compatible with paranoia; two others (pressure of speech, agitation and tension) resemble hypomania; and the remainder do not seem to have sufficient compatibility to form any readily identifiable clinical category. Nevertheless, some validating support for the

"paranoid-withdrawal" distinction as here defined comes from three further reports based on the same multihospital collaborative study. Earlier, Goldberg *et al* reported that phenothiazines had the greatest therapeutic effect on those symptoms which were labeled "withdrawal" (or retardation-apathy and psychotic disorganization).[42] They also found a predominance of these symptoms among those which did not significantly decline in the placebo-treated patients. In another publication it was reported that ward atmosphere, measured by degree of social interaction and amount of disturbed and/or aggressive behavior, had the greatest impact on the "paranoid" group of symptoms and least effect on the "withdrawal" symptoms.[43] Low disturbed/aggressive behavior and high social interaction were associated with decline in "paranoid" symptoms. Finally, a battery of performance tests was administered repeatedly over the 26 weeks of the study.[44] Although most changes occurred during the first 5 weeks, further changes continued to occur throughout the remaining weeks. There were found more and stronger correlations between test performance and "withdrawal" symptoms and cognitive disturbance than there were between performance and "paranoid" symptoms. There thus appears to be some support for the phenomenological dimensions described here, and each seems to have a different temporal pattern of remission. However, it should be recalled that there are several symptom factors within the two groups that do not strictly conform to this dichotomy and may be better understood if examined separately (Table 2.2.1.2).

Supporting the finding of different temporal patterns of symptom remission but somewhat in contrast to the above results with respect to drug-palcebo differences on certain symptom groups are the findings of Johnstone *et al* and Cotes *et al*.[45,46] They have reported a study of the effects on symptom remission and neuroendocrine

Table 2.2.1.2

Table 2.2.1.2 Summary and reinterpretation of the findings of Goldberg et al.[39]

Pattern of symptom remission	No change after 5th week		Further improvement during 5th–13th weeks	
Categorization on basis of comparison with Venables-O'Connor scale[40,41]	Withdrawal	Other	Paranoid	Other
IMPS symptom factors	*Slow speech and movements (NPR) *Indifference to environment (NPR) + Hebephrenic symptoms (NPR) + Disorientation	Guilt + Incoherent speech (NPR) + Nonauditory hallucinations (PR)	Hostility Delusions of grandeur (PR) Ideas of persecution	‡Agitation and tension ‡Pressure of speech + Auditory hallucinations (PR) *Memory deficit (PR)
Effect of ward atmosphere	Least effect	Intermediate effect	Greatest effect	Intermediate effect
Correlations with performance tests	Frequent and higher		Infrequent and lower	
Treatment response	Four out of seven symptom factors show no improvement or deterioration on placebo		Three out of seven symptom factors show high placebo responsiveness	

NPR = No placebo responsiveness; tend to respond only to phenothiazines.
PR = Placebo responsiveness high.
* = Possibly interpretable as retardation-apathy symptom dimensions.
+ = Possibly interpretable as psychotic disorganization symptom dimensions.
‡ = Possibly interpretable as hypomanic-like symptom dimensions.

(Table reproduced from Carr, V.J. Recovery from Schizophrenia: A review of patterns of psychosis. *Schizophrenia Bulletin, 9,* 95-121, 1983).

function of the α- and β-isomers of flupenthixol compared to placebo in acute schizophrenic patients. Using the rating scale of Krawiecka *et al*, they measured change in nine symptoms over a period of 4 weeks.[47] Symptoms declined sharply in the first 2 weeks in all treatment groups and drug-placebo differences were not significant during that time. Thereafter, only positive symptoms (delusions, hallucinations, and incoherent speech) showed clear further improvements. The antipsychotic action of α-flupenthixol was responsible for this decline in positive symptoms, but in no treatment group was there a further significant effect on the remaining symptoms, which included incongruous affect, negative symptoms (psychomotor retardation, flat affect, poverty of speech or muteness) and neurotic or nonspecific symptoms (anxiety and depression).

Using the Object Sorting Test, Harrow and his colleagues examined thought disorder during the hospital treatment of a group of nonchronic schizophrenic patients and at follow-up 8 months after discharge.[48-50] They found that during the first 10 days after admission these patients had high scores on the indices of idiosyncratic thinking and conceptual overinclusion. There were high positive correlations between these indices of thought disorder and clinical ratings of overall psychopathology as well as certain specific symptoms (delusions, bizarre speech and behavior, paranoid thoughts). With the passing of the acute phase of illness, the patients entered a period of partial clinical remission by the 7th week of hospitalization. At this time, scores on idiosyncratic thinking and conceptual overinclusion were significantly lower than at first testing and correlations with clinical ratings of psychopathology were insignificant. There was a suggestion that conceptual overinclusion was a more common feature than idiosyncratic thinking throughout. Eight months later, the patients had demonstrated a

further decline in conceptual overinclusion but not in idiosyncratic thinking. The authors concluded that conceptual overinclusion was more a characteristic of the acute disturbance and was perhaps a function of psychotic disorganization, whereas some degree of idiosyncratic thinking could be conceptualized as a more enduring trait measurable on a continuum of severity across time within any given individual. Therefore, it seems that some aspects of thought disorder decline over the short-term as a function of symptomatic remission, whereas other aspects plateau after the initial decline and persist at a residual level in some patients.

In another group of studies, Harrow and Silverstein examined the frequency of psychotic symptoms in schizophrenic patients approximately 3 years after hospitalization.[51,52] They used a revised version of the Present State Examination (PSE).[3] Overall, they found that 47 percent of their sample had definite psychotic symptoms at followup. The most common symptoms that were definitely present were delusions (43 percent); these were followed by Schneider's first-rank symptoms (28 percent), hallucinations (15 percent), and other "strange" experiences such as severe depersonalization and derealization (13 percent). Such a high frequency of psychotic symptoms at followup is supported by the study of Astrachan *et al*, in which over two-thirds of a sample of 132 patients had psychotic symptoms as measured by the New Haven Schizophrenia Index at 2 to 3 years post-discharge.[36] Approximately a quarter of the sample in that study were sufficiently symptomatic to be considered "actively psychotic", however. Having categorized the symptoms as to definite presence, absence, or an intermediate grade of severity (i.e. weak, infrequent, uncertain), Harrow and Silverstein found that almost a quarter of the schizophrenic patients received this intermediate rating on various psychotic symptoms.[51,52] This

finding led them to suggest that, when present, psychotic symptoms, especially delusions, may differ in "quality, intensity, and relevance" for the patient in the postacute stage compared to the more "active" stages when such symptoms absorb more of the patients' attention and occasion more subjective distress. At followup, such symptoms were often found to be weak in intensity, sporadic in frequency, and "insufficiently salient or compelling" to impair function or necessitate hospitalization. The patient often realized that these "experiences were not grounded in reality and had more insight, perspective, or recognition that his problem had its source within himself and not in the world around him."[51]

The evidence of these investigations points to the likelihood that delusions and hallucinations can each legitimately be conceptualized on continua, a view consistent with the descriptions of Lansky.[53] This concept gains support from two other sources. On the basis of interview data from the International Pilot Study of Schizophrenia, Strauss suggested that hallucinations and delusions could be considered as points on continua.[54] He claimed that such phenomena could be characterized by: (1) the degree of the patient's conviction of the objective reality of the experiences, (2) the extent to which there are cultural or stimulus determinants of the experiences, (3) the amount of time spent preoccupied with the experiences, and (4) the degree to which the experiences represent distortions of consensual reality (i.e. the extent of implausibility). The second source of support comes from observations of recovering schizophrenic patients in a research setting.[55] A "double-awareness" phase intervening between delusional and nondelusional phases of illness was described. The authors reported patients' increasing abilities to "establish distance" from delusions, to be no longer "totally immersed" in them, and to accept and reject them simultaneously. Often the

patient concealed or tried to suppress the delusions. This seems to be a process of reasserting reality testing in which the patient "increasingly recognizes the delusion as a symptom" and is able to differentiate perceptions from ideas.

The data on delusions and hallucinations thus indicate that these symptoms are not merely "turned off" at a discrete point during recovery but quantitatively decline along several possible indices of a continuum of severity. This process seems to plateau to a greater or lesser extent in about a half of all cases and, in addition, the experiences themselves may become qualitatively different from those in the acute phase.

With regard to depression in schizophrenic patients, Donlon *et al* applied repeated meaures* (over 8 weeks) to a group of 41 acute schizophrenic patients treated with depot fluphenazine.[56] They found that depression was greatest at baseline and was a prominent symptom in 60 percent of patients. Over the remainder of the study period, depression decreased, closely paralleling improvements in "cognitive symptoms" (conceptual disorganization, grandiosity, suspiciousness, hallucinatory behavior, unusual thought). By contrast, anxiety scores remained relatively constant. This study complements an earlier investigation by Rada and Donlon in which it was reported that exacerbation of an acute psychosis in chronic schizophrenic patients was accompanied by a significant degree of depression which was interpreted as "an integral component of the schizophrenic episode".[57] However, certain other investigations of the depression continuum during recovery from psychosis are somewhat at variance with these findings. Steinberg *et al* found significantly higher ratings of depression

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* Brief Psychiatric Rating Scale; Clinical Global Impression Scale; Hamilton Rating Scale for Depression; Zung Self-Rating Depression Scale.

during the "remission" period following acute schizophrenic psychosis than during the phase of marked psychotic symptoms.[58] But this was a retrospective study of only eight patients and diagnostic criteria were not clearly defined. Stern *et al* repeatedly rated* 17 patients over a 6-month period following hospitalization for schizophrenia.[59] Two patients developed a major depressive syndrome and one developed mild depressive symptoms afte remission of the acute psychotic symptoms. Two further patients were rated as significantly depressed during the psychotic phase and for a period of time thereafter, while three were mildly depressed only during the psychotic phase. The remaining nine patients were reported to show no significant depressive symptoms at any time. Some light is shed on this rather confusing picture by three other studies. Bowers and Astrachan studied 36 hospitalized schizophrenic patients using weekly behavior evaluations of psychotic and depressive symptoms.[60] After the initial rapid fall of all symptoms, two patterns emerged during a phase of more gradual symptomatic decline. The first was that of a concomitant gradual decline in depressive symptoms paralleling the diminution in psychotic symptoms. The second pattern showed a separation between psychosis and depression, with the depressive symptoms predominating over the psychotic symptoms for the remainder of hospitalization. Shanfield *et al* repeatedly studied 44 schizophrenic inpatients and a comparison group of 36 depressed patients with a rating scale similar to that in the Bowers and Astrachan study as well as nurses' ratings and self-reports.[61] By the third week of hospitalization there had been a significant decline in all symptoms. By week 7 most psychotic

*Profile for Rating Depressive and Schizophrenic Behavior.

symptoms were rated as "almost nonexistent" but the schizophrenic patients showed slight evidence of retardation. At week 10 the schizophrenic patients were rated as slightly more depressed than the comparison group and had some traces of paranoid thoughts and delusional thinking. The authors concluded that schizophrenic patients generally become less depressed as their psychotic symptoms subside and that the onset of new depressive symptoms during the postpsychotic period generally does not occur. Furthermore, they noted that in spite of the decline in all symptoms, the rate of recovery of depressive symptoms was slower in the schizophrenic patients than in those with primary depressive disorders.

These findings are partially supported by the evidence of Strian *et al* who attempted a finer discrimination in the longitudinal patterns of depressive symptoms present in 60 percent of 134 schizophrenic patients.[62] Excluding their "akinetic" type, which is attributable to the extrapyramidal effects of neuroleptics, they described an "initial" pattern in which high depressed mood at the onset of treatment declined over 3 weeks. Their "latent" type showed an increase in the severity of depression in the 3rd to 8th weeks of treatment and their "persistent" type showed constant levels of depression throughout. These findings help to place the above studies, particularly those of Steinberg *et al* and Stern *et al* in clearer perspective.[58,59]

The conclusion of Strian *et al* was that "depression in schizophrenia is predominantly an experience or consequence of the underlying illness",[62] which is virtually identical to the conclusion of Rada and Donlon.[57] This view is consistent with the findings of the investigations quoted above, as well as the results of a retrospective case history review of 115 patients conducted by Planansky and Johnston, who similarly concluded that "depressive psychopathology is endogenous, and represents an

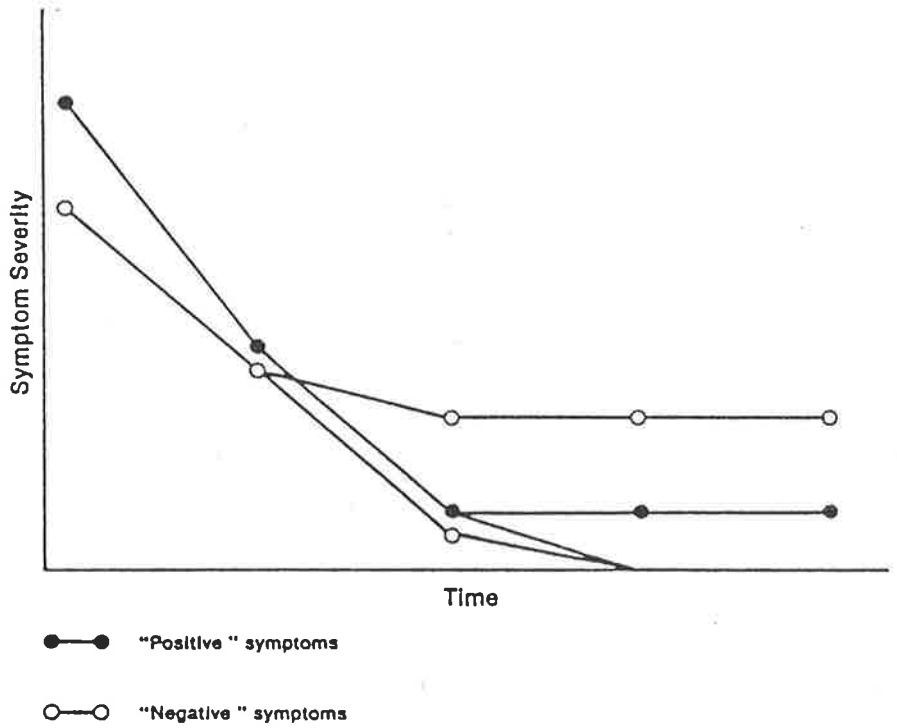
integral part of the schizophrenic process."[63]

In summarizing these articles on depressive symptoms in schizophrenia, it appears that such symptoms are ubiquitous and generally accompany florid psychotic manifestations. Initially, they may be overlooked until the florid symptoms subside, at which time they may overshadow the latter. McGlashan and Carpenter report such a pattern in 50 percent of cases.[64] The pattern of emerging predominance of depressive symptoms may be partly due to their comparatively slower rate of recovery but perhaps also to a temporary incrementation in some cases. In other patients depressive symptoms decline at the same rate as the psychotic symptoms throughout recovery and do not persist beyond the point of remission of psychotic symptoms.

A convenient way of concluding this review of the continuum model of recovery would be to propose that symptoms be divided into three broad groups - positive and negative symptoms and dysphoric symptoms (i.e. depression and anxiety). The articles discussed in this section suggest that, whatever the time period of the investigation under review, symptoms tend to decline in an exponential fashion, although differences between symptom groups are often apparent (figure 2.2.1.1). During the initial sharp decline, positive symptoms usually tend to color the clinical picture more than they do in the remainder of the course. The negative symptoms tend to subside less steeply, if at all. This is followed by a more gradual decline in which two separate pathways emerge. In one, the positive symptoms diminish more rapidly than the negative symptoms, whose curve flattens out so that they predominate over positive symptoms in the total clinical picture. In the alternate pathway, positive and negative symptoms decline at about the same rate. Dysphoric symptoms are generally less predictable and may predominate from time to time in either pathway, although the

patterns of depressive symptom remission may mimic those of the negative symptoms. Positive symptoms eventually vanish altogether or persist in a residual form, but in either case negative symptoms usually predominate if they also endure.

Figure 2.2.1.1



Differential Rates of Decline in Symptom Groups.

2.2.2 The Categorical Model

This model is based on the asumption that the course of recovery from schizophrenic psychosis can be divided into a sequence of discrete, reliably identifiable stages which are qualitatively distinct and mutually exclusive.

Clinicians have commonly recognized a period of partial clinical remission between the phase of florid psychotic symptomatology and the eventual recovered or residual state. Eissler identified this as a phase of "relative clinical muteness" characterized by a qualitative change or decrease in the intensity of symptoms.[65] Although still partially affected by symptoms, the individual possessed areas of function relatively free from them. Symptoms that did remain were often concealed, disregarded, or suppressed, and the patient often denied their existence, sometimes avoiding situations that tended to exacerbate or precipitate a recurrence of delusions. Klein and Davis described the different patterns of this phase of partial clinical remission in three types of patients during treatment with phenothiazines.[66] (pp 151,152,156). In both schizophrenic and schizoaffective patients the "resolving phase" was one of "fearful demoralization with a trend toward maladaptive social, self-isolating behavior." Self-esteem was impaired, and the patient vacillated between "massive denial of difficulty and feeling overwhelmed by interpersonal, social and economic tasks." They noted that this phase may be accompanied by depressive symptoms. In their second group, schizophrenic patients with a history of childhood asociality, they identified a pattern of "schizoid compliance" during the course of illness. This was characterized by "passive, compliant adaptation" at the fringe of social activities. The patients spent much time in bed or sitting inactively; denial was marked and they were verbally unproductive, which obscured their continuing thought disorder. Delusional

material could be elicited, along with flattened affect, and somatic complaints were a prominent focus of concern. No mention of depressed mood was made in relation to this group. Among patients of the third group, the paranoid type, a pattern called "suppressive denial" was described in which suppression of suspiciousness and thought disorder was accompanied by "decreased spontaneity and limited social interactions." In addition to reduced ideas of reference and other psychotic symptoms, there was also less fearfulness and aggressiveness. Enhanced denial of illness was accompanied by a guarded, evasive manner and the use of "short, abrupt, superficial replies." This was interpreted as reflecting attempts to control emotional exploration and reduce the threat of deviant ideation emerging. Patients of the third group were also "actively self-isolating, socially fearful and withdrawn," and they resisted participation in activities. Again, there was no mention of depressed mood occurring in this group.

Features common to all of these descriptions could be classified as follows:

- *Symptom reduction.* Psychotic symptoms are decreased in number and/or intensity and may show qualitative changes as well.

- *Function resumption.* Partial return to normal social, instrumental, and other functions occurs, but the patient displays continuing deficits or inadequacies in these areas.

- *Illness avoidance.* This covers denial of illness, ignoring and/or suppressing remaining symptoms, as well as concealing them from the view of others and shunning situations which exacerbate symptoms.

- *Social avoidance.* This involves a varying degree of seclusiveness or social

isolation in the form of active or passive withdrawal from interpersonal relationships. Passive compliance may be the style adopted in conceding reluctantly to social demands.

Other investigators using the stage model have sought to explicate this phase of partial clinical remission in more detail. One of the earliest of these was the attempt by Apter to describe the characteristics of six "grades" of recovery in a group of chronic schizophrenic patients treated with hydrazides in the 1950s.[67,68] These were severely ill, chronically institutionalized patients. Apter's descriptions were of motor behavior, daily activities, and social interactions (Table 2.2.2.1). Of interest are the early changes in motility described at grade I and continuing in grade II, which preceded the period of engagement in group activities and spontaneous entry into nonverbal but cooperative social relations in grade III. Compulsive behaviors were noted and passive compliance was a feature (cf. [65,66]). Grades IV to VI describe the further behavioral and social changes that took place. However, on close examination of all six grades, these descriptions do not seem to be sufficiently clearly defined for purposes of reliable classification. The division into six grades is quite arbitrary, and there appears to be overlap of characteristics from one grade to another. In addition, the characteristics of each grade are globally defined in terms of a particular set of behaviours without precise quantification. The validity of the points of division consequently is questionable.

Pious described a series of stages in what amounted to encapsulated psychotic episodes during the course of psychoanalysis of a patient who initially presented with an obsessive-compulsive neurosis but subsequently behaved in a manner suggestive of schizophrenia.[69] Precipitated by a perceived deprivation or distancing from the therapist, the process would begin with a phase called "emptying". This was followed

by "focusing", which consisted of a progression through a series of five stages from most to least "archaic" developmentally. Each of these stages had its own "characteristic combination of gestures, movements, affects, intonations and verbalization," and they are summarized in their reported sequence in Table 2.2.2.1. Although a description of a single case, this report is remarkable for its account of an experience of psychotic disorganization followed by the development of a paranoid, delusional state which, in turn, merged into an obsessive-compulse state as the patient returned to his previous level of integration. Others have described shifts between obsessive-compulsive states and schizophrenic psychoses[70,71] and the relationship between obsessive-compulsive behaviour and amphetamine or cocaine psychoses.[72,73] But the above description also raises questions about the relationship between two possibly distinct processes, psychotic disorganization and delusion formation.

Donlon and Blacker described four stages observed during recovery from schizophrenic psychosis.[74] This was a study of 30 patients who were put on placebo and the sequential unfolding of stages of psychosis described. The stages were then observed to recur in reverse order, similar to the "rollback phenomena" described by Detre and Jarecki[75] after the patients were placed on neuroleptic agents. Summary descriptions of these stages are given in the order in which they occurred during recovery in Table 2.2.2.1. Unfortunately, the descriptions given by these authors are not sufficiently comprehensive for reliable clinical use. More clearly detailed definitions of which symptoms are present or absent in each particular stage are required. Furthermore, clear indications of which symptoms are present or absent in more than one stage would also be essential and the qualitative and/or quantitative changes taking

Table 2.2.2.1

(Reproduced from Carr, V.J. Recovery from Schizophrenia: A review of patterns of psychosis. *Schizophrenia Bulletin, 9,* 95-121, 1983).

Table 2.2.2.1 Summary of stages of recovery from schizophrenic psychosis

	Apter[67,68]	Pious[69]	Donlon and Blacker[74]
Prominent psychotic symptoms			**IV. Psychic disorganization and relief from subjective pain** Begin to feel well Painful affects excluded from awareness or transformed Ego-syntonic auditory hallucinations Compensatory delusions Insight lacking Attention deficit marked Preoccupation with inner world No communication possible Form 1. Autistic ruminations Form 2. Hebephrenic silliness
	Severe communication disability Unkempt, incontinent **I. Motility changes** "Fixed stare" gone Negativism Untidy and incontinent	Emptying Abrupt onset Suddenly stops talking Expression drains from face Eyes dull, unfocused, "out of touch" Focusing (on detail) Horror Feels self "slipping" (a) Perplexity Blocking Bizarre, incoherent verbalization (b) Estrangement Disturbed hearing, vision, equilibration Surroundings recede Objects lose their interrelationships Limited to isolated percepts (c) Ideas of reference Paranoid thoughts Delusions	**III. Panic and horror—Primitive fantasies and images** Panic, horror, fright Painful memories and affects Marked concern over loss of control and mutilation Withdrawal, social isolation Increased psychomotor activity Primary process thinking Ego-dystonic auditory hallucinations Social relationships markedly impaired
	II. Spontaneous activity Increased motor flexibility Better self-care Automatic compliance	(d) Agitation Intense preoccupation with self-tormenting thoughts (delusional or obsessional) Rituals Stereotyped behavior	

Table 2.2.2.1 Summary of stages of recovery from schizophrenic psychosis

	Kayton[76-79]	Sachar et al.[80,81]	Docherty et al.[82]
Prominent psychotic symptoms		**Psychotic equilibrium** Fixed, stable, organized psychotic defense system Projection or denial of conflict Projection or denial of primitive impulses and sensations Anxiety much reduced Psychotic restructuring of environment (replaces cognitive confusion) New psychotic omnipotent sense of identity People placed at distance (delusional system becomes primary interest)	**V. Psychotic resolution** Decreased anxiety Increased (psychotic) organization Types: Paranoid—organizing delusional system Hebephrenic—massive denial of unpleasant affect and responsibility
	I. Internal disorganization Fears of annihilation, suffocation, world destruction Preoccupied with good and bad objects or sinister forces Out of contact with reality Oral concerns—Fears or delusions about obesity Mute, blank; huddled fetal position Self-abomination alternates with grandiosity	**Acute psychotic turmoil** Breakthrough of painful conflicts into consciousness Breakdown of defenses Severe annihilation anxiety (fears of death; fantasies of world destruction) Fluid, unstable delusions and ideas of reference (rapidly formed and discarded) Flooding with bizarre sensations and primitive sexual/aggressive impulses Hypersensitivity to stimulation Cognitive confusion Primary process thinking Loss of sense of identity	**IV. Psychotic disorganization** 1. Destructuring of external world Perceptual and cognitive disorganization Fragmented percepts assembled by conscious effort Disturbed speech and comprehension Ideas of reference prevalent 2. Destructuring of self Loss of sense of identity and connectedness Dramatic fluctuations in manner of behaving Intrusion of primitive sexual and aggressive images into consciousness Severe anxiety, panic, horror Hallucinations 3. Total fragmentation Complete loss of self and control Fatal catatonia
			III. Disinhibition Unmodulated impulse expression Hypomanic-like (sexual promiscuity, rage attacks, unrestricted spending) Dissociative phenomena Uncharacteristic risk-taking Elevated mood Ideas of reference Repressed material intrudes into consciousness

Table 2.2.2.1 Summary of stages of recovery from schizophrenic psychosis

	Apter[67,68]	Pious[69]	Donlon and Blacker[74]
Partial clinical remission	**III. Group activities** Nonverbal interactions Compulsions Passive compliance	(e) Obsessive compulsive behavior (similar to obsessive compulsive neurosis)	**II. Depression and intensification of defenses** *Either* agitated depression *or* projection and obsessive mechanisms Anorexia, sleeplessness Suicidal fantasies Feels "dying inside" *or* fantasizes "world destruction" Patients with obsessions, compulsions, somatization and projective mechanisms appear less depressed
	IV. Verbal communication Social interest Assertiveness Respect for others Old memories reactivated Modulated affect (Paranoid patients submissive)		**I. Denial and anxiety—Feeling of excitement and loss of control** Racing thoughts Anxiety: Fears losing impulse control Initial insomnia Difficulty concentrating and integrating thoughts Feels vulnerable Frightening thoughts and dreams Low sexual drive Reality testing grossly intact Troubling affects and thoughts considered foreign
	V. Reestablish old relationships Appropriate affect Child-like dependency Seeks affection and approval		
Recovery or residua	**VI. Realistic plans for future** Intellectual and manual competence	**Feeling of reality** "In touch"	**Recovery** (No summary description given)

Table 2.2.2.1 Summary of stages of recovery from schizophrenic psychosis

	Kayton[76-79]	Sachar et al.[80,81]	Docherty et al.[82]
Partial clinical remission	**II. Postpsychotic regression** Sleep rhythm reversed or distorted Daytime sleeping *early*: Prolonged nocturnal sleeping *later* Food aversion *early*: Gorging and weight gain *later* Emptiness, passivity, lack of energy Impaired concentration and comprehension Clogged thoughts: Staring into space Prefer to be alone, social avoidance *but* experience dyadic preoccupations Somatic symptoms Depression or "affective blockade"	**Anacilitic depression** Breakdown of psychotic defenses (replaced by tenuous, ineffective, dependent, and neurasthenic defenses) Reexperience of internal conflict Sense of loneliness: Fears of abandonment Depression and anxiety Reexperience of unusual body sensations in hypochondriacal fashion Defective, devalued self-image replaces omnipotence Perception of others as urgently needed and powerful	**II. Restricted consciousness** Limitation of range of thought Boredom, apathy, listlessness Social withdrawal Decreased movement Obsessional and phobic symptoms Somatization Hopelessness, dissatisfaction, loniiness, dependency
	III. Middle phase of postpsychotic regression Normal sleeping and eating patterns Better grooming: Increased concern about personal appearance Improved concentration, comprehension and thought processes Memories more distinct Social interactions resume (mostly nonverbal) Somatic symptoms decrease	**Stage A: Parasitic** "Parasitic" dependency on staff Reliance on "borrowed" coping mechanisms and defenses Tenuous ability to distinguish self from others returns Episodes of anxiety, confusion, and disturbing sensations more circumscribed Reduced stimulability Reduced impulsiveness Beginning return of secondary process thinking Less awareness of conflict	**I. Overextension** Sense of being overwhelmed (due to external demands or internal conflict) Increased mental effort required Feels need to "run faster and faster just to keep up" Overstimulation Persisting anxiety Irritability, parapraxes, distractibility Low performance efficiency
		Stage B: Compliant Compliant dependence on others Return to fragile premorbid defenses Rare episodes of anxiety and confusion (anxiety much less global and intense) Reality testing and secondary process thinking present but tenuous Disturbing sensations and impulses largely absent	
Recovery or residua	**IV. Termination of postpsychotic regression** Spontaneous interactions and initiation of activities Feels strengthened Less passive Return of ambition (with realistic scaling down of goals) Pleasure in social interactions Increased confidence and security	**Recovery** (No summary description given)	**O. Equilibrium** Well-adapted to milieu Feeling of control Positive sense of future Minimal anxiety Adaptive resourcefulness is sufficient for current demands

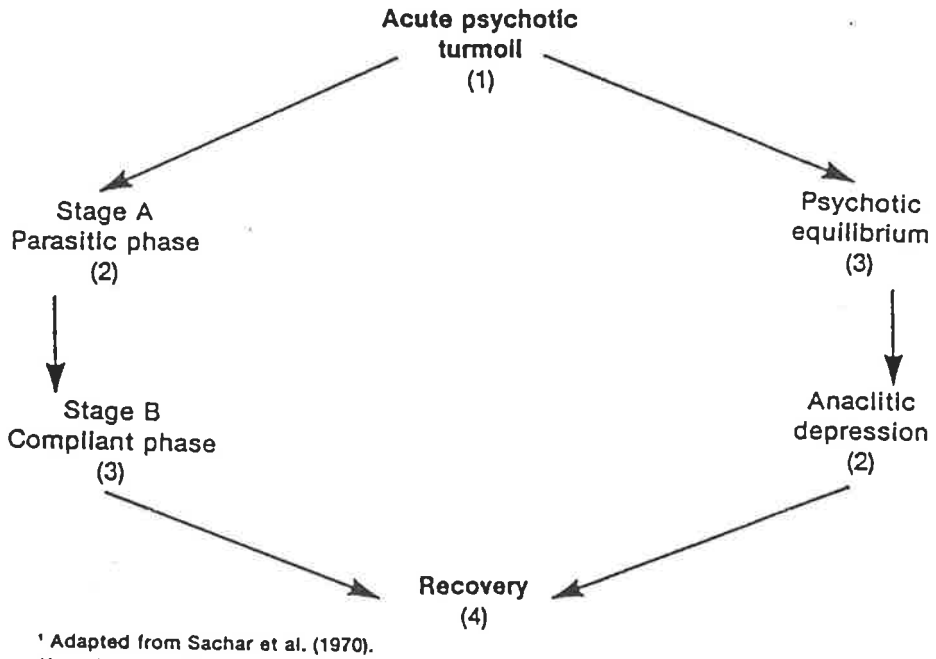
place in symptoms during movement from one stage to another need to be described. These stages are thus tentatively defined and there appears to be considerable overlap among them.

In a series of publications Kayton and colleagues have described and discussed four phases in the recovery from schizophrenic psychosis.[76-79] The initial delineation of these phases was based on a retrospective analysis of therapists' and nurses' progress notes on a sample of 13 hospitalized schizophrenic patients. Subsequent work involved the application of these phases to the study of the course of illness in a larger group of patients. Phases I to IV are summarized in Table 2.2.2.1 in their reported sequence. To some extent at least, the same criticisms must apply to these descriptions as to those of the Donlon and Blacker study. However, the phases are generally more clearly articulated in the Kayton studies, and some similarities to other stage descriptions can be seen (Table 2.2.2.1).

Sachar *et al* used a stage model in their descriptions of the endocrine changes associated with recovery from psychosis in which eight patients were studied intensively during hospitalization.[80,81] They also delineated two alternative pathways by which this recovery process could occur (Figure 2.2.2.1). Of the stages summarized in Table 2.2.2.1, that of "acute psychotic turmoil" was associated with the highest levels of urinary 17-hydroxycorticosteroids (17-OHCS) to be obtained in the study. The "psychotic equilibrium" stage, characterized by the development of a "fixed, stable, organized psychotic defense system" (presumably delusions), was associated with low urinary 17-OHCS levels. If the patient took the path to recovery through this stage, he then moved into the stage of "anaclitic depression" before reaching a point of recovery characterized by a return to premorbid levels of function at which 17-OHCS

levels were at their lowest. "Anaclitic depression" was marked by high urinary 17-OHCS levels, comparable to those of stage A, the "parasitic phase" of the alternate pathway. In stage B, the "compliant phase", urinary 17-OHCS levels were relatively low and comparable to those of the stage of "psychotic equilibrium".

Figure 2.2.2.1



[1] Adapted from Sachar et al. (1970).
Note. Numbers in parentheses refer to rank order of urinary 17-OHCS levels (1 = highest; 4 = lowest).

Pathways of Recovery.

Some of the stage descriptions in these studies are crisp with relatively clear differentiation between "acute psychotic turmoil", "psychotic equilibrium", and the other three stages. However, among the latter, characterized by evidence of partial clinical remission, differentiation of one stage from another becomes less clear as there appears to be some phenomenological overlap between the stage of "anaclitic depression" and the "parasitic" and "compliant" phases. It is unfortunate that in differentiating the stages these investigators have relied considerably on psychodynamic criteria (e.g. conflict, defense, primary process), which require degrees of inference in interpreting behavioural data rather than on clearly identifiable manifestations of psychopathology. Two of the cases in the first report of Sachar *et al* demonstrated periods of overactivity reminiscent of hypomania.[80] Case 3 showed euphoria and overactivity following electroconvulsant therapy. Case 4 had two episodes of overactivity, one of which was accompanied by belligerence, sarcasm, and hostility. This behaviour does not clearly fit in with the descriptions of the stages given and seems to deserve separate categorization. However, the relationship between levels of urinary 17-OHCS and the various stages must be taken as partial validating support for the categories as here defined, and it would be useful to operationalize the descriptive criteria of these stages more clearly for further study.

Docherty *et al* reviewed the literature describing the onset of schizophrenic psychosis.[82] They identified five stages in the process of psychotic decompensation, and these are also said to be observed during recovery from psychosis (J.P. Docherty, personal communication, 1978). Given in reverse order to that of psychotic decompensation, the stages are summarized in Table 2.2.2.1. These stages are particularly well articulated and rely mostly on readily identifiable psychopathological

manifestations. They can also be identified with satisfactory levels of interrater agreement (J.P. Docherty, unpublished material, 1979). Some compatibilities with other stage descriptions exist, but the inclusion of the hypomanic-like phase of "disinhibition" characterizes phenomena which have been hitherto largely overlooked in other models.[e.g.80] Mention was made by Detre and Jarecki, however, of common "fluctuations between hyperactive and inhibited states" (pp. 108-119)[75]. Nevertheless, this model was derived from studies of the onset of schizophrenic psychosis as was that of Donlon and Blacker.[74] Consequently, even though similarities between onset and recovery appear to exist and the stages themselves can be reliably identified,* the validity of applying an "onset" model to the phenomena of recovery can be questioned on the grounds that these are two fundamentally different processes. Despite other shortcomings, the models of Kayton and Sachar *et al* are strengthened by being derived directly from observations of recovering schizophrenic patients.

As can be seen in Table 2.2.2.1 some compatibility between the various studies does seem to exist. This is particularly so in the period when psychotic symptoms are prominent. Here, the similarities between the stages variously described as "resolution", "psychotic equilibrium", or "subjective relief" are quite striking, and similar compatibilities exist between such stages as "disorganization", "turmoil" and "panic and horror". In turn, both of these sets of stages seem to be distinct from the later stages of illness which occur during partial clinical remission. However, the divisions between the latter are less clear, and considerable overlap exists as certain symptom manifestations persist through several stages in sequence. Most investigators

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*This has only been demonstrated in the Docherty *et al* model.[82]

report prominent neurotic-like symptoms such as obsessions, compulsions, and somatization, as well as variable degrees of depression and anxiety in the stages of partial remission. The prominence of such symptoms helps to distinguish these stages from the period of prominent psychotic symptoms, but the divisions between the stages themselves seem to be quite arbitrary and less reliability of identification would be expected.

As is the case with many categorical models, there is a certain arbitrariness in all of these stage divisions - indeed, even in distinguishing prominent psychotic symptoms from partial clinical remission and recovery. The arbitrary nature of this approach is particularly apparent when it is compared with the dimensional approach in which symptoms are reported to change on continua of severity. The fact that, on cross-section, symptom profiles may well appear sufficiently qualitatively different to warrant categorization as stages may be misleading. If symptoms are indeed continuous over time and one uses a categorical model to describe changes within them, then the stage specifications of qualitative distinctness and mutual exclusion become very difficult to meet. It is not valid to draw a line on a symptom dimension and propose that the two regions thus created are qualitatively distinct unless some other crucial variable is introduced. Secondly, with the use of any of the categorical models reviewed so far, it is possible that a given patient may have, on one dimension, symptoms that are characteristic of one particular stage while being characterized on another symptom dimension as belonging to a second stage.

Even the concept of recovery may be called into question with both the dimensional and categorical models. The term "stage" itself implies direction in a progression from a stated origin to an outcome or goal. But, in any one of the stages

described previously, a given patient may well be considered "recovered" on one set of parameters but not another. The question then arises as to which set of parameters to use. Instead of "stages" of recovery, then, it would seem to be more neutral to talk about "states" of illness, if they can be defined. These states would have no necessary implications for the degree of sickness or health. The concept and definition of clinical state in psychiatry has been thoroughly explored in an earlier publication and will not be discussed further at this point.[17] It is sufficient to propose that the stage (or state) models reviewed above need to be operationalized in a more rigorous manner than they have been hitherto before they could become reliable instruments for general use in clinical psychiatry.

2.2.3 Postpsychotic Depression

A phase characterized by depressed mood has been reported to occur during the process of recovery from schizophrenic psychoses. Since McGlashan and Carpenter have published a comprehensive review of this phenomenon,[83] no description of the clinical features of the condition will be given here. Instead, some of the lines of investigation will be summarized and areas of contention highlighted.

Eissler is generally credited with the first description of this syndrome, but from his account, summarized in the previous section, it appears that his own term "relative clinical muteness" may be a more apt descriptive phrase than "postpsychotic depression" since depressed mood itself was not mentioned in his article.[65]

There have been essentially two approaches to the phenomenon of postpsychotic depression. One of these has been to examine the course of depression and related symptoms longitudinally throughout the illness episode. Several investigations in this area have already been reviewed in the previous section on

dimensional models.[56-62] Investigations using this approach tend to give a view of depression as a cluster of symptoms on continua like other psychopathological manifestations of schizophrenia rather than as a distinct syndrome in itself.

The other principal methodological approach, which has been to focus more or less exclusively on the postpsychotic phase itself, tends to have a different emphasis - namely, depression as a postpsychotic syndrome.[84-86] The consequent view of depression from this vantage point is as a phenomenon discontinuous from the preceding psychotic phase. Roth interposes what he calls a "compensated-transition phase" between the "acute psychosis" and the "depressive-neurasthenic phase" or postpsychotic depression.[85] He characterizes this by loss of "open" psychotic symptoms such as thought disorder, delusions, and hallucinations and by a return of "ego-strengths" which enable a resumption of social and work functions.[85] He noted that some patients retained some "psychotic residua" during this phase for 1 to 8 weeks before the onset of the postpsychotic depression syndrome.[85] It thus appears that his patients experienced an absolute decline in overall psychopathology for a period before the phase of postpsychotic depression brought about another general increase in psychopathology - a transient peak (average duration, 3 months) similarly reported by a variety of other investigators.[37,38,58,59,87]

Clearly, reports that identify postpsychotic depression as a stage phenomenon, a syndrome discontinuous from the preceding stage - especially if separated from the latter by a relatively quiescent transition period - are subject to the criticism that the patients were suffering from a bipolar disorder. Indeed, Goplerud and Depue have argued on these and additional grounds that a phase of postpsychotic

depression is a manifestation of bipolar disorder rather than schizophrenia.[88] This view has previously sparked some controversy in the literature,[89,90] but no contributions to that dispute will be made here except to note that Siris *et al* found that only 6 percent of carefully diagnosed schizophrenic patients met Research Diagnostic Criteria[4] for a major depressive syndrome in the postpsychotic period, although some 40 percent experienced depressed mood.[91] Thus, although the syndrome status of depression in schizophrenia after florid psychotic symptoms have subsided may be doubtful, there is fairly solid evidence to suggest that depression is a frequent if not invariable component of the total schizophrenic symptom profile and that it tends to change with time as do other symptoms of this psychosis.

One other source of contention that may shed light on the above argument has to do with the validity of labeling certain symptoms as depressive in quality. Beginning with Eissler's description of the phase of "relative clinical muteness",[65] symptoms such as affective "blockade"[77] or flattening, social isolation, withdrawal, retardation, apathy, anergia, indifference, and passivity are phenomenologically distinguishable from the group comprising depressed mood, hopelessness, worthlessness, low self-esteem, self-reproach, shame, and guilt. Whereas the latter symptom group reflects distress and is clearly recognizable as a depressive constellation, the former can be interpreted differently. Possible interpretations include defect state as in the negative symptom concept[24] or "clinical poverty syndrome",[92] a deactivation or "turning off", a "neurophysiological inhibitory state"[76] or process of disengagement and inactivity in relation to the environment. Such inhibitory or disengagement phenomena do occur with and without dysphoric (depressive) symptoms. Some clarity may therefore accrue

from distinguishing between dysphoric/depressive and inhibitory/nondepressive dimensions in reference to postpsychotic states. Some support for this distinction comes from Siris *et al* who reported a positive therapeutic response to antidepressants in some schizophrenic patients with postpsychotic depressive symptoms but not in those who were apathetic, anergic, or withdrawn.[93]

2.3 A FORMULATION

The two main approaches to describing recovery from schizophrenic psychosis - namely, the dimensional and the categorical - each have something to recommend them but carry their own particular disadvantages as well. The dimensional approach seems to be the less ambiguous of the two and more closely reflective of the actual changes that take place in this process. On the other hand, the categorical model is likely to be more economical and to have the greater clinical utility provided the boundaries between states can be sharpened by operationalizing their content. Even though the present level of knowledge is limited, a workable answer can no longer be postponed to the question, "How best to describe symptoms in schizophrenia in a comprehensive, reliable manner that has both heuristic value and clinical relevance?"

It is proposed that symptoms be measured in eight basic dimensions arranged under five broad headings as shown in Table 2.3.1. This approach would also have the advantage of permitting the course of symptoms over time to be followed on continua and of facilitating the operationalization of reliable state categories in terms of different scores on each dimension should a categorical shorthand be desired.

TABLE 2.3.1

Summary of Proposed Symptom Dimensions

		Dimension
(1)	Psychotic Disorganization	1
(2)	Inhibition	2
(3)	Activation	3
(4)	Organizing Phenomena	
	(a) Perceptual Organization i.e. Hallucinations	4
	(b) Ideational Organization	
	(i) Delusional Organization	5
	(ii) Neurotic Organization	6
(5)	Dysphoric Symptoms	
	(a) Anxiety	7
	(b) Depression	8

2.3.1 Psychotic Disorganization

The first dimension is proposed to reflect the "core" psychotic process as suggested by Overall *et al.*[34] It is thought of as the phenomenological grouping most closely linked to the primary underlying abnormality in schizophrenia. Typical items would include bizarre or disorganized behaviour, affective incongruity or perplexity,

disorganization of thought, incomprehensible speech and certain perceptual distortions. Such a dimension is supported by factors identified in the literature and labeled "psychoticism"[34] and "turbulent"[36] (Table 2.2.1.1) and is reflected in the states of "panic and horror",[74] "internal disorganization"[80,81] and "psychotic disorganization"[82] (Table 2.2.2.1). Certain cross-sectional descriptive studies have also identified similar symptom profiles. Examples include "bizarre disorganization" (factor 4 in Strauss *et al,*[94]) "flagrant schizophrenia" (cluster 2 in Carpenter *et al*[95]) and clusters 1 and 3 in an earlier study of Strauss and his colleagues.[96] The factors of "schizophrenic excitement" and "hebephrenic negativism" identified by Wittenborn[97] also seem to conform descriptively to this dimension. Lorr *et al* [98] similarly described a "disorganized" type of schizophrenia defined by their first order factors of "disorientation", "motor disturbance" and "conceptual disorganization". They also identified another first order factor, "perceptual distortion", which would probably fit into this dimension as well.

2.3.2 Inhibition

A constellation of phenomena which includes such items as negative formal thought disorder,[22,23] anergia, loss of interest, anhedonia, flat affect, retarded movement and social avoidance seem to cohere sufficiently to warrant measurement on a single symptom dimension. This dimension is not substantially different from what is more generally referred to as negative symptoms.[24,25,27]

As far as the literature reviewed here is concerned, this dimension is represented by the "general retardation",[34] "motor retardation"[36] and contact

disturbance"[37] factors (Table 2.2.1.1) and by the states of "postpsychotic regression",[76-78] probably also including "restricted consciousness"[82] and both the "parasitic" and "compliant" stages[80,81] (Table 2.2.2.1). In the cross-sectional studies referred to above, it is similar to a factor labelled "bizarre retardation"[94] and also to cluster 7 identified by Strauss *et al.*[96] The corresponding first order factor of Lorr *et al*[98] would be "retardation and apathy", and Wittenborn's "depressive retardation"[97] factor reflects a similar set of phenomena.

2.3.3 Activation

Symptoms comprising this dimension include overactivity, increased rate and amount of speech, elated, hostile or labile mood, heightened perception and racing thoughts. The similarity of this dimension to hypomania is obvious, yet the literature reviewed here supports the presence of these phenomena in at least some cases of schizophrenia. For instance, the types of symptoms which make up this dimension are represented in the literature review by the "psychomotor"[37] and "manic"[38] factors (Table 2.2.1.1) and by the state of "disinhibition"[82] (Table 2.2.1.1). In earlier cross-sectional studies it is reflected in the hypomania and grandiosity cluster of Strauss *et al.*[96] The "manic state" factor of Wittenborn is consistent with these phenomena, whereas his "psychotic belligerence" factor appears to reflect a combination of the psychotic disorganization and activation dimensions.[97] The corresponding first order factors of Lorr *et al* are "excitement" and "hostile belligerence."[98]

2.3.4 Organizing Phenomena

The reason for combining the following apparently disparate group of symptoms under one heading stems not from the literature reviewed thus far but rather from a particular theoretical position. This is the assumption that these symptoms serve an organizing or restitutive function, not unlike the concept of ego defense in psychoanalytic theory. In other words, the formation of hallucinations, delusions and certain neurotic symptoms represents the individual's attempts to restore psychological equilibrium and achieve adaptive mastery over the experience of psychotic disorganization through the construction of perceptual and ideational schemata. This view is one in which these symptoms are conceptualized as secondary phenomena. They are seen as growing out of individuals' attempts to organize their experience by imposing order and meaning on percepts or other subjective phenomena that would otherwise be experienced as orderless or meaningless. This process of organization is viewed as a regulatory one which helps to reduce or, at least, focus the free-floating anxiety which frequently accompanies the psychotic process.

The issue of perceptual and ideational organization in schizophrenia has been reviewed and more fully discussed elsewhere in the context of a proposed information-processing model of schizophrenia.[99]

(a) Perceptual organization

This dimension is simply a measure of the severity of hallucinations in any sensory modality. It is striking that these phenomena are mentioned explicitly in relation to particular factors or stages on only three occasions in the recovery literature reviewed.[36,74,82]

(b) Ideational Organization

(i) Delusional organization.

Measurement of delusions should take into account the range or type of delusions present and also their severity in terms of degree of preoccupation, conviction and implausibility as suggested by Strauss.[54] The extent to which delusions are systematized, permeate aspects of the patient's life and disrupt social and instrumental functioning should be estimated. A scale for measuring this symptom dimension in terms of the above variables has been described.[100]

The recovery literature supporting the differentiation of this dimension includes the identified "paranoidism" factor[34] (Table 2.2.1.1) and the states of "subjective relief",[74] "psychotic equilibrium"[80,81] and "psychotic resolution"[82](Table 2.2.2.1). To some extent it is also represented in cross-sectional studies by "typical schizophrenia" (cluster 1)[95] and the first order factors "paranoid projection" and "grandiose expansiveness" of Lorr *et al.*[98] It is also represented by Wittenborn's "paranoid schizophrenia" factor.[97]

(ii) Neurotic organization

Symptoms drawn together here include obsessions, compulsions, phobias, hypochondriasis, conversions, dissociative phenomena and depersonalization/ derealization. In traditional psychoanalytic theory, each is thought to represent the outward manifestations of certain ego defense mechanisms operating to contain anxiety.

In the recovery literature, the "guilt-conversion"[34] and "neurotic"[36] factors (Table 2.2.1.1) generally conform to this dimension while the states of "depression and intensification of defenses",[74] "postpsychotic regression",[76-78] "anaclitic

depression"[80,81] and "restricted consciousness"[82] include such symptoms among their characteristics (Table 2.2.2.1). In cross-sectional studies, "hypochondriacal schizophrenia" (cluster 4)[95] and "somatic concerns and depression" (cluster 4)[96] also include similar symptoms as do the "conversion hysteria" and "phobic compulsive" factors of Wittenborn.[97]

2.3.5 Dysphoria

This is intended to reflect the degree of subjective distress experienced by the patient, along the following two dimensions.

(a) Anxiety

(b) Depression.

The latter refers only to that dysphoric quality of mood known as sadness, helplessness or hopelessness which is usually associated with tearfulness, low self-esteem, self-reproach and so on, all of which are phenomenologically distinct from the inhibition dimension or negative symptom group mentioned above.

Dysphoria is widely represented in the recovery literature. For instance, the "depression", "anxiety and tension"[34] and "neurotic"[36] factors describe this phenomenon (Table 2.2.1.1). Similarly, all of the states within the group reflecting partial clinical remission (Table 2.2.2.1) include depression and anxiety as prominent features. In cross-sectional studies it is represented by "insightful schizophrenia" (cluster 3)[95] and by the "anxious intrapunitiveness" first order factor of Lorr *et al.*[98] The Wittenborn factor, "anxiety", similarly reflects this dysphoric dimension.[97]

2.4 SUMMARY

A review of the descriptive literature on recovery from schizophrenic psychosis has highlighted the symptomatic heterogeneity of schizophrenia but has also suggested a systematic method for describing, accounting for and exploring further this variability. This method is to describe symptomatology in terms of several continua or symptom dimensions. Beginning with the positive-negative symptom distinction to which was added the dysphoric dimension comprising anxiety and depression, it has been concluded that the negative symptom dimension is relatively homogeneous but not so the group of positive symptoms. The latter were divided into dimensions of psychotic disorganization, activation and organizing phenomena, namely, delusions and hallucinations. A third set of organizing phenomena was identified and labelled neurotic organization.

CHAPTER 3

ELECTRODERMAL ACTIVITY

3.1. NEURAL MECHANISMS AND THE CHARACTERISTICS OF ELECTRODERMAL ACTIVITY.

3.1.1. Control of Electrodermal Activity.

The term electrodermal activity (EDA) has been adopted as a generic descriptor for palmar (or plantar) sweat secretion measured in terms of the electrical conductance or resistance of the skin[1]. This measurement technique dates back to the late 1880's[2] and the phenomenon has been commonly referred to as the galvanic skin response (GSR) or psychogalvanic reflex (PGR). Unfortunately, our understanding of the neural control of EDA is incomplete. Nevertheless, there is sufficient knowledge of the mechanisms and characteristics of EDA to justify the experimental use of this psychophysiological measure and to render the results of such experiments comprehensible, in most cases.

All levels of the nervous system are involved in the regulation of EDA. The subject has already been thoroughly reviewed and certain aspects summarized elsewhere[3-5]. Basically, there appear to be at least three systems which govern EDA. The first mediates *thermoregulatory* activity[6] and involves the anterior hypothalamus[3]. A second system has been identified in which control appears to centre on the premotor cortex (Brodman area 6) as well as other parts of the frontal lobe[7]. Efferents from these regions bypass the hypothalamus and descend along the pyramidal tracts. The basal ganglia appear to have a modulatory influence on this EDA pathway[3]. Edelberg has proposed that this EDA system serves in a "motor accessory capacity"[4]. In particular, he has suggested that its function is to maintain an optimal level of hydration of the extremities for the facilitation of movement and grasping[4].

This, the *manipulative* EDA system, is regulated by both excitatory and inhibitory cortical influences and appears to be independent of the thermoregulatory EDA system.

The third neural control network, and the one which is of central importance in the present research, is the *orienting-arousal* system. Efferents from the lateral frontal cortex[8, 9] pass through the amygdala-hippocampus complex and the reticular formation, both of which profoundly influence EDA. At the periphery, EDA is mediated by the sympathetic nervous system[6, 10, 11] in which the final pathway governing activity of the sweat glands in the skin is under cholinergic control[12].

The orienting-arousal system has, for some time, been a research field marked by lively controversy in a number of respects. The mechanisms of neural control and the functional significance of EDA within this system have not been the least of these. The closely related issues of lateralized control and the roles of inhibitory versus excitatory pathways need to be addressed first of all.

Although both excitatory and inhibitory areas can be located at the cortical level, and both crossed and uncrossed efferent pathways may be involved, the most consistent effect appears to be that stimulation or activation of one cerebral hemisphere relative to the other has an *inhibitory* effect on EDA via crossed pathways to the contralateral side. A very thorough and critical review of the evidence supporting the concept of EDA control via *contralateral inhibition* has already been published by Hugdahl[5]. Therefore, only a selective review and summary of the material will be undertaken here.

In certain animals it has been found that unilateral cortical stimulation reduces EDA on the contralateral side,[7,13] whereas unilateral cortical lesions are associated with contralateral increases in EDA.[14] The latter finding is consistent with human studies in which a reduction in EDA has been reported on the side ipsilateral to a cortical

lesion,[15,16] or, conversely, an elevation of EDA on the contralateral side[17]. Complicating this picture, however, is the finding of Heilman *et al* that right sided cerebral lesions were associated with a decrease in EDA and left sided lesions with an increase in EDA[18]. However, only unilateral electrodermal recordings were made in this study (on the side ipsilateral to the lesion). Finally, a study of temporal lobectomy patients by Toone *et al* found no bilateral differences in EDA at all[19].

Thus, of 8 neural studies of cerebral control of EDA, 6 provide some support for the concept of contralateral inhibition. Research findings are even more contradictory, however, in studies involving task-related differential activation of the two cerebral hemispheres. Bilateral electrodermal recordings have been made on subjects during tasks involving verbal or numerical manipulations and compared to those during tasks of a visuo-spatial or 'emotional' kind. The former tasks are said to involve processing in predominantly the left cerebral hemisphere whereas the latter are thought to involve mainly right hemisphere functions.

In a widely quoted study by Lacroix and Comper[20] (subsequently replicated by the same authors[21]) it was found that performance of the left hemisphere-activating task was associated with inhibition of right-sided EDA relative to the left whereas the right hemisphere-activating task was associated with the opposite electrodermal asymmetry. Lacroix and Comper concluded that bilateral differences in EDA response "appear to provide an accurate index of relative hemispheric activation" and the control of EDA could be "tentatively" identified as contralateral inhibition.[20] Support for these findings comes from three other sources, two studies of task-induced right hemisphere activation,[22,23] and one of left hemisphere activation[24]. However, earlier findings by Myslobodsky and Rattock, using a similar research design, had been in the opposite direction to these studies and supported the concept of contralateral excitatory control of

EDA[25,26]. Other investigators have found no consistent lateral EDA asymmetries in relation to type of task.[27-30] This was also the case with Fedora and Schopflocher[31] who, following a thoughtful methodological critique of the Lacroix and Comper[20,21] and Myslobodsky and Rattock[25,26] studies, attempted a replication while trying to avoid some of the design weaknesses of the earlier studies.

A fundamental criticism that could be made of these studies is that they assume an extreme hemisphere specificity for task type. A more appropriate position to take may be that of differential processing strategy depending on task type rather then differential hemisphere activation. Both hemispheres can use more than the one processing strategy for which they have become specialized. Furthermore, when the tasks used in the abovementioned studies are examined, it becomes apparent that many would involve more than one form of processing strategy. For instance, even what were clearly visuo-spatial tasks often involved processes of selective attention for which the left hemisphere is thought to be more specialized than the right. Thus a supposedly right hemisphere task also involved left hemisphere operations in its performance. It is not surprising then that the findings in this area should be so diverse and contradictory.

Nevertheless, having sampled a wider range of the literature than has been cited here and having performed a more critical analysis of it, Hugdahl has reached the very cautious conclusion that "the empirical support for the hypothesis of contralateral excitation is ... less than the support for contralateral inhibition"[5]. He states, finally, that "the hypothesis of contralateral inhibition seems to fare better than the hypothesis of contralateral excitation".[5]

Therefore, ambiguities of the literature notwithstanding, the assumption has been made, in the present research project, that EDA is controlled by the means of contralateral inhibition.

3.1.2 Characteristics of Electrodermal Activity

3.1.2.1 Basic Concepts

The term EDA is relatively non-specific and it would be appropriate at this juncture to articulate more precisely some of the particular phenomena and terminology which are encompassed by it.

Firstly, as described by Lader, the sweat glands in the skin "form low resistance pathways through the high-resistance stratum corneum" and can be "respresented electrically as a number of switchable resistors in parallel with each other and with the high resistance of the stratum corneum".[32] Measurement of sweat secretion can be made in terms of the resistance offered to the passage of a small electric current through the skin, hence the term electrodermal activity. An increase in sweat secretion, by increasing the electrical conductivity of the skin will be recorded by this method as a drop in skin resistance. Rather than measuring skin resistance, the preferred contemporary measure is that of skin conductance which bears a reciprocal relationship to skin resistance. As demonstrated by Lader, skin conductance (SC) bears a linear relationship to sweat gland activity whereas skin resistance does not.[32] The latter, therefore, is not regarded as a biologically valid unit.[32] The unit of SC is the microSiemen (μS).

The concept of *arousal* has been so closely associated with SC measurement that the two sets of phenomena are often thought to be synonomous. This is a most inaccurate view: the relationships between arousal and SC are very complex. To begin an understanding of this field it must be borne in mind that the subject of arousal itself is one in which there is no unanimity of opinion. Arousal, as argued by Lacey, is probably not a unitary phenomenon and therefore one has to be very careful in defining one's terms in order to avoid ambiguity.[33]

Firstly, the term arousal has two meanings.[34] One is that of the overall level of excitability or wakefulness of the organism : the other is that of reactivity to stimuli. The former corresponds to the concept of *tonic arousal* and the latter to *phasic arousal* as proposed by Sharpless and Jasper.[35] Tonic arousal as defined by Pribram and McGuiness is a physiological tonic readiness to respond to stimuli which they term 'activation'.[36] They emphasize the preparatory nature of the activation concept claiming that its neural circuitry centres on the basal ganglia and utilizes dopaminergic and noradrenergic neurotransmission[36]. Phasic arousal, on the other hand, is defined as a transient response to stimulus input and in which neural control is believed to centre on the amygdala.

Absolute levels of SC and the frequency of spontaneous (i.e. non-response-elicited) fluctuations in SC are taken as indicators of tonic arousal or activation levels.[37] Using these measures, tonic arousal has been found to be influenced by a range of phenemonena among which are included, for example, certain stressful tasks[38] and the administration of amphetamines.[39] The latter finding is particularly interesting in view of the proposed role of basal ganglia catecholamines in the control of tonic arousal. Evidence supporting hemisphere lateralization of control of tonic arousal has been mentioned in the previous section (**3.1.**1.). The right cerebral hemisphere, according to a recent review article, appears to have a dominant role in governing tonic arousal by way of a noradrenaline-mediated system related to the brain's sensory gating mechanism.[40] The latter mechanism has also been identified as one function of the basal ganglia by Schneider.[41] There is evidence, therefore, which links tonic arousal with catecholamine-based neurotransmission, the basal ganglia and sensory gating.

The other neurophysiologically distinct system in the account given by

Pribram and McGuinness is phasic arousal, the transient physiological response to stimulus input[36]. Sokolov, in his seminal publication of 1963, distinguished two types of such physiological response, the orienting reflex and the defense reflex.[42] The autonomic components of the orienting reflex (OR) identified by Sokolov were phasic cephalic vasodilatation, digital vasoconstriction and electrodermal responding, all of which show habituation (*v.i.*).[42] The defense reflex (DR) differed from the OR by virtue of the presence of cephalic vasocontriction rather than vasodilatation and the absence of habituation. The DR is generally elicited in reaction to high intensity stimuli. A third form of response, the startle reflex has also since been identified and described by Graham.[43] It is characterized by rapid habituation and is elicited by stimuli of very sudden onset. The distinguishing characteristics of each of these three forms of reflex response have been reviewed and summarized by Turpin.[44] In addition to the autonomic response components of the OR listed above, other constituents include transient heart rate deceleration, EEG alpha desynchronization, pupillary dilatation and a respiratory pause.

3.1.2.2 The Orienting Response

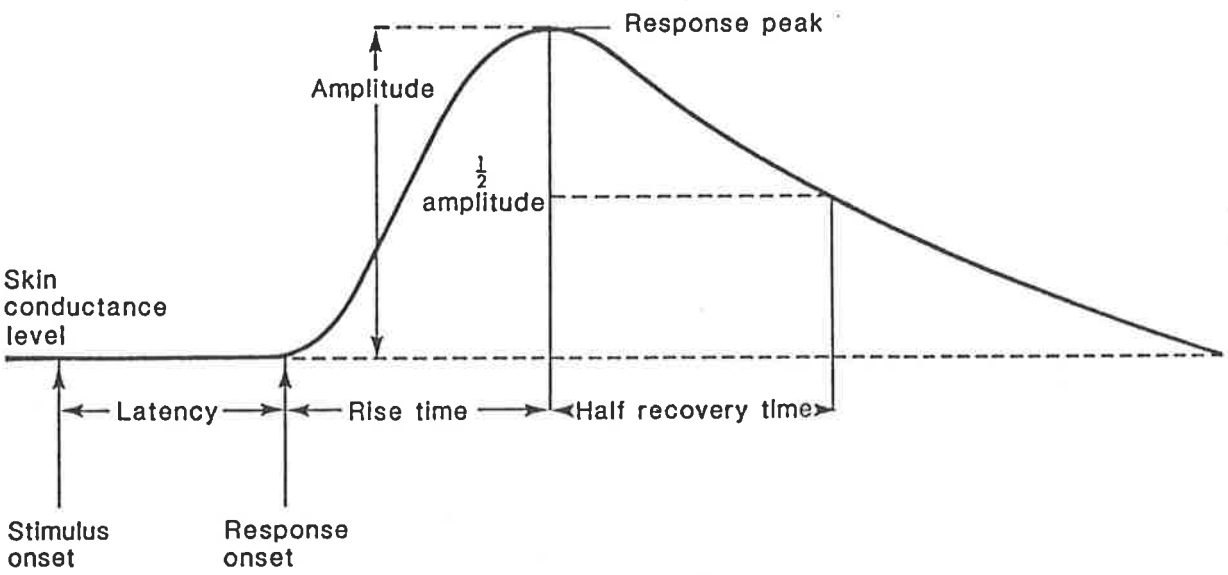
The orienting response, which is the reflex of interest in the present study, was first described in 1927 by Pavlov as the "What is it?" reflex. Although Sokolov conceptualized the OR as a unitary reaction of the whole organism to a novel stimulus, characteristics of stimuli other than their novelty are also important. Bernstein and his colleagues have demonstrated the important role played by the significance or potential significance of the stimulus.[45,46] In another publication, Bernstein also emphasized the importance of interaction between uncertainty (i.e. degree of novelty) and significance in triggering the OR.[47] Thus, the characteristics of a stimulus required to elicit an OR

include novelty, or a degree of uncertainty, together with the significance or potential significance of the stimulus to the organism. Research investigations which have attempted to explore the effects of varying these and other parameters such as stimulus intensity have led to the conclusion that the OR is not a unitary phenomena. In other words, the various autonomic components of the OR referred to earlier do not covary.[48] For instance, EEG alpha desynchronization and the respiratory pause vary in relation to manipulations of novelty but not in relation to those of stimulus intensity.[49] The SC measure of the OR may be the only component which is sensitive to manipulations of intensity, novelty and signal value.[49]

Thus, when a sufficiently intense, relatively new stimulus which may be of actual or potential significance is introduced to the stimulus field, the human organism responds, after a short latency period of one or more seconds, with a phasic elevation of SC characterized by an exponential recovery limb in which the SC level declines and approaches prestimulus values.[50] This is the Skin Conductance Orienting Response (SCOR). With repeated exposures to the same stimulus the magnitude of successive responses progressively diminishes until responses cease completely. At this point, repeated presentations of the same stimulus will elicit no further responses. This phenomenon is referred to as habituation. If there is subsequently an alteration in one or more of the qualities of the stimulus (i.e. a new stimulus is created) or its significance to the organism changes, then the SCOR will be reinstituted. This is known as dishabituation.

A number of parameters of the SCOR are of research interest and these are illustrated in figure **3.1.**2.2.1. Latency (lat.) is the time from the onset of the stimulus to response onset, risetime (ris.t) is the time from onset of response to peak level and half recovery time (rec. t/2) is the time taken for SC to return to a level which is 50% of the response amplitude.

Figure 3.1.2.2.1



Temporal and amplitude parameters of the skin conductance orienting response (SCOR).

There are a number of interrelationships between the SCOR temporal and amplitude variables, habituation rate, tonic arousal and manipulations of stimulus characteristics. For instance, if the signal value of the orienting stimulus is retained by converting the stimulus into a Pavlovian conditioned stimulus (i.e. one that elicits a particular response) then habituation will not occur. Increased stimulus significance is also associated with increased SCOR amplitudes and prolonged recovery times.[51,52] This effect on recovery time is retained even when prior level of tonic arousal is controlled[53], the latter being known to bear an inverse relationship with recovery time.[54] The association between slow habituation and shortened recovery time described by Edelberg led to the belief that this pattern of responsiveness reflected a longer maintenance of "set to respond".[50] In brief, Edelberg concluded that a shortened recovery time reflected a "mobilization for goal directed behaviour".[50]

Slowing of habituation and increased SCOR amplitudes can be effected by high intensity stimuli.[55] Increased stimulus intensity, in turn, is associated with shortened latency of responses but prolonged risetimes.[56] Slow habituation, which is linked with reduced response latency,[57] is also a characteristic of high tonic arousal[58] whether this be induced by stressful tasks[38] or amphetamines.[39] These stimulant drugs, however, produce "sluggish" responses with prolonged latencies and risetimes and smaller response amplitudes[39] whereas the arousal induced by stressful tasks[38] or high task demand situations[59] is associated with increased SCOR amplitudes.

3.1.3 Model of the Orienting Response

Any explanatory model of the OR must be able to account for two fundamental aspects of this reflex. They are the phenomenon of habituation and the functional significance of the OR. Ohman has proposed such a model[60] which involves an extension of Sokolov's theory of habituation[42] from an information-processing perspective.

Sokolov's theory stated originally that an OR would be elicited if there was a "mismatch" between stimulus input and information about the immediate environment stored in memory. With repeated presentations of the same stimulus, a representation of that stimulus, based on its particular characteristics, would be built up in short-term memory. In other words, a "neural model" of the stimulus would be constructed by some form of comparator system. As long as there continued to be a mismatch between the actual stimulus and its "neural model" an OR would be elicited. As the degree of mismatch declined with progressive elaboration of the neural representation of the stimulus, so the amplitude of the OR diminished until, eventually, there would be no mismatch between the "neural model" and the actual stimulus. At this point no OR would be elicited by repeated presentations of the stimulus and habituation would have occurred.

One of the problems with this model is that it is based solely on stimulus novelty. If, after habituation, the same stimulus is imbued with signal value and presented once more, then an OR will be elicited even though the stimulus is not new. The "neural model" of Sokolov does not adequately account for this observation. Bernstein's proposal regarding an interaction between degrees of novelty (i.e., uncertainty) and significance (or potential significance) in eliciting the OR is an attempt to come to grips with this phenomenon[46,47]. He proposed that an individual's scanning of the perceptual field is constantly biased towards the detection of significant rather

than novel stimuli. If a potentially significant stimulus is actually detected, then increased information scanning is triggered and this is coupled with a lowering of OR "criterion levels" (i.e. OR threshold). The former increases the probability that uncertainty (i.e. novelty) will be detected; the latter raises the likelihood that an OR will occur in the event that uncertainty is detected. Both combine to increase the probability of occurrence of an OR.

The neuronal network controlling the OR and its habituation would have to possess a number of important characteristics. It would require access to information about the external world from sensory pathways. It would need to be able to construct representations of selected components of that external world; that is, to generate specific predictions about the world. It would need to be able to test those predictions against the sensory inputs which constitute the actual evidence about the external world. Finally, it would need to be in communication with short-term memory centres in monitoring the potential significance of stimulus inputs. Such a system would, in effect, function as a comparator undertaking preliminary information processing prior to the institution or inhibition of action sequences.

Vinogradova[61] has identified the hippocampus (specifically area CA_3) as a comparator whose neuropsychological and functional characteristics are consistent with these requirements. The work of Douglas[34,62] also strongly supports this view and his model overlaps and dovetails substantially with that of Vinogradova.[61] Gray has attempted to synthesize the work of these two investigators in combination with his own work and that of others in the development of his theory of septo-hippocampal function[63].

The role of limbic system structures in relation to the OR has been studied in animals with mixed results. In some studies, hippocampal lesions have been associated

with slow or absent habituation and loss of internal inhibition, effects which can be mimicked by the administration of anticholinergic drugs.[34] Conversely hippocampal stimulation has been found to reduce electrodermal reactivity.[3] Quite different effects occur with manipulations of the amygdaloid nuclei. Amygdalectomy has been associated with a complete absence of ORs or a reduction in their number[64] together with rapid habituation.[34] These effects have been summarised by Pribram and McGuiness.[36] Stimulation of the amygdala, on the other hand, is associated with increased EDA.[65-67] The apparently opposite actions of hippocampus and amygdala in these animal experiments have led to the proposal that there is a reciprocal relationship between these two structures.[68,69] Specifically it has been stated that the amygdala is involved in triggering the OR and the hippocampus is responsible for habituation of those responses.[69] Put in somewhat different terms, the amygdala is thought to gate stimuli in and the hippocampus to gate out stimulation.[68]

In the course of human research it has been proposed that habituation of the OR is a form of gating out sensory inputs; that is, removing them from active attention and, hence, further processing.[70] It has been suggested, in the light of Edelberg's work,[50,71] that prolongation of the OR recovery time is associated with gating out[72-74] and, in a reanalysis of the animal data of Bagshaw *et al*[64] reported by Venables,[73] it was found that hippocampectomy was associated with reduced recovery times whereas amygdalectomy had the opposite effect on this variable. Hence, the hippocampus, in reciprocal relationship with the amygdala, has been identified as responsible for OR habituation, the functional significance of which, in neurophysiological terms, is the gating out of sensory inputs.

Before leaving aside the neurophysiological field, it must be stated that this summary is a very simplified account of a complex area in which experimental results

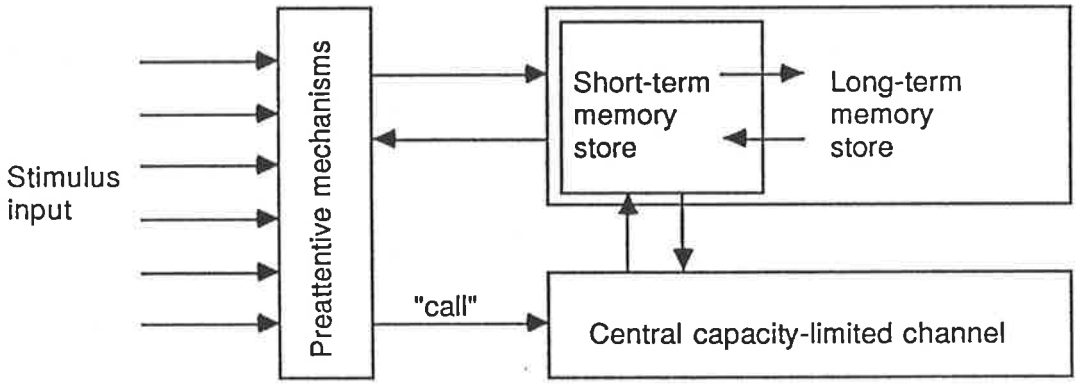
are not as straightforward as they may appear from the above. The data is often equivocal and yields sufficient inconsistencies that further research must obviously be necessary before firm conclusions can be reached.

With this caveat in mind, it is appropriate to return to the point of identification of the hippocampus as a comparator and pursue a formulation of the OR in information processing terms. Having addressed the issue of habituation as best as the data allow, the task now is to pinpoint more exactly the functional significance of the OR itself.

It is first necessary to draw the distinction between preattentive processes and those of selective attention. Preattentive processes occur automatically, without effort and utilize parallel processing.[75-78] One important form of preattentive processing is known as preattentive grouping.[75,79] Selective attention involves serial information processing: it is subject-controlled, requires effort and is resource-limited.[75-77, 80] The serial processing of selective or focal attention is said to occur within a central limited-capacity channel.[81]

According to Ohman, the OR represents a "call for processing resources" within this central limited-capacity channel.[60] Ohman's model of the OR is represented diagrammatically in Figure 3.1.3.1. "When the preattentive mechanisms fail to identify a stimulus because there is no matching representation in short-term memory, a nonsignal OR is elicited and the stimulus is admitted into the central channel. Alternatively, a stimulus can elicit an OR because it matches a memory representation that has been primed as "significant", and then the stimulus enters the central channel for further processing."[60]

Figure 3.1.3.1



Model of the orienting response reproduced from Ohman, 1979[60].

"If a stimulus gets into the central channel because there is no match in short-term memory, a long-term memory search for associated memory representations is initiated, and the stimulus is processed for encoding into the long-term store. If the stimulus matches a representation primed as significant, the central channel is called and retrieves relevant information from the long-term store, allowing the initiation of plans for actions. Such plans include expectations of forthcoming stimuli whose representations are transferred to short-term store."[60]

"Stimulus memory mismatch and the identification of a significant stimulus are assumed to activate a common path providing a link between preattentive mechanisms and the central channel. This link conveys a call for processing space and may be thought of as opening the gate to the central channel. The immediate effect of activating this path is reallocation of processing resources for analysis of the stimulus."[60]

The model of Ohman allows for the fact that "the call represented by the OR may not be answered because the central channel is too busy performing other tasks."[60] It also entails "a stimulus memory comparater process for elicitation and habituation of the OR similar to that of Sokolov."[60] Habituation of the OR, within the model, requires central processing capacity and it is predicted that "little habituation of the OR would occur in situations involving heavy processing demands because of subsidiary tasks."[60] This prediction has been confirmed in a study by Kroese and Siddle.[59]

Ohman's model also receives support from the work of Dawson and his colleagues[82,83] although the latter take a view which emphasizes more the OR as reflecting actual expenditure of processing capacity rather than a "call" for processing resources. These authors found an association between larger SCORs and allocation of greater processing capacity to significant stimuli.[82] They also found that processing began and was completed more rapidly (i.e. shorter latencies, risetimes and recovery times) in association with the larger SCORs.[82]

The OR is not simply an indicator of passive registration of stimuli. For instance, Spinks *et al* found that theSCOR amplitude increases in proportion to the amount of anticipated information.[84] They viewed the SCOR as part of an activational or alerting mechanism which is initiated in preparing the central nervous system for whatever extra information processing capacity may be required or anticipated.[84]

In summary, an OR is elicited when there is a mismatch between preattentive processing of a stimulus and short-term memory representations or, in the absence of mismatch, when short-term memory representations are significance-primed. The OR represents a call for (or actual) allocation of processing resources to the stimulus in a central limited-capacity channel, a serial information processor.

3.2 ELECTRODERMAL ACTIVITY IN SCHIZOPHRENIA

The literature dealing with this subject will be examined in relation to the headings: orienting-arousal, lateral asymmetry and symptomatology.

3.2.1 Orienting-Arousal

Three important reviews of this area have appeared in recent years: they are those of Ohman,[85] Bernstein *et al*[86] and Dawson and Nuechterlein.[87] The following owes much to these publications which, together, present a more comprehensive account of the subject than can be offered here. The present review and discussion focuses predominantly on those studies which involve *nonsignal* stimuli in eliciting the SCOR.

According to the very thorough review of American, British and European studies conducted by Bernstein *et al,* the majority of reports on the OR in schizophrenia prior to 1970 showed hypo-responding; that is, few ORs with fast habituation or no ORs at all (non-responsiveness).[86] However, Depue and Fowles, in their review of 1973, had reached the opposite conclusion and suggested that schizophrenic subjects had a hyper-responsive pattern.[88] At about that time a series of reports appeared which showed schizophrenic subjects to have both patterns. Gruzelier and Venables

demonstrated hypo-and hyper-responsiveness in a bimodal distribution in which a majority of subjects who exhibited ORs failed to habituate (non-habituators).[72,89] This finding was subsequently replicated by Gruzelier and his colleagues[90,91] as well as by others.[92] However, Tarrier *et al* were unable to confirm these findings.[93] Indeed, there had already been evidence to suggest that the phenomenon of hypo- versus hyper-responding was a continuous dimension related to tonic arousal.[94] The finding of intermediate forms, namely, responders who habituated, also undermined the view that the hypo/hyper-responder distinction was a true dichotomy.[93,95,96]

The three reviews cited at the outset[85-87] together examined all of the major studies in this field and each arrived at the conclusion that, compared to normal controls, there was a high frequency of non-responsiveness in schizophrenia which they estimated to be around 40-50%. No clear bimodal distribution was found except in the studies of Gruzelier and his colleagues[72,89-91] and in that of Rubins and Lapidus.[92] Another common finding was that, overall, there was no over-representation of hyper-responders or non-habituators but, rather, that schizophrenic responders tended to habituate early.[86]

The high frequency of non-responsiveness in schizophrenia has since been confirmed in three more recent studies which yielded non-responder rates of 46-60%.[97-99] This compares with rates of 5-10% in normal or nonschizophrenic psychiatric samples.[96,100,101]

It has not been clarified what the significance of nonresponding may be in schizophrenia. Variations in the intensity of the stimuli presented to the subject may be important. A substantial number of schizophrenic nonresponders do exhibit ORs when the intensity of the orienting stimulus is increased, for example.[102-104] The methodology of skin conductance recording has been examined but this does not seem

able to account fully for the findings.[85] As pointed out in section 3.1.3, the signal value of the stimulus plays an important part in eliciting the SCOR. Gruzelier and Venables clearly demonstrated that almost all schizophrenic non-responders to non-signal stimuli exhibited orienting responses when the same stimuli were given significance.[105] Although a study by Rippon[106] failed to confirm this result, others[107,108] have been able to demonstrate an increase in responsiveness when the stimuli presented to schizophrenic subjects are imbued with some degree of significance.

Finally, medication is another variable which may account for the frequency of nonresponsiveness in schizophrenia but that issue will be discussed separately in section 3.4.

Among the electrodermal characteristics of schizophrenic nonresponders, as reviewed by Ohman,[85] were low skin conductance levels (SCL)[72,89,92,98,106,109,110] and a lower number of spontaneous fluctuations or non-specific skin conductance responses (NSSCR).[72,89,92,96,98,104,106,109,110] Exceptions to this trend were found in two studies, but only in relation to SCL[96,104]. Reduced SCL and NSSCR in schizophrenic nonresponders were observed not only in comparison to schizophrenic responders but in relation to normal subjects as well.[72,92,104,109]

The very high rate of non-habituation (94%, 95%) among schizophrenic responders reported by Gruzelier and Venables[72,89] has not been replicated in other studies, although nonhabituation rates have been reported ranging from 25 to 83%.[92,95,96,104,111-113] Horvath and Meares similarly reported nonhabituation as a feature of nonparanoid schizophrenia[114]. Many of these estimates of the proportion of non-habituators may be inflated, however. All SCOR studies specify a time range, measured in relation to stimulus onset, within which the onset of a phasic elevation in

SC is defined as an OR. This is referred to as the latency window. As Levinson and Edelberg point out, broad criteria for defining the latency window will tend to have the effect of allowing a certain number of spontaneous fluctuations arising within the latency window to be counted as ORs.[115] This will produce a false elevation in the estimate of number of trials to habituation and yield a higher proportion of nonhabituators in the sample than would otherwise have been the case. Variations in the criteria for defining habituation (e.g. two versus three trials without a SCOR) may have a similar effect.[115] As Levinson and his colleagues[116,117] point out, many of the studies which report a high frequency of nonhabituation have a broadly defined latency window, 1 to 5 seconds for Gruzelier and Venables[72,89] and others[92,96,104,111,113] and 1 to 3.5 or 4 seconds in the work of Zahn *et al.*[118,119] Research investigators who use more restrictive criteria for the latency window (e.g.1-3 sec.) tend to report a lower proportion of nonhabituators and rather more nonresponders.[95,97,103,110] By varying these latency criteria, Levinson and his colleagues were able to demonstrate clearly the role of this factor in determining the distribution of ORs and hence the classification of nonresponders versus nonhabituators.[116,117]

Therefore, as Ohman concluded, schizophrenic responders do tend to habituate, sometimes even faster than controls.[85] In fact, the group called fast habituators has been investigated and described in detail by Patterson and Venables who, incidentally, used restrictive latency criteria.[110]

Schizophrenic responders show higher SCL and NSSCR than nonresponders[72,89,92, 104,106,109,110] and normal controls.[72,92,104,109] That is to say, schizophrenic responders have higher levels of tonic arousal than controls and schizophrenic nonresponders who, in turn, have lower arousal levels than controls, as mentioned previously.

The review of Ohman revealed no reliable differences between schizophrenic subjects and normal controls in terms of SCOR amplitude, latency or risetime.[85] A number of studies, however, have reported faster recovery times in schizophrenia compared to normal[72,92,119-121]and psychiatric controls.[89,105] This is particularly important in the light of the same finding in subjects genetically at risk of developing schizophrenia[122,123] and in those with the personality characteristic described as "schizophrenism".[124] Others, however, have failed to obtain this result[104,110] and some have reported a prolonged recovery time in schizophrenic subjects,[125,126] particularly the group described as 'fast habituators' by Patterson and Venables.[110]

The evidence reviewed suggests, therefore, that the phenomenon of non-responsiveness occurs in about half of all schizophrenic patients and that, among responders, the phenomenon of nonhabituation may be a methodological artefact (i.e. the latency window effect) masking more rapid habituation. Nonresponders tend to have low levels of tonic arousal whereas high levels seem to occur in responders and 'non-habituators.' This distinction is not unique to schizophrenia but is a more general, non-specific finding (e.g. Carr *et al*[127]). Lastly, schizophrenic nonresponders do exhibit ORs when stimulus intensity or significance is increased.

Among schizophrenic responders the SCOR recovery time data are inconclusive and no other skin conductance parameter is able to distinguish schizophrenic subjects reliably.

Thus, the only relatively consistent finding in the schizophrenia orienting-arousal literature is the over-representation of nonresponders. This is not unique to schizophrenia though (see section 3.3) and, in the case of the schizophrenia research, may be a sampling artefact. The overwhelming majority of studies which report high rates of nonresponsiveness in schizophrenia have a number of important

characteristics in common. First, there is a marked preponderance of male subjects. This varies from 100% in the studies of Bernstein,[102] Gruzelier and Venables,[72,89] Patterson,[95] Patterson and Venables,[110] and Zahn *et al*[118] - a total of around 400 subjects - to 73% in Gruzelier[90] and Gruzelier *et al*[128] (108 subjects) and 45% in Frith *et al*,[111] Straube[96] and Zahn *et al*[119,129] with a combined total of 177 subjects. Thus out of a grand total of around 680 subjects, approximately 80% were male.

Secondly, the overwhelming majority of schizophrenic subjects were described as "chronic". The only "acute" subjects, amounting to about a quarter of the total subject pool of the studies just cited, were found in the reports of Frith *et al*,[111] Straube[96] and Zahn *et al*[119,129]. The latter were the very studies in which the sex ratio approached 1:1.

Thirdly, the chronic male schizophrenic patients who made up the bulk of the studies reporting high nonresponder rates were an overwhelmingly institutionalized group. The average duration of hospitalization in each of these studies was as follows: 8 to 15 years (Bernstein[102]), 17 and 23 years for "institutionalized" groups and one week to 4 years (mean <1 year) for "short-stay" groups (Gruzelier and Venables[72,89]), more than 4 years (Patterson[95] and Patterson and Venables[112]), 15.3 years (Zahn *et al*[118]) and 7 years in the pharmacological study of Gruzelier and his colleagues.[90,128] In contrast, the studies reporting data on "acute" subjects had, without exception, tested subjects within days or, at most, a few weeks after hospital admission.[96,111,119,129] Symptoms tended to be of recent onset. All subjects were virtually drug-free except for 21 out of 50 in the study of Straube,[96] and even these had been treated with antipsychotic drugs for an average of only six days. Many of the chronic, institutionalized patients of the other studies were on long-term antipsychotic medication. The issue of the effects of antipsychotic drugs will be discussed more fully

in section 3.4.

The point to be made here is that the reseach which has led to the conclusion that electrodermal nonresponsiveness is a characteristic of such a large proportion of schizophrenic subjects is based on clinical samples that are overwhelmingly male, "chronic", institutionalized and undergoing long-term pharmacotherapy. Frith *et al* have suggested that non-responsiveness may be "a special feature of chronic patients with predominantly negative symptoms who have been extensively treated with drugs."[112] Similarly, Mirkin has demonstrated a like relationship between the acute-chronic distinction and extremes of EDA.[130] Research samples such as the above which are skewed in this direction suggest that the relationship between non-responsiveness and schizophrenia is not a straightforward one. This is particularly so in light of contrary findings, in the studies based on a different representation of schizophrenic patients. Indeed, Gruzelier and Venables have pointed out that chronicity is associated with suppression of EDA.[72]

In summary, the validity of the schizophrenic responder/non-responder dichotomy[131] is not firmly supported by the literature. Responders tend to habituate and extreme hyperresponsiveness or nonhabituation is not the modal pattern in this group. Schizophrenic responders do not differ reliably from control responders on any electrodermal variables except, perhaps, OR recovery time which may be shorter in schizophrenia. Nonresponsiveness is common (40-50%) in schizophrenic samples made up predominantly of chronically ill, institutionalized males on long-term antipsychotic medication. On the other hand, studies which involve a more acute, noninstitutionalized sample of schizophrenic subjects of roughly equal sex distribution have yielded lower non-responder rates of 10%,[111] 26%[119,129] and 40%.[96] Responders tend to have high tonic arousal levels whereas nonresponders have low levels of arousal.

The fact that schizophrenic nonresponders may exhibit ORs with increases in stimulus intensity or significance together with the phenomenon of switching from responding to nonresponding and vice versa over time need also to be taken into account in attempting to explain the patterns of orienting-arousal observed in schizophrenia.[92,106] The data are consistent with the view that nonresponsiveness/ low arousal is not a primary schizophrenic deficit but a secondary phenomenon, a view shared by Ohman.[85] This pattern may represent certain underlying psychophysiological processes which compensate for the primary abnormality in schizophrenia.

3.2.2 Lateral Asymmetry

Flor-Henry's neuropsychiatric work stimulated efforts to identify an association between schizophrenic psychosis and dysfunction of the dominant cerebral hemisphere.[132] Gur's neuropsychological research is one instance which has provided support for this association.[133,134] Similarly, electrodermal investigations have been pursued as another way of confirming this association.

Gruzelier was the first to report lateral SC asymmetries in schizophrenia.[121] In a series of papers, Gruzelier and his colleagues were able to demonstrate higher EDA in the right hand compared to the left in schizophrenia.[89,91,105,135] Assuming contralateral inhibitory control of EDA (see section 3.1.1), these investigators concluded that this asymmetry was consistent with left (i.e. dominant) hemisphere dysfunction. These findings have since been substantially replicated by others.[110,136] The asymmetries are overwhelmingly of OR amplitudes, not SCL or NSSCR. Indeed, at low levels of SC or in nonresponders, SCL was greater on the left than the right, whereas at higher levels of SC or in responders, SCL was greater on the right than the left.[89,105,106,121] Similarly, in nonresponders NSSCR was greater on the left than the

right and the reverse asymmetry applied in responders.[91] Complicating the picture further, however, is the fact that a substantial number of other investigators have been unable to replicate the findings of OR amplitude asymmetry.[93,97,99,103,137]

In more recent work, Gruzelier, together with his colleague Manchanda, has reported heterogeneity of electrodermal asymmetry in schizophrenia.[138-140] They found larger right-sided responses in certain subjects who were characterised by a particular symptom profile (*v.i.*) and larger left-sided responses in others with a different symptom profile. That these results may be related to tonic arousal is supported by the reported association in normals between left greater than right OR amplitude asymmetry and both fast habituation and reduced NSSCR.[141] The opposite OR amplitude asymmetry in normal subjects is associated with slow habituation and high NSSCR.[141]

These results imply an interaction between EDA asymmetry and control of both the OR and tonic arousal. Heilman and his colleagues[18,142] have reported low SCL and reduced SC response amplitudes in association with right cerebral hemisphere lesions in humans and higher SCL with increased SC response amplitudes in patients with left hemisphere lesions. This, together with the pattern of task-related functional EDA asymmetries mediated by contralateral inhibition as summarized in section 3.1.1, suggests the following model of EDA control. A relative dominance of right compared to left hemisphere activity would tend to produce a generalised increase in tonic arousal (NSSCR) and responsiveness to orienting stimuli (i.e. slow habituation) and greater OR amplitudes on the right than on the left. Conversely, relative dominance of left compared to right hemisphere activity would have the effect of a generalised decrease in tonic arousal and responsiveness to orienting stimuli (i.e. fast habituation) and greater OR amplitude on the left than the right. Gruzelier *et al* postulate a dynamic reciprocal interaction between the cerebral hemispheres in which, in net effect, the left hemisphere

is inhibitory and the right excitatory.[141] These authors go further by incorporating Dimond's model of hemisphere specialization in attention in which it is proposed that the right hemisphere is specialized in the processes of "sustained" attention and the left is specialized in selective attention[143]. Gruzelier *et al* thus link increased tonic arousal, increased responsiveness and right greater than left OR amplitude asymmetry with broadened attention - the right hemisphere processing mode.[141] Similarly, they link decreased tonic arousal, decreased responsiveness and left greater than right OR amplitude asymmetry with narrowed or focal attention - the left-hemisphere processing mode. This model provided the basis for Gruzelier's interpretation of the symptom-related EDA asymmetries in schizophrenia[139] which will be discussed in the next section. The model of hemisphere specialization in information processing put forward by Dimond[143] can be revised and substantially refined as a result of the work of Wale and Geffen.[144] The latter suggest that right hemisphere processing could be more accurately characterized as holistic or global, a mode of operating which was "more adept at divided attention or parallel processing." In contrast they view the left hemisphere as adept at selective processing or focused attention.[144]

In summary, the original findings of Gruzelier, namely larger right than left SCOR amplitudes in schizophrenia, have not met with unequivocal confirmation. Tonic arousal and responsiveness to orienting stimuli are also not unrelated to indices of electrodermal asymmetry. There has thus been an attempt to link both response asymmetries and overall levels of responsiveness in seeking to explain the contradictory findings in this area. This attempt has led to the proposal, outlined above, in which hemisphere specialization in mode of information processing has been linked to EDA control in the manner described.

3.2.3 Symptomatology

The first to report an association between EDA and particular clinical manifestions of schizophrenia were Venables and Wing.[146] They found evidence of high arousal in the more withdrawn schizophrenic patients.[146]

In more recent work there have been relatively few associations identified between symptom measures and tonic arousal levels. One of these was the study of Deaken *et al* in which a positive correlation between illness severity (Krawiecka scale) and SCL was reported.[146] Incidentally, SCL and heart rate were inversely related to MHPG excretion rates. In addition, this study also reported a higher severity of illness (and lower MHPG excretion) in nonhabituators.[146] Toone *et al* reported a greater frequency of spontaneous responses in schizophrenic subjects who were hallucinating at the time of testing.[147] A similar finding was reported by Cooklin *et al* although they relied heavily on ratings of behaviour presumed to signify the presence of hallucinations rather than on patients' self-reports.[148]

More positive and, to some extent, relatively consistent findings have been reported in studies where the EDA responder/nonresponder dichotomy has been examined in relation to symptomatology. Gruzelier found that noninstitutionalized schizophrenic responders had higher scores (Wittenborn Psychiatric Rating Scale) on the scales manic state, psychotic belligerence, anxiety, attention demanding and assaultive.[149] No such differences were found for institutionalized subjects, although in this group the more withdrawn patients exhibited low amplitude responses and those with high levels of 'schizophrenic behaviour'* had high tonic arousal levels. Rubens and Lapidus reported higher levels of anxiety (Taylor Manifest Anxiety Scale) and

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*Hebephrenia, incontinence, silliness, resistance, motoric, verbal.

fear-worry (Structured Clinical Interview Scales) in 'over-responders' compared to 'under-responders'.[92] They also found that 'over-responders' had poor stimulus barrier functioning (Bellak Ego Functions), suggesting that they were defective in their capacity to selectively filter out stimuli, whereas 'under-responders', at the other extreme, were more likely to exclude stimuli from awareness.

Straube identified increased scores (Brief Psychiatric Rating Scale) on emotional withdrawal, motor retardation and conceptual disorganisation in schizophrenic nonresponders.[96,150] He also reported more depressed mood and somatic concern but reduced excitement and mannerisms/posturing in this group. These findings together with results of dichotic listening tasks led him to suggest that nonresponders have reduced stimulus intake rather than a selective attention deficit and that hyporesponding and withdrawal are protective mechanisms against overstimulation.[96] As far as symptom correlates of nonresponsiveness is concerned, almost identical results were obtained by Bernstein *et al* in which schizophrenic nonresponders showed (Brief Psychiatric Rating Scale) less excitement but greater emotional withdrawal, conceptual disorganization and blunted affect than responders.[103] These authors interpret their findings as suggesting that nonresponders differ from responders in terms of significance evaluation which leads them to allocate attention differently and "to engage the OR to different signals within a given field" (see Bernstein and colleagues[46,108]).

Although others have failed to identify relationships between symptoms and responsiveness in schizophrenia (e.g. Alm *et al*[98]) some consistencies can be found in the small range of literature available. For instance, nonresponsiveness was associated with negative symptoms and conceptual disorganization in two sets of studies,[96,103,150] while over-responsiveness was associated with anxiety in another two studies.[92,149]

These findings take on added significance in the light of electrodermal research in normal populations where, for example, hyporesponsiveness has been associated with anhedonia, a measure of so-called "schizotypy".[151,152] (c.f. Straube,[96,150], Bernstein *et al*[103]), and high tonic arousal, a characteristic of hyper-responders, has been associated with traits of anxiety and fearfulness[124] (c.f. Gruzelier[149] and Rubens & Lapidus[92]).

In regard to lateral electrodermal asymmetry, clinical correlates have been reported by Gruzelier[138,139] and Gruzelier and Manchanda.[140] They divided their sample of schizophrenic patients into two groups: (1) those with greater right than left SCOR amplitudes and (2) those with amplitudes greater on the left than the right. The former group was characterized using discriminant function and factor analyses of clinical symptom rating scale data (Present State Examination, Brief Psychiatric Rating Scale), as chronic, non-florid, non-paranoid schizophrenia with a preponderance of negative symptoms, together with depressed mood. The second group was characterized as acute, florid, paranoid schizophrenia in which positive symptoms predominated. There are two objections which undermine this interpretation and which the authors acknowledge. First, the CATEGO diagnostic system was used in which the hierarchical decision rules permit a diagnosis of schizophrenia in the presence of a major affective syndrome.[153] The sample, therefore, would very likely have included significant numbers of patients who would have been diagnosed as major affective disorder, especially mania, or schizo-affective disorder by diagnostic systems with different decision rules and operational criteria (e.g. DSM-III[154]). The second problem supports the validity of the first objection. On inspection of the symptoms exhibited by patients with greater left than right responses, the overwhelming majority are manic items. They were grandiosity, euphoria, pressured speech and flight of ideas, in

addition to a variety of delusions and anxiety symptoms. Although it is important for these two criticisms to be kept in mind when interpreting these research findings and in evaluating any conclusions based on them, it is not likely that the results themselves are invalid given the well known phenomenological overlap between schizophrenic and affective syndromes.

In summary then, the clinical correlates of electrodermal hyporesponsiveness appear to be, at the least, negative symptoms and, perhaps, a global index of thought disorder referred to as conceptual disorganization.[96,103,150] By comparison, hyper-responsiveness seems to be associated with anxiety, [92,149] impaired stimulus barrier functioning[92] and manic-like phenomena.[149] In relation to lateral asymmetry of EDA, greater right-sided OR amplitudes seem to be identified with negative symptoms and depressed mood whereas larger OR amplitudes on the left are associated with manic-like items and some delusions.[138-140] Thee laterality findings are weakened, however, by the likelihood of a substantial presence of patients with major affective syndromes within the schizophrenic sample.

3.3 ELECTRODERMAL ACTIVITY IN DEPRESSIVE DISORDERS

This review, as with section 3.2, will be organized under the headings: orienting-arousal, lateral asymmetry and symptomatology. Most of the literature in this field has involved studies of endogenous, psychotic or major depressive disorders. Except where otherwise indicated, the following review is confined to these forms of depression.

3.3.1 Orienting-Arousal

High rates of non-responsiveness have been a consistent finding in

electrodermal research of depressive illnesses. The lowest figure reported in the present range of publications was 22%[155] and this included fast habituators as well as nonresponders; the highest rate was 90%.[156] The latter study, however, had a very small sample size.

In a *post hoc* analysis of their data, Bernstein *et al* reported nonresponsiveness in 33-43% of depressed subjects.[99] Heiman reported 50% for nonresponders and fast habituators combined.[157] Higher rates of nonresponsiveness (>50%) have been reported by Mirken and Coppen[158] and Iacono *et al.*[159,160] The proportion of nonresponders in endogenous depression also appears to be higher than in nonendogenous forms of depression.[158] No studies of endogenous-type depressive illness have reported an overall increase in responsiveness or the phenomena of nonhabituation in any but a small minority of subjects.

Although subjects whose depressive illness is in remission show an increase in responsiveness in relation to a more intense stimulus,[160] neither currently depressed nor remitted nonresponders show any increase in responsiveness in relation to alterations in the significance of stimuli.[99,160] This stands in contrast to the effect of stimulus significance in schizophrenia as discussed in section 3.2.1. Were it not for the effect of stimulus intensity, this would suggest that nonresponsiveness in depressive disorders is a stable characteristic of these conditions.[156,159,160]

Low skin conductance level (SCL) is an almost universal finding in studies of depressive illness[155,158-166] and, when also measured, increased heart rate is the usual accompaniment.[155,159,162,163] The combination of low tonic electrodermal arousal and high tonic heart rate has been described in amygdalectomized animals in which it has been interpreted as a nonspecific but effortful "defense" reaction in which the organism attempts to shut off further input (elevated heart rate) and lacks readiness to respond

meaningfully (low skin conductance) to inputs.[36] This is not inconsistent with the pattern in humans of high tonic heart rate combined with low skin conductance responsivity and low heart rate responsivity (see Dawson *et al* for the latter phenomenon in depression)[162,163] to stimuli which is said to suggest preoccupation with internal events, rejection of environmental stimulation[167] or lack of vigilance with regard to the environment.[33]

When skin conductance responses do occur in depressed subjects they tend to be of low amplitude,[159-163,168] few in number[159,160,162,165] and rapidly habituating.[155,159,160] At least one investigator has reported prolongation of SCOR latency[162] but no other alterations in such temporal variables were found in the literature surveyed here.

In addition to nonresponsiveness being more widespread in endogenous depression[158] Noble and Lader reported lower SCL and fewer spontaneous fluctuations in skin conductance in endogenous compared to reactive depression.[169]Similarly, Byrne found evidence of decreased arousal in 'psychotic' compared to 'neurotic' depression.[170] In relation to electrodermal measures, he reported decreased numbers of spontaneous fluctuations, decreased response amplitude and faster habituation in 'psychotic' compared to 'neurotic' depression.[171]

In summary, there are more consistent findings with respect to electrodermal measures of orienting-arousal in depressive disorders compared to those reported for schizophrenia. In major depressive disorder, whether defined as such or as psychotic/endogenous depression, failure to elicit a SCOR occurs in probably more than 50% of cases. Orienting responses that do occur are relatively small in amplitude, few in number and exhibit rapid habituation. Tonic arousal level is decreased with low SCL and few spontaneous fluctuations. Heart rate is usually increased, however. The

continued presence of this electrodermal profile after treatment[162] and in euthymic patients[159,160] together with no alteration in SCL under different experimental conditions[164] or increase in responsiveness with alterations in stimulus significance, have led several investigators to suggest that this profile is a trait characteristic of major depressive disorder.[156,159,160,166] The presence of similar electrodermal characteristics in normal subjects identified as at risk for depression could be taken as supporting this view.[172,173]

3.3.2 Lateral Asymmetry

Again, John Gruzelier has pioneered this field in addition to his substantial contribution to the subject of lateral electrodermal asymmetry in schizophrenia. He and Venables reported greater SCOR amplitudes on the left than the right in depression[89,105,135] and also higher left than right SCL in depression.[105] The latter finding persisted regardless of changes in the experimental condition. By contrast, lateral SCL asymmetrics in schizophrenic subjects were sensitive to task performance and altered in relation to changes in arousal brought about by the nature of the task. That is, in schizophrenia increased arousal was associated with right greater than left asymmetry and low arousal with left greater than right. In depressed subjects, the level of arousal did not change with task and SCL asymmetry remained left greater than right, a low arousal phenomenon.[105]

Other investigators have since reported the same lateral electrodermal asymmetries in depressed subjects, either in SCL or SCOR amplitude or both.[136,147,165,174] Unanimity does not prevail, however, as Iacono and his colleagues[159,175] and Ward *et al*[166] could find no electrodermal asymmetries in their subjects. Nevertheless, no investigator has reported the reverse asymmetry - that is, right greater than left - in the publications reviewed here. There appears to be only one

group to have reported lateral electrodermal asymmetry in subjects at risk for a major depressive disorder.[176,177] This was of smaller skin conductance response amplitudes on the right compared to the left, a result which is consistent with those reported asymmetries referred to above.

In summary, five independent sets of investigators support a left greater than right electrodermal asymmetry in depression whereas two found no asymmetry at all. It does not seem unreasonable to accept the majority finding in this instance, particularly as one of the studies reporting negative lateral asymmetry findings was of patients whose depressive illness was in remission.[159,176]

Given the assumption of contralateral inhibitory control of skin conductance, the reported direction of asymmetry is compatible with a reduction in right cerebral hemisphere activation relative to the left. Such a relative underactivation of right hemisphere functioning is also compatible with generalized low tonic arousal on the basis of the findings of Heilman *et al* in relation to right-sided cerebral lesions.[18] Not only is low tonic arousal a feature of both right hemisphere lesions and major depressive disorders (section 3.3.1) but impaired right hemisphere function resulting from structural neurological disease or tissue loss has been associated with flat affect or emotional indifference.[18,142] This is the type of abnormality of emotional expression observed in severe major depression and in the Type II syndrome of schizophrenia. Thus, in completing the circle which links right hemisphere inactivation with low tonic arousal, left greater than right electrodermal asymmetry and impaired emotional expression (and, perhaps, experience), the negative symptom dimension in schizophrenia suggests itself side-by-side with major depression. Of course, this is not to say that these two syndromes are identical, but rather that they may have certain characteristics or processes in common. It will be recalled that schizophrenic nonresponders, characterised often, and in part, by negative symptoms (section 3.2.3)

tend to have low tonic arousal levels at which, according to Gruzelier and Venables,[105] skin conductance asymmetry (L>R) tends to be the reverse of that found in schizophrenia as a whole (R>L) and schizophrenic subjects with higher levels of arousal, in particular.[89,105,106,121]

3.3.3 Symptomatology

A number of research investigators have reported an association between certain skin conductance variables and symptomatology. Among the first of these was that of Lader and Wing in which agitated and retarded forms of depression were distinguishable on the basis of lower SCL, fewer orienting and non-specific responses, more rapid habituation and lower heart rate in the retarded compared to the agitated groups.[169] The lower heart rate with retardation compared to agitation has also since been reported by Dawson *et al.*[162] This is of importance in relation to the finding of increased heart rate coupled with low SCL in depression reported in section 3.3.1. This seemingly paradoxical finding can be resolved when it is recalled that Lader and Wing quite correctly pointed out that agitation and retardation did not represent extremes of a bipolar dimension but appeared to be independent and could be present simultaneously within the same patient.[169] Thus, the association between low tonic electrodermal arousal and high heart rate could remain valid when a given sample is considered as a whole. Lower tonic EDA has also been reported subsequently in association with retardation in other similar investigations of depressive illness.[178,179] On the other hand, increased EDA has been found in relation to a measure of anxiety in depressed patients.[157]

As might be expected, the differences between agitated and retarded depression have not always been replicated. Iacono *et al*, for example, found no relationships between electrodermal variables and these symptom groups.[159] But,

again, he was dealing with euthymic patients whose depressive illness had undergone previous treatment. Lapierre and Butter found low SCL in both agitated and retarded groups of depressed subjects.[180] They also were unable to find any differences in frequency of spontaneous fluctuations between agitated and retarded depressed subjects and normal controls.[180]

Overall severity of depression, according to some studies, appears to be inversely related to some electrodermal variables. Noble and Lader found this relationship for SCL.[178] Heiman reported a similar relationship between severity and number of spontaneous fluctuations[157] and Dawson et al reported that increased severity of depression was associated with increased SCOR latency and decreased SCOR amplitude.[162] Others, however, have failed to find relationships between severity of depression and electrodermal variables.[179] More recent work has attempted to identify relationships between nonsuppression on the dexamethasone suppression test (DST) and EDA. Reus *et al* reported low tonic arousal and more rapid habituation in nonsuppressors[181] but others have found no difference on the basis of DST classification.[179]

On balance, there does appear to be a relationship between severity of depression, (particularly if measured in terms of psychomotor retardation) and reduced tonic arousal and, perhaps also, reduced responsiveness to stimulation (e.g. increased latency, reduced amplitude, rapid habituation). The association between psychomotor retardation and low tonic arousal is of particular interest in light of the functional neuro-anatomical model linked with affective-expression and the control of EDA as outlined at the end of section 3.3.2.

3.4 ELECTRODERMAL ACTIVITY AND DRUG EFFECTS

Most references about the effect of drugs on EDA are to be drawn from research investigations of schizophrenic patients treated with antipsychotic medication. This area has been thoroughly reviewed some time ago and little new information has come to light since then.[182,183]

There is considerable evidence that antipsychotic drugs reduce tonic arousal levels. Several investigators have independently concluded that these drugs lower SCL.[90,93,96,99,103,184-187] There is also some evidence that they reduce the number of spontaneous fluctuations[136,182-184,186,187] although others have failed to confirm this finding.[93,99] At least one study has reported a reduction in the magnitude of spontaneous fluctuations as well.[136]

With regard to specific or stimulus-elicited skin conductance responses, the majority of studies together suggest that there is no systematic effect of drugs on number of responses, their amplitude or habituation rate.[90,91,93,96,99,100,103,135,150, 186-189] It is important to keep in mind that these findings are in relation to non-signal tones. Only one study in the literature reviewed has reported a clear reduction in responsiveness, including amplitude, as an effect of antipsychotic medication.[136] In contrast, several have reported a reduction in number of responses,[184] amplitude[190] or both[186] in relation to *signal* tones which suggests that drugs affect responsiveness when active attention is engaged but not under conditions of passive attention.

Spohn and his colleagues have reported a linear inverse relationship between drug dose and SCL and NSSCR.[184,187] This is an important finding in that it suggests that the effect of antipsychotic drugs on tonic arousal levels in schizophrenia can be controlled or accounted for by taking into consideration not only the fact of their

prescription but the amount actually administered as well.

Investigations of the effects of antipsychotic drugs on lateral EDA symmetry in schizophrenia are quite limited in number. Those that exist report no effect of drugs on lateral asymmetry.[90,91,135,136] However, Gruzelier and his colleagues have reported a loss of the observed asymmetry when schizophrenic patients are treated with a combination of chlorpromazine and propranolol.[90,91,135] Either drug alone has no effect on the skin conductance asymmetry observed in schizophrenia by these research investigators.

Patterson and Venables administered three drugs to normal volunteers and measured bilateral EDA in an habituation study.[191] The anticholinergic drug scopolamine eliminated the SCOR completely and lowered SCL bilaterally. Chlorpromazine was associated with reduced SCOR amplitude, risetime and recovery time and these effects were more pronounced on the left than the right. Chlorpromazine did not lower SCL significantly. Haloperidol was associated with increased SCOR amplitude and, on the right side only, reduced risetime and recovery time. It is difficult to know what to make of these findings. These drugs were given once only and in very low doses which is quite unlike the clinical situation. A cautious conclusion, taking the effects of scopolamine into account, would be that drugs with considerable anticholinergic potency (e.g. chlorpromazine) may have a relatively greater effect on tonic arousal in schizophrenic subjects than those with less anticholinergic potency (e.g. haloperidol). Electrodermal studies of schizophrenic patients treated with the latter drugs may yield more valid results than those in which drugs with greater anticholinergic activity are used.

Finally, in studies of depressed patients, no effect of tricyclic antidepressants on various indices of EDA have been reported.[159,165,166,179,180] This may be because tonic arousal levels are already so low in most depressed patients that any additional

effect (possibly anticholinergic) of antidepressants passes undetected.

In summary, antipsychotic drugs in schizophrenia reduce tonic arousal (SCL, NSSCR) but appear to have no appreciable effect on orienting responses, their number, amplitude or habituation rate unless the orienting stimuli have signal value. The effects on arousal are dose dependent and are probably related, in part, to the anticholinergic properties of these drugs. There appear to be no antipsychotic drug effects on lateral asymmetry of EDA.

CHAPTER 4

THEORY AND HYPOTHESES

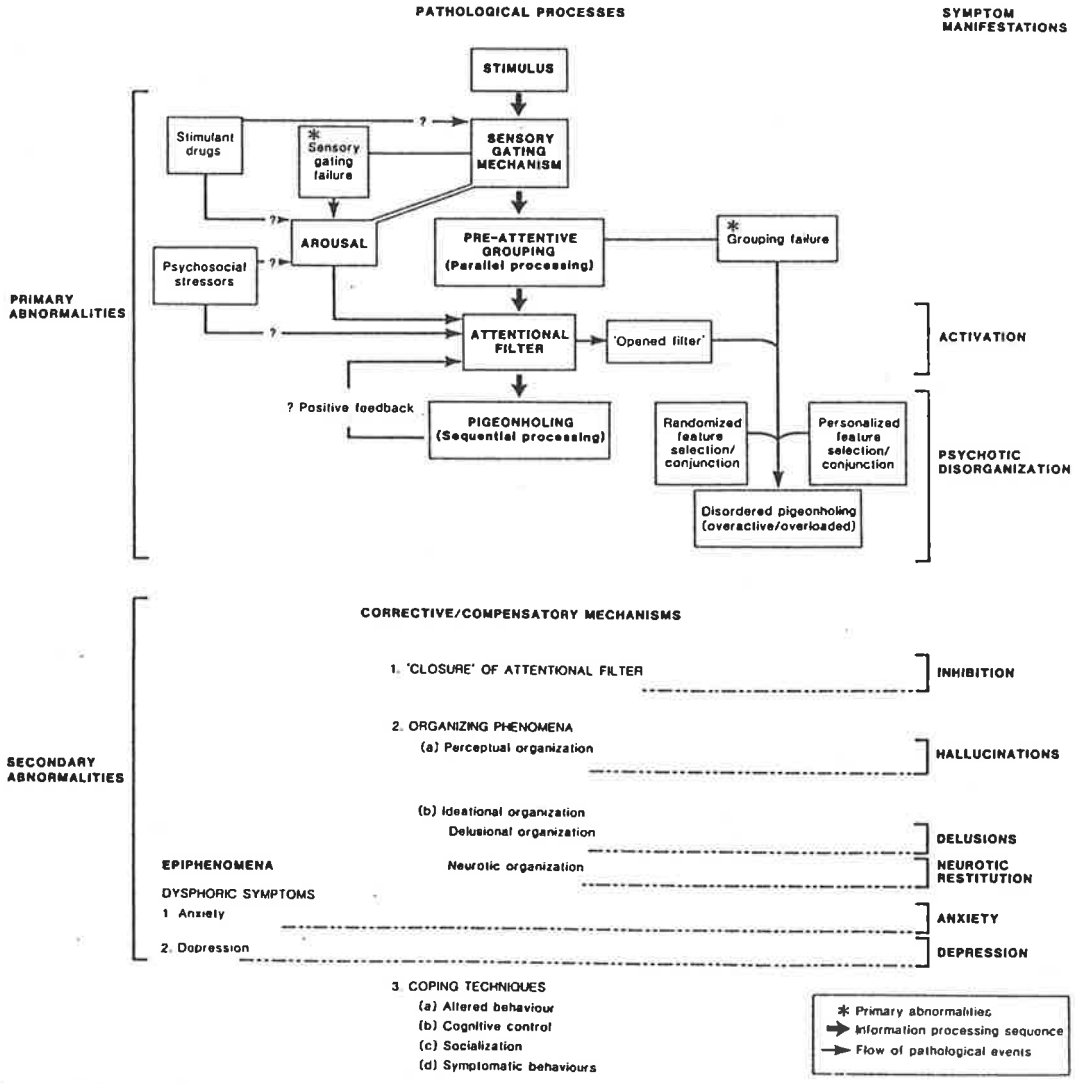
4.1 A MODEL OF SCHIZOPHRENIA

A model of schizophrenia has recently been put forward based on information processing theories[1]. It would not be appropriate to review the evidence in support of this conceptualization here, but a full account is given in Appendix E. A summary follows which outlines the main features of the model so that it can be seen how the hypotheses of the present study were derived. A schematic representation of the model has been reproduced in Figure 4.1.1.

It is proposed that the primary abnormalities in schizophrenia include a breakdown of a premorbidly vulnerable or compromised information processing activity known as preattentive perceptual grouping. The latter is a function which utilizes parallel (automatic, global) processing and may be predominantly a right hemisphere specialized mode of processing. Preattentive grouping can be defined as the preliminary perceptual organization or "chunking" of the stimulus field which prepares stimulus inputs for optimal selective processing. Among the consequences of the disruption in preattentive grouping, it is proposed, would be a tendency towards randomization of feature selection and conjunction in the course of the preliminary preattentive processing of inputs which provides the foundation for the generation of percepts. This, it is thought, would then result in disorder of a process referred to as pigeonholing. The latter is a function of a putative central, limited-capacity information processing channel which operates, in contrast to preattentive mechanisms, on the basis of serial processing. This is thought to be predominantly a left hemisphere specialized mode of processing. It is proposed that pigeonholing operations become dysfunctional owing to their being forced to process relatively 'ungrouped' information (i.e. randomized feature

selection/conjunction) which is transmitted from the dysfunctional preattentive mechanisms. In other words, the failure of preattentive grouping presents relatively unorganized inputs to the limited-capacity sequential processor which then becomes overloaded by "noise" and thus dysfunctional. This is what is meant by pigeonholing disorder.

Figure 4.1.1

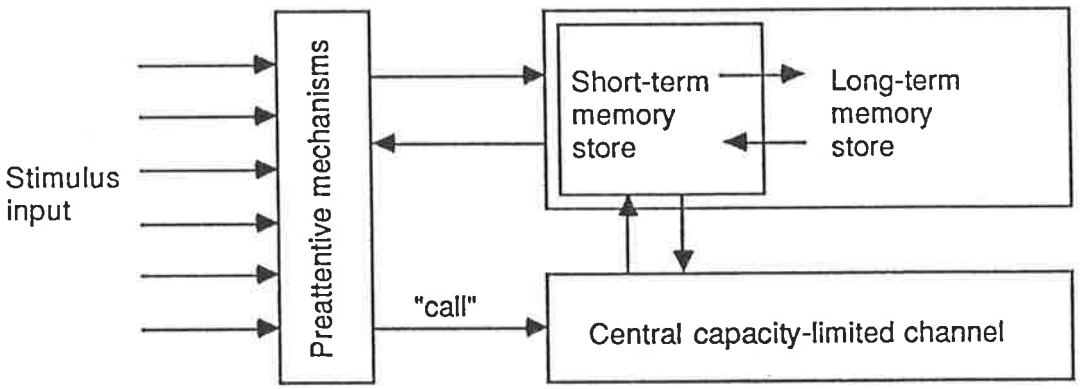


Schematic representation of the proposed pattern of information processing abnormalities in schizophrenia.

Ohman has put forward a model of the OR based on information processing literature.[2] His more recent revision of this model to explain certain forms of conditioning[3] does not alter those fundamental aspects of the model of relevance to the present study. Ohman's schematic representation of this model is reproduced in Figure 4.1.2.

Figure 4.1.2

(Reproduced from Ohman[2])



An information processing model of the orienting response. Stimulus input is examined for recognition by automatic, preattentive mechanisms that examine the stimulus for matches with information held in a short-term memory store. The short-term store is conceptualized as an activated subset of the long-term memory store. If the preattentive mechanisms fail in finding a matching memory element for the stimulus input, a call for processing resources in a central capacity-limited processing channel is emitted. The orienting response is associated with this call. The call may also be emitted in the case of the stimulus matching memory elements primed as "significant" in the sense that they cannot be handled automatically.

In this model, the short-term memory store (STS) is considered to be an activated subset of the long-term memory store (LTS) in keeping with the position of Shiffrin.[4] According to this view the STS holds a continuously updated record of memory elements that are contextually primed by changing situational cues. "Automatic perceptual mechanisms match incoming stimuli to the information held in the short-term store to achieve automatic (but not necessarily conscious) recognition of expected events, that is, events finding matches in the short-term store. When these preattentive mechanisms fail to recognize a stimulus because of a mismatch with the content of the short-term store, controlled processes have to be activated in order to analyze the consequences of the implied environmental change. As part of this call for processing capacity in the central channel, an OR is elicited, the peripheral physiological manifestations of which are postulated to be part of efferent priming for efficient potential action."[3]

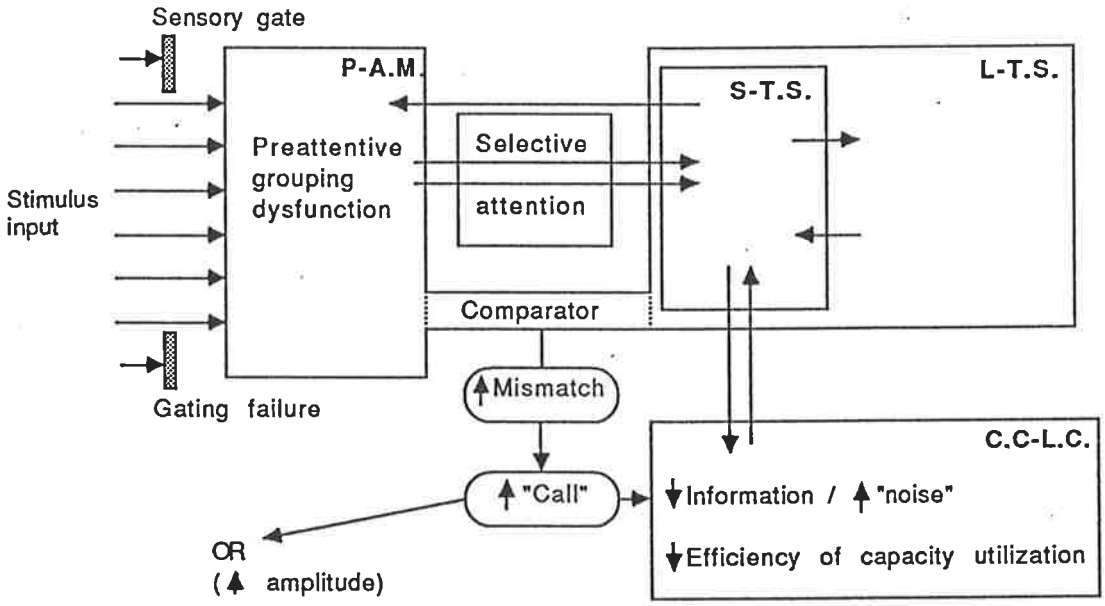
The determination of what Ohman refers to as 'mismatch' would require a system with 'comparator' characteristics. 'Comparator' function was mentioned in Chapter 3 and identified with the hippocampus. In that chapter it was also pointed out that hippocampectomized animals showed an electrodermal pattern of hyper-responding with delayed or absent habituation. This suggests that the phenomenon of matching preattentive inputs with STS may indeed depend on the integrity of the hippocampus.

Consider electrodermal measures of the OR in the light of the proposed model for schizophrenia[1] and Ohman's model for the OR.[2,3] The proposed dysfunctional preattentive grouping in schizophrenia would produce increased degrees of mismatch between preattentively processed input and STS. High degrees of mismatch would augment the "call" for allocation of processing capacity

in the central limited-capacity channel. This would be expected to be revealed as an increase in the magnitude of the OR thus elicited. In brief, then, dysfunctional preattentive grouping would produce greater mismatch between inputs and STS which, in turn, would lead to increased OR amplitudes concomitant with increased allocation of central channel processing capacity to "noise" (i.e. relatively ungrouped, low information inputs secondary to dysfunction in preattentive mechanisms). The latter effect would be responsible for dysfunctional pigeonholing in the form of relatively ineffective sequential processing of "noise" elements in the central channel. A schematic representation of the above is illustrated in Figure 4.1.3 which is an adaptation of the Ohman model.[2]

It was also suggested in presentation of the model for schizophrenia[1] that an *acute episode* of schizophrenic psychosis may be mediated by dysfunction in the subcortical sensory gating mechanism which is believed to be based in certain catecholamine pathways of the limbic-basal ganglia system. This sensory gating failure was proposed to have two related effects. One was an increase in the rate of information input requiring processing and the other an increase in the level of tonic arousal. In effect, each would probably initiate an 'opening' of the attentional filter located somewhere between the preattentive mechanisms and STS at the entrance to the central channel (i.e. the 'input dysfunction' of Venables). This model also allows for pathogenic ('filter opening') increases in tonic arousal to be initiated by mechanisms other than sensory gating failure - life events or high 'expressed emotion' families, for instance.[5,6] Thus sensory gating failure and its associated increased tonic arousal can be seen, either separately or together, as possible initiators and/or augmentors of the effects of mismatch between compromised or vulnerable preattentive grouping processes and STS in schizophrenia. Direct

Figure 4.1.3



Information processing model of the primary abnormalities in schizophrenia in relation to the orienting response.

evidence for sensory gating failure would be an increase in number of ORs (and NSSCRs), delayed or non-habituation and abbreviation of the OR temporal variables. Evidence for increased tonic arousal would be found in increases in SCL, NSSCR, and a lateral electrodermal asymmetry of right greater than left.

Thus a dual process model for acute schizophrenic psychosis is proposed. Grouping/pigeonholing dysfunction with increased OR amplitudes would be manifest symptomatically by the dimension referred to as psychotic disorganization (Chapter 2). Sensory gating failure, or 'opening' of the attentional filter with increases in orienting activity and tonic arousal, would be reflected in the symptom dimension of activation.

It is suggested that in an attempt to correct or compensate for this 'high entropy' state of psychotic disorganization and activation, a number of regulatory information processing operations are employed. These could be referred to as secondary abnormalities.

Probably the earliest and most important of these would be the tendency for 'closure' of the attentional filter; that is, restricted attention or reduced scanning of the environment.[1] This may even occur during the prodromal phase of a schizophrenic illness episode. The symptom manifestation of this, a processing strategy of 'shut-down', is proposed to be the dimension of inhibition. In other words, the type II syndrome or negative symptom group would be seen as a secondary phenomenon in this model of schizophrenia and not a primary one of dementia or neural tissue destruction which Crow[7] regards as fundamental in schizophrenia. Electrodermally, it is predicted that restricted attention would reduce the volume of input from the preattentive mechanisms and that therefore the degree of mismatch between the preattentively processed inputs and STS would be reduced

concomitantly. Consequently the 'call' to the central channel for allocation of processing capacity would be diminished and this would be manifest as a reduction in OR amplitude (and spontaneous response amplitude) in direct proportion to the severity of inhibition symptoms.

The other main set of compensatory operations are referred to as organizing phenomena, of which there are at least two forms, perceptual (hallucinations) and ideational (delusions). It is proposed that hallucinations and delusions are the outward expressions of higher cortical processes which operate on unorganized (i.e. ungrouped) inputs in an effort to organize them into coherent, meaningful patterns. That is, to impose order on disorder or make information out of noise. This would presumably occur through interaction between LTS and STS whereby LTS would activate STS in a way that could be called *expectancy priming*. This is intended to refer to a process in which inputs from LTS alter STS content to represent more closely what is expected in the immediate environment - that is, what LTS 'expects' from the environment. The consequent STS content would then determine the nature of *perceptual bias* which operates on the preattentive mechanisms.

Perceptual bias would determine which stimulus features would be conjoined with which in percept construction and which features would be selected for further processing. According to Treisman's feature-integration theory,[8] when preattentive mechanisms are overloaded by increased stimulus inputs (i.e. sensory gating failure in the case of schizophrenia) false percepts can be constructed by incorrect conjunctions of stimulus features such that what is perceived is not actually 'there'. These are called 'illusory conjunctions'.[8] It has been proposed that the phenomenon of 'illusory conjunctions' combined with the operation of

perceptual bias, under conditions of restricted attention (i.e. filter closure), provides the nidus upon which the pathogenesis of hallucinations is based in schizophrenia where there is (a) sensory gating failure and (b) dysfunctional preattentive grouping.

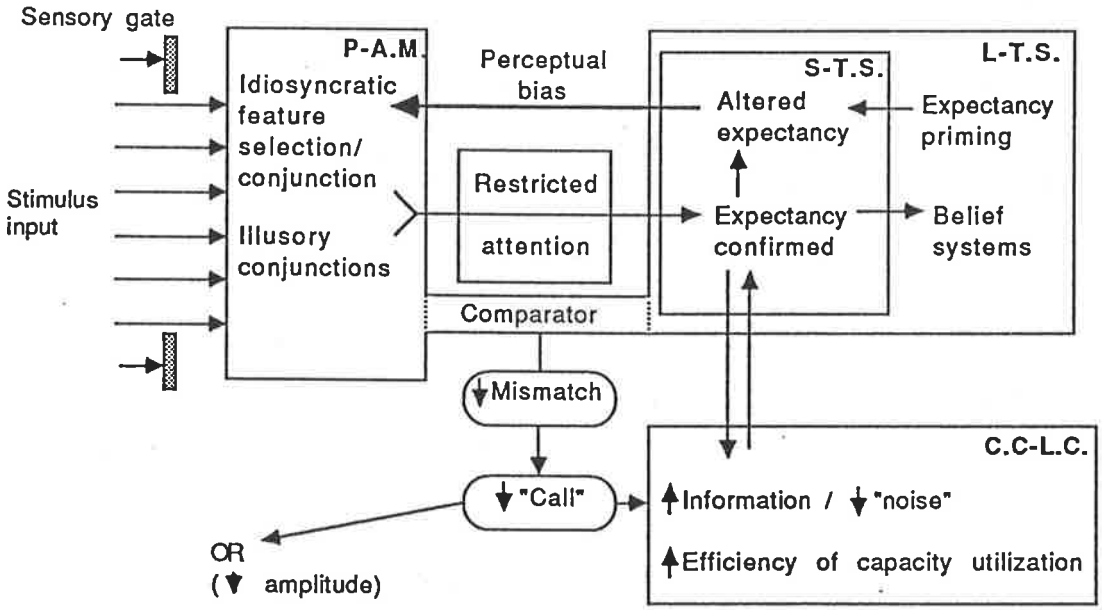
In combination with restricted attention (filter 'closure'), the perceptual bias in selecting preattentively 'ungrouped' inputs would bring about a reduction in the degree of mismatch between STS and those inputs which will be subsequently elaborated in the central channel to form hallucinations. Reduced mismatch would diminish the magnitude of the 'call' for capacity allocation in the central channel and thus be associated with ORs of smaller amplitude. The order or degree of organization thus imposed on inputs by higher cortical processes would provide a form of preliminary input processing which the dysfunctional preattentive mechanisms otherwise fail to provide in schizophrenia. This sequence of operations would thereby yield information which could be processed by the central channel whereas, in all likelihood, the unorganized inputs entering from the dysfunctional preattentive mechanisms unmodified by compensatory restricted attention and perceptual bias would not be in a suitable (i.e. preliminarily processed) form for further processing in the central channel. Psychotic disorganization then would be associated with underutilization or ineffective utilization of the central channel in spite of strong 'calls' for processing capacity allocation and larger amplitude ORs owing to high noise (low information) input. On the other hand, psychotic organization (hallucinations and delusions) would be associated with more efficient central channel utilization with smaller calls for processing capacity and smaller OR amplitudes owing to low "noise" (high information) input. The proposed processes underlying all of the above secondary

or compensatory operations are illustrated in Figure 4.1.4.

The combined operation of the processes of restricted attention (inhibition symptoms), and perceptual bias in stimulus feature selection/conjunction (hallucinations) and input interpretation (delusions) are viewed as operating to counter the high entropy arousing effects of preattentive grouping dysfunction and sensory gating failure. Their tendency to produce a shift towards more effective utilization of the central channel would be reflected in fewer ORs and earlier habituation and in a shift away from the right-greater-than-left EDA asymmetry towards the opposite asymmetry combined with a lowering of tonic arousal (SCL, NSSCR).

Within this framework the affects of anxiety and depression are viewed as epiphenomena, considerably removed from the "core" psychotic process. Apart from these dysphoric symptoms, the principal symptom dimensions discussed above are viewed as having importance in two respects. On the one hand they can be regarded at a descriptive level as vectors, the measurement of which enables the psychopathological state of an individual schizophrenic patient to be characterized. At an explanatory level, on the other hand, these dimensions are viewed as the correlates of underlying information-processing operations. Aspects of the latter are to be tested empirically in this dissertation.

Figure 4.1.4



Information processing model of the secondary, compensatory operations in schizophrenia which are manifest as "negative" symptoms (inhibition), hallucinations and delusions.

The model presented here does not purport to represent a temporal sequence of events beginning with the primary abnormalities and proceeding stepwise through a series of secondary abnormalities. Instead, it is intended to represent the dynamic interplay between various processes in the construction of psychopathological states. At any one time one or more processes may dominate giving the clinical picture a certain set of characteristics. These may differ from those witnessed at another point in time at which the relative contributions from underlying information processing operations may have changed substantially. Thus, symptoms will alter in severity and, under some conditions, vanish completely depending on the way in which information processing is influenced within the individual patient.

4.2 HYPOTHESES

4.2.1 Schizophrenia

4.2.1.1 Tonic arousal

Acutely psychotic schizophrenic subjects have increased levels of tonic arousal compared to controls. This will be manifest as:

(a) Increased SCL

(b) Increased NSSCR

4.2.1.2 Orienting activity

Owing to decreased sensory gating, orienting activity is increased in acute schizophrenic psychosis. This will be manifest as:

(a) A low proportion of non-responders and a relatively high

proportion of non-habituators.

(b) An increased number of ORs.

(c) Delayed habituation

(d) Reduction in the OR temporal variables of latency, risetime and recovery time, the latter being of particular interest as an index of "openness" to the environment or the "gating-in" of stimuli.

4.2.1.3 Response Amplitude (Capacity Allocation)

Increased mismatch between inputs and STS owing to preattentive grouping dysfunction will cause the magnitude of stimulus-elicited and spontaneous skin conductance responses to be augmented. This will be manifest as:

(a) Increased amplitude of ORs

(b) Increased amplitude of spontaneous skin conductance responses.

4.2.1.4 Lateral asymmetry

Consistent with the view that in schizophrenia both increased levels of tonic arousal and ineffective functioning of the central channel will be related to dominance of right hemisphere activation relative to left (i.e. underactive left hemisphere-specialized processing), it is predicted that right-greater-than-left asymmetries will tend to occur in the following variables in acute schizophrenic psychosis.

Tonic arousal:

(a) SCL

(b) NSSCR

Response amplitude (capacity allocation):

(c) OR amplitude

(d) Spontaneous response amplitude

Orienting activity:

(e) Number of ORs

(f) Point of habituation

4.2.1.5 Symptomatology

(a) The symptom dimension of activation, proposed to be associated with sensory gating failure, will positively correlate with:

(i) tonic arousal

(ii) orienting activity (i.e., increased responsiveness, delayed habituation, abbreviated temporal variables)

(iii) indices of right-greater-than-left asymmetry in tonic arousal and orienting activity

(b) The symptom dimension of psychotic disorganization, proposed to be associated with preattentive grouping dysfunction and, thus, increased mismatch between preattentively processed inputs and STS with consequent pigeonholing dysfunction, will be positively correlated with the magnitude of 'calls' for capacity allocation, namely:-

(i) OR amplitude

(ii) Spontaneous response amplitude.

Secondary relationships may also exist between between psychotic disorganization and tonic arousal as for the activation symptom dimension, as it is proposed that psychotic disorganization, in itself, is likely to be physiologically highly arousing (possibly through positive feedback mechanisms).

(c) The symptom manifestations of the combined compensatory or corrective processes referred to as restricted attention (inhibition or negative symptoms) and organizing phenomena (hallucinations and delusions) will correlate *inversely* with:-

(i) The magnitude of 'calls' for capacity allocation as measured by OR amplitude and spontaneous response amplitude.

(ii) Tonic arousal as measured by SCL and NSSCR

(iii) Orienting activity (i.e. decreased responsiveness, early habituation, prolonged temporal variables)

(iv) Degree of right-greater-than-left EDA asymmetry, as arousal declines and information processing becomes more dominated by left hemisphere, sequential strategies in the service of hallucination and delusion construction.

4.2.2 Depression

4.2.2.1 Tonic arousal

In keeping with the literature in this field, depressed subjects will have reduced levels of tonic arousal compared to controls. This will be manifest as:

(a) Decreased SCL

(b) Decreased NSSCR

4.2.2.2 Orienting activity

Also in keeping with the literature, orienting activity will be reduced in depression and this will be manifest as:

(a) A high proportion of non-responders and a relatively low proportion of non-habituators

(b) A reduced number of ORs

(c) Rapid habituation

(d) Prolongation of the OR temporal variables of, latency, rise time and recovery time.

4.2.2.3 Lateral asymmetry

Consistent with the view that decreased levels of tonic arousal are related to dominance of left hemisphere activation relative to right, it is predicted that left-greater-than-right asymmetries will occur in the following variables in depression:

(a) SCL

(b) NSSCR

(c) OR amplitude

(d) Spontaneous response amplitude

(e) Number of ORs

(f) Point of habituation

4.2.2.4 Symptomatology

(a) The symptom dimension which is referred to in the context of schizophrenia as inhibition and is related to the concept of the negative symptom group or Type II schizophrenia, has *prima facie* validity of application in relation to affective disorder. This is due to the very close similarity at a descriptive level between the depression-related phenomena of psychomotor slowing, withdrawal, affective flattening and so on, compared to the spectrum of negative symptoms discussed in relation to schizophrenia. It is predicted that, as in schizophrenia, inhibition will be associated with:

(i) decreased tonic arousal,

(ii) reduced orienting activity,

(iii) a tendency towards left-greater-than-right asymmetry in skin conductance activity.

(b) In contrast, the symptom dimension of anxiety will be associated with:

(i) increased tonic arousal,

(ii) increased orienting activity,

(iii) a tendency towards right-greater-than-left skin conductance asymmetry.

No specific predictions are made regarding the other dysphoric dimension, depressed mood.

CHAPTER 5

METHOD

5.1 SUBJECTS

A total of 79 subjects participated in this research project. They included 44 experimental subjects (24 with a diagnosis of schizophrenia, 20 with major depressive disorder) and 35 normal controls. Experimental subjects were all recent admissions to one of two inpatient psychiatric units. Most (N=34) were located on the 24-bed psychiatry ward of the Royal Adelaide Hospital, a large general teaching hospital. The remainder (N=10) were patients at Mason House, an acute 24-bed inpatient treatment facility for schizophrenic patients at Hillcrest Hospital which is a large mental hospital in this State.

Experimental subjects were selected from consecutive admissions to the Royal Adelaide Hospital unit and, at Mason House, a random sample of admissions during a 10 month period. Criteria for entry into the study were as follows:

(i) Age 15 to 65 years

(ii) Either sex

(iii) Sufficient English language skills to permit a clinical interview and the completion of clinical rating scales by the investigator on the basis of that interview.

(iv) Diagnosis of schizophrenia, schizophreniform disorder or unipolar major depressive disorder on the basis of DSM-III criteria.[1]

(v) Absence of organic brain disease, alcohol or drug dependence, mental retardation, other major psychiatric disorders and debilitating physical disease.

Every effort was made to enter the experimental subjects into the research protocol as soon after admission as practicable. This was to help ensure that the

subjects were quite definitely ill, with relatively severe psychiatric symptoms at the time of the study. This procedure was also undertaken in an effort to avoid where possible, and minimize where not, the effects of psychotropic medications. There is a very great difficulty in this community in studying psychiatric patients who are medication-free. Comparatively few patients with major mental illness are admitted to hospital nowadays without heaving been given some form of psychotropic drug prior to admission. To wait for potential research subjects to be admitted in a drug-free clinical state would unreasonably extend the duration of the study. The Department resources at the Royal Adelaide Hospital and at Mason House were such as to make a 3 to 4 week drug wash-out period impractical. Furthermore, ethical objections would have been raised against incorporating a drug wash-out component in the research protocol. Of considerable importance also is the fact that a proportion of newly admitted psychiatric patients (more than one third in the case of schizophrenia[2]) clinically improve or recover completely during an initial drug-free wash-out period. Since the principal focus of the present study was to be on patients who were acutely ill at the time of investigation, a drug wash-out period would not only cause a reduction in the size of the research sample but would also, by excluding those who improve without drugs, fail to be representative of the population of acutely ill, newly admitted inpatients with major psychiatric disorder. The administration of psychotropic drugs, therefore, did not preclude admission to the study. Whenever it was clinically feasible, patients who were drug-free on admission remained drug-free until the research protocol was completed. The view was taken in relation to schizophrenia, however, that a newly admitted, acutely ill subject given a modest quantity of antipsychotic drug over a very brief period, which could facilitate co-operation with the researcher, would be preferrable to a drug-free unco-operative

subject - that is, no subject at all. Given the definite but limited effects of psychotropic drugs on electrodermal variables (section 3.4), it was felt that this was a satisfactory compromise solution to the medication problem. The nature and dose of all drugs administered in each case, if recorded, would enable examination of drug effects in the process of subsequent data analysis.

Normal control subjects were volunteers from among medical and paramedical staff of the Royal Adelaide Hospital and laboratory staff of the Institute of Medical and Veterinary Science. No formal attempt was made to match exactly the controls with the experimental subjects for age and sex. Keeping in mind that this was primarily a study of schizophrenia it was expected that the ages of control subjects drawn from these sources would match relatively well the age range of the schizophrenic subjects. No such age matching was expected for the depressed group who were anticipated to have a higher age range than within the schizophrenic subjects and the group of normal controls drawn from the sources referred to above.

5.2 RATING INSTRUMENTS

5.2.1 Demographic and Background Data

A range of demographic and background data together with past and family history information were collected from the experimental subjects. These variables are listed in Appendix A where sample copies of data record sheets used in the collection of this information are provided. If patients were taking psychotropic drugs the type and dose in each case was recorded. If antipsychotic drugs had been used, doses were converted to chlorpromazine equivalence units using generally accepted methods of conversion.[3]

5.2.2 Hand preference

Annett's 12-item handedness questionnaire (Appendix A) was administered to both the experimental and control subjects.[4] This is a widely used measure of hand preference and was included in the protocol so that the issue of cerebral dominance could be addressed, at least in part. This instrument enables subjects to be classified as right- or left-handed or mixed. By simple addition of responses regarding performance for one hand over another, handedness can be expressed on an ordinal scale as well. In view of contradictory reports regarding hand preference in schizophrenia,[6-9] together with the unknown relationship between hand preference and lateral asymmetry of EDA, the Annett questionnaire was used to ensure comparable patterns of hand preference in schizophrenic and control subjects. It was also anticipated that the questionnaire would be used in an exploratory way to determine if a relationship did exist between hand preference and electrodermal variables, particularly lateral asymmetry.

5.2.3 Symptomatology

The Present State Examination (PSE) of Wing *et al*[10] and the Brief Psychiatric Rating Scale (BPRS) of Overall and Gorham[11] were chosen to provide ratings of clinical symptoms. The PSE is a semi-structured clinical interview which provides ratings on 140 symptom or mental state items. Each item and the criteria for the various specific ratings within each item are carefully defined in the PSE manual.[10] A programme of training in the use of this instrument is available in the

UK but, although highly desirable, is not absolutely essential for a trained psychiatrist. This programme of training was not available to the writer who therefore underwent a period of self-instruction prior to the present study. This consisted, in addition to four years of formal psychiatric training, a three month period in which the PSE manual was thoroughly studied and a series of trial interviews conducted. The latter involved 12 patients with a variety of diagnoses. Six of these interviews were conducted jointly with another psychiatrist after which the ratings for each PSE item were compared and discussed. In skilled hands the PSE has demonstrated adequate reliability. The above programme of skill acquisition in this writer's case is believed to have been sufficient to ensure reliability in the present study.

The BPRS[11] is an even more widely used symptom rating scale than the PSE. In the present study the 16 item version was used (see Appendix A). Each item is well defined and ratings are made on a 7 point ordinal scale in each case. Again, with practice and in the hands of a trained psychiatrist, the BPRS has demonstrated adequate levels of reliability.[11]

Normally, the PSE data is subjected to analysis using the CATEGO computer programme.[10] This yields scores on a variety of syndromes and descriptive classes and subclasses which are each combinations of particular symptom items. It also gives estimates of the severity of psychopathology on four hierarchical subscales and provides an "index of definition" (I.D.). The latter is also a measure of illness severity or, more precisely, "caseness". Below a particular I.D. criterion level, a "case" of illness in a given subject is said to be absent whereas above that level, a "case" of the illness in question is said to be present. Finally, PSE/CATEGO provides diagnostic classification according to certain 'decision-tree'

rules and assigns the individual to a particular diagnostic group within the International Classification of Diseases system. It provides an estimate of the degree of certainty of the diagnosis in each case as well.

In the present study it was determined that the CATEGO programme would not be used for analyzing the PSE data. In particular, the main thrust of the present study from the symptomatological point of view was to characterize each patient on the particular symptom dimensions referred to in section 2.3. Accordingly many of the PSE items were assigned each to one of the 8 principal symptom dimensions identified on the basis of that literature review. Thus, 8 ordinal scales intended to measure the severity of psychopathological symptoms within each of those dimensions were constructed. These are given in full together with their corresponding PSE items and the method for scoring them in Appendix B.

Likewise, the BPRS items were singled out and some combined to form ordinal scales reflecting the same symptom dimensions. These are also described in full in Appendix B.

5.3 PSYCHOPHYSIOLOGICAL APPARATUS

5.3.1 Laboratory

The laboratory in which the subjects were tested was located in the University Department of Psychiatry at the Royal Adelaide Hospital. This Laboratory measured 2.0 by 3.5 metres. Ambient temperature was 22^{o}C ($\pm$ 1^{o}C) and humidity ranged from 40% to 67% (mean = 55.3%). Lighting was provided by two standard fluorescent lamps shielded with a perspex covering. All

psychophysiological recordings were made on an eight-channel Hewlett-Packard 7700 polygraph located in an adjoining room.

5.3.2 Skin Conductance

Measurement of skin conductance was by the constant voltage method (0.3V, 10 Hz sine wave, AC). Bipolar placement of silver-silver chloride, 10 mm diameter disc electrodes was used, and the electrodes were fixed by means of double-sided adhesive discs to the palm of each hand on the hypothenar eminence within the area of the C8 dermatome. The electrodes were placed after the site had been cleansed with alcohol and allowed to dry. A ground surface electrode was placed on the ventral surface of each forearm midway between the elbow and the wrist. The electrolyte medium was an inert gel (K-Y jelly) in which the salt concentration had been adjusted to 0.05M sodium chloride making it isotonic with human sweat. These procedures were adapted from standard texts of psychophysiology method.[12,13] The electrodes were connected to two Autogen 3400 feedback dermographs which provided DC signals linearly proportional to relative conductance levels. The DC signals were fed into two Hewlett-Packard 8803A low-level preamplifiers and each was recorded with a full scale range of 2.5 to 25 μS per 50 divisions (40 mm) of chart recording paper. The system incorporated voltage suppressors capable of suppressing voltage from 0 to 100 mV (i.e. 0-10 μS). Thus the range of skin conductance measurable with this equipment was 0-35 μS.

5.3.3 Stimulus Conditions

A 30-minute audiotape was prepared consisting of a 9 minute baseline period of blank tape followed by 15 minutes of tones which were then followed by a further 6 minutes of blank tape. The tones were 91 dB, 1000 Hz and 1 second duration with rise and decay times less than 10 milliseconds. There were 20 of these orienting tones distributed at pseudo-random intervals over a period of 14 minutes and 15 seconds. The mean interval duration was 45 seconds with a range of 20 to 80 seconds. This series of tones was followed after 45 seconds by a single dishabituating tone of 91 dB, 4000 Hz and 1 second duration with rise and decay times similar to the previous 20 tones.

This tape was played on a stereocassette deck and fed binaurally into a set of earphones along with continuous white noise at 55 dB generated by an integrated circuit. Each subject would thus be exposed to a pre-tone baseline of white noise for 9 minutes followed by 15 minutes of tones with continuous white noise, which was then followed by a 6 minute post-tone baseline of white noise. The white noise was used to mask out low-level extraneous auditory stimuli and to provide a standardized testing condition. Each tone generated a signal which, simultaneously with the sound of the tone, triggered an event marker on the polygraph so that the exact time from the stimulus onset to physiological response could be readily computed.

5.4 PROCEDURE

5.4.1 Demographic and Clinical Assessment

Potential experimental subjects were screened for possible inclusion in the study as soon after hospital admission as practicable. This was usually within 72 hours of admission at the Royal Adelaide Hospital, slightly longer at Mason House. If, as a result of preliminary screening of the hospital casenotes and following discussion with the responsible clinician, it appeared that a subject was suitable for the study, he/she was entered into the protocol.

The first task then was to ensure informed consent and this was obtained verbally following as complete a discussion of the rationale of the project as was possible with each subject. Only three subjects declined to participate out of a total of 70 who were initially approached. Two were Mason House patients and one was hospitalized at the Royal Adelaide Hospital. In each case the subjects were extremely hostile to the treatment facility and perceived the research project to be an extension of the treatment they were striving to resist.

Having obtained informed consent each subject was interviewed by the writer. Each interview began with the collection of that demographic or background information which could not be gathered reliably from the casenotes. This was followed by administration of the handedness questionnaire.[4] The PSE interview then took place on the basis of which the BPRS was also completed. Diagnoses were made by the writer according to DSM-III criteria using the material gathered in the course of this interview and information available in the hospital casenotes.

Of 67 subjects initially accepted, 9 did not receive a PSE interview and

therefore no clinical symptom ratings were obtained on them. This group was entered into the psychophysiological component of the project during the pilot phase of the study and prior to the introduction of the PSE into the experimental protocol. In these cases, diagnoses were made on the basis of a clinical interview with the writer combined with a review of the casenotes. Six of the 67 subjects who were initially entered into the study were subsequently excluded on the basis of their failure to meet criterion (v), absence of other significant diseases (section 5.1). Three of these were among those who had not been interviewed using the PSE. Of the 61 remaining subjects, a further 17 were also excluded after data collection for failure to meet criterion (iv), diagnosis. Three of these had not had PSE interviews. This left a total experimental group of 44 subjects, only 3 of whom had not undergone a PSE interview. All interviews and ratings of symptomatology by the writer were made blind to the results of the psychophysiological component of the protocol.

5.4.2 Psychophysiological Testing

It was not possible to incorporate a period of familiarization with the laboratory prior to testing. Nevertheless, on each occasion, the subject was shown all of the monitoring equipment, which included closed circuit television, and explanations were given as to the purpose of the apparatus. Questions were encouraged and, when necessary, reassurance was given that all procedures would be harmless and non-painful. Subject were then asked to sit in an adjustable recliner chair and make themselves as comfortable as possible. The recording electrodes were then applied. Before the earphones were put on, subjects were instructed in a standardized manner that they were to try to relax as much as possible and that they

could close their eyes if they wished, but should try not to go to sleep. They were also told that for about half an hour they would hear some sound and some tones through the earphones. They were told to *ignore* these and remain as relaxed and as still as possible. A copy of the exact instructions to the subjects is provided in Appendix C. These instructions were given by the same person who had applied the recording electrodes and who then operated the equipment throughout the test session.

Experimental subjects always participated in the psychophysiological component of the protocol during an afternoon within 24 hours of the clinical or PSE interview. In most cases both took place on the same day. With respect to the Mason House subjects, they were screened for possible inclusion in the study at Mason House in the morning and transported by taxi (in the company of a nurse) to the Royal Adelaide Hospital in the afternoon where the PSE interview took place followed by the psychophysiological recording session. Control subjects were tested and administered the handedness questionnaire in the afternoon as well.

For purposes of data analysis, the psychophysiological records were divided into three sections. Of the 9 minutes prior to the onset of the first tone, data from the first 4 minutes, during which the subject was adapting to the test conditions, were discarded. The record of the remaining 5 minutes before the commencement of the tone sequence was retained for analysis as the resting or pre-tone baseline. The second section comprised recordings made during the 15 minute tone sequence and the third section comprised the first 5 minutes after cessation of the tones, the post-tone baseline. Thus, a total of 25 minutes of continuous recording provided the basis upon which data analysis was later undertaken.

A list of the psychophysiological variables which were collected and

subsequently used in data analysis is given in Table 5.4.2.1. Mean values for SCL were based on 10 samples at 30 second intervals during the resting and post-tone periods and 15 samples at 60 second intervals during the tone sequence. A spontaneous skin conductance response was defined as a characteristically shaped phasic elevation of .05μS or more. A skin conductance orienting response was defined as a phasic elevation of .05μS or more with its onset between 1 and 3 seconds from the onset of a tone. Criteria for estimating the amplitude and temporal variables of the SCORs were defined on the basis of standard criteria[13] as described in Section 3.1.2.

Habituation of the SCOR was defined as three successive failures to respond to the tones. Counting the number of trials to the habituation point gave one measure of habituation rate. Another measure of this phenomenon, here called the X-intercept, was determined by calculating the regresion equation for the rate of decline of the SCOR amplitudes over the tone series. From the equation, $Y = aX + b$ where a is the slope of the regression line, b is the Y axis intercept, Y is the SCOR amplitude and X is the number of tone presentations, the value for X was calculated for a Y value of 0. This gives a projected estimate of the point at which the regression line representing the rate of SCOR amplitude decline reaches zero and thus provides an index of habituation rate. Although when the rate of change of SCOR amplitude is measured for a sample of experimental subjects the decline fits an exponential pattern, in a single case linearity is approximated. Hence, the linear equation $Y = aX + b$ can be justified to yield an estimate of habituation in the individual case but not for a whole sample where mean SCOR amplitude across subjects is the dependent variable.

Table 5.4.2.1

Skin Conductance Variables

(a) Mean values for each of the following variables were obtained from the *left* and *right* hands during the *resting* (pre-tone), *tone* and *post-tone* periods.

SCL	Skin Conductance Level (μS)
NSSCR	Number of Spontaneous Skin Conductance Responses (Number per minute)
ASSCR	Amplitude of Spontaneous Skin Conductance Response (μS)

(b) Values for each of the following variables were obtained from the *left* and *right* hands during the *tone* habituation sequence.

Lat.	Latency of the Skin Conductance Orienting Response (SCOR) (Sec.)
Ris t.	Rise time of the SCOR (Sec.)
Rec t/2	Half recovery time of the SCOR (Sec.)
AOR	Amplitude of the SCOR (μS)
NOR	Number of SCORs
TTH	Number of trials to habituation of the SCOR
XINT	X-intercept, a measure of habituation in addition to TTH

Using the three trials of no response to define habituation, a number of skin conductance orienting response categories could be defined as follows. Non-responders (NR) were those who failed to show a SCOR to the first and subsequent tones, fast-habituators (FH) were defined as those who responded only to the first or first and second tones and non-habituators (NH) were those who continued to show a SCOR throughout the tone sequence (i.e. more than 17 responses in the present protocol). A fourth group could be designated intermediate habituators (IH) and comprised those who habiatuated between the third and seventeenth tones. So few subjects responded to the dishabituating (21st) tone at the end of the sequence that analysis of the phenomenon of dishabituation was not undertaken in the present study.

CHAPTER 6

RESULTS

6.1. COMPARISON OF GROUP CHARACTERISTICS.

Three groups comprised the main subject pool of this study. They were designated schizophrenia (N=24), major depression (N=20) and normal control (N=35). According to DSM-III criteria, the schizophrenic group contained three subjects with a diagnosis of schizophreniform disorder at the time of testing. However, these subjects were followed over several months and each case eventually met the DSM-III duration criteria for schizophrenia. They have therefore been included within the schizophrenic group. The distribution of DSM-III diagnostic subtypes at the time of entry into the study is shown in Table 6.1.1.

Table 6.1.1

Distribution of DSM-III Diagnostic Subtypes

SCHIZOPHRENIA			DEPRESSION	
Schizophreniform disorder*		3	Major Depressive Disorder:	
Schizophrenia:	Disorganized	2	with psychotic features	5
	Catatonic	1	with melancholia	8
	Paranoid	10	without melancholia	7
	Undifferentiated	6		
	Residual	2		
		24		20

*All subjects with schizophreniform disorder at the time of testing subsequently met DSM-III duration criteria for schizophrenia.

The age, sex and handedness characteristics of these three groups are summarized in Table 6.1.2. It can be seen that the schizophrenic and control groups were well-matched for age. The depressed group was significantly older than both of these. This was not unexpected as the control subjects were chosen for their likely age compatability with the schizophrenic rather than the depressed group. Although the male:female ratio was 2:1 in schizophrenia, there was no significant difference in sex distribution when the schizophrenic and control groups were compared (χ^2 = 2.516, 1df). Within each group males and females showed no significant differences in age. Likewise, handedness classification did not differ significantly between the groups, even with separate comparisons of schizophrenia with control (χ^2 = 0.616, 2df) and depression with control (χ^2 = 3.768, 2df). Nevertheless when the number of right-hand responses (of the 12 items in the Annett handedness questionnaire) were compared across the three groups there was a tendency for the depressed group to appear more strongly right-dominant than the control group. The schizophrenic and control groups did not differ on this parameter.

In summary, the schizophrenic and control subjects showed satisfactory compatibility in terms of age, sex and handedness. The depressed group, however, were significantly older than the other groups and showed a tendency to differ from controls by virtue of a slightly stronger right-hand preference.

The schizophrenic and depressed groups were then compared on a number of background and clinical variables in those cases where such information was available or known to a reliable informant. Table 6.1.3 shows that schizophrenic subjects were younger at the onset of their illness than depressed subjects but that the absolute duration of illness did not differ between these two groups.

Table 6.1.2

Descriptive Characteristics of all Groups

Age, Sex, Handedness

	SCHIZOPHRENIA	CONTROL	DEPRESSION	
N	24	35	20	
		*p<.001		
(1) Mean Age (yr)	30.25	31.24	50.20	
		*p=NS	*p<.001	
(2) Sex: Male	16	16	10	χ^2=2.618 2 df
Female	8	19	10	p=NS
(3) Handedness:				
(a) Classification				
Left	1	4	0	χ^2=4.501
Right	14	25	16	4 df
Mixed	4	6	1	p=NS
(b) Mean Number of Right Hand Responses (out of 12)		**p=NS		
	10.47	9.20	11.47	
		**p=NS	**p<.010	

*Student's t-test, 2-tailed.
**Mann-Whitney U-test, 2-tailed.

Table 6.1.3

Comparison of Schizophrenic and Depressed Groups

Illness Onset and Duration

	SCHIZOPHRENIA	DEPRESSION	p*
Age at Illness Onset (yr)	25.26	44.72	<.001
Duration of Illness (yr)	4.20	5.15	NS

*Student's t-test. 2-tailed.

Although the two clinical groups did not differ in terms of duration of the current illness episode, the depressed group had experienced more severe recent stress and showed significantly higher levels of adaptive functioning in the past year than their schizophrenic counterparts, according to the DSM-III ratings (Table 6.1.4).

Further comparisons between these two groups are shown in Table 6.1.5. Schizophrenic subjects were more likely than depressed subjects to have never married. This is mirrored by the finding that in this sample 50% of schizophrenic subjects compared to 5% of those with depression were living in their family of origin, whereas 23% of schizophrenic subjects and 75% in the depressed group were living with a spouse and/or their own offspring. Only 23% and 15% respectively were living alone at the time of hospitalization. From their developmental histories it appeared that schizophrenic subjects were more likely to show developmental delays in the acquisition of motor skills and/or speech and to exhibit a variety of childhood behavioural

Table 6.1.4

Comparison of Schizophrenic and Depressed Groups

Duration of illness episode, severity of stress, level of function

		SCHIZOPHRENIA	DEPRESSION	Mann-Whitney U-test
DURATION OF CURRENT ILLNESS EPISODE	<1 week	2	0	
	1-3 weeks	3	3	U=153.0
	1-6 months	8	13	z=-0.302
	7-12 months	1	2	p=NS
	>1 year	3	1	
SEVERITY OF PSYCHOSOCIAL STRESSORS (DSM-III AXIS 4)	Unknown	2	0	
	None	8	0	
	Minimal	2	3	U=91.0
	Mild	5	4	z=3.576
	Moderate	7	4	p=.0003
	Severe	0	7	
	Extreme	0	2	
HIGHEST LEVEL OF ADAPTIVE FUNCTIONING IN PAST YEAR (DSM-III AXIS 5)	Unknown	1	0	
	Superior	0	0	
	Very good	1	1	U=94.5
	Good	2	9	z=3.567
	Fair	2	8	p=.0004
	Poor	14	2	
	Very poor	4	0	

symptoms such as temper tantrums, bed-wetting, thumb-sucking, nail-biting, head-banging, school refusal and sleep disturbance. The groups did not differ in terms of previous psychiatric hospitalization or presence of previous suicide attempts. However, the number of previous suicide attempts showed a tendency to be greater in the depressed group, but this difference fell just short of statistical significance (Mann-Whitney, U=135.0, z=-1.816, p=.069). Schizophrenic subjects were also more likely to have been admitted involuntarily under certificate.

Table 6.1.5

Comparison of Schizophrenic and Depressed Groups

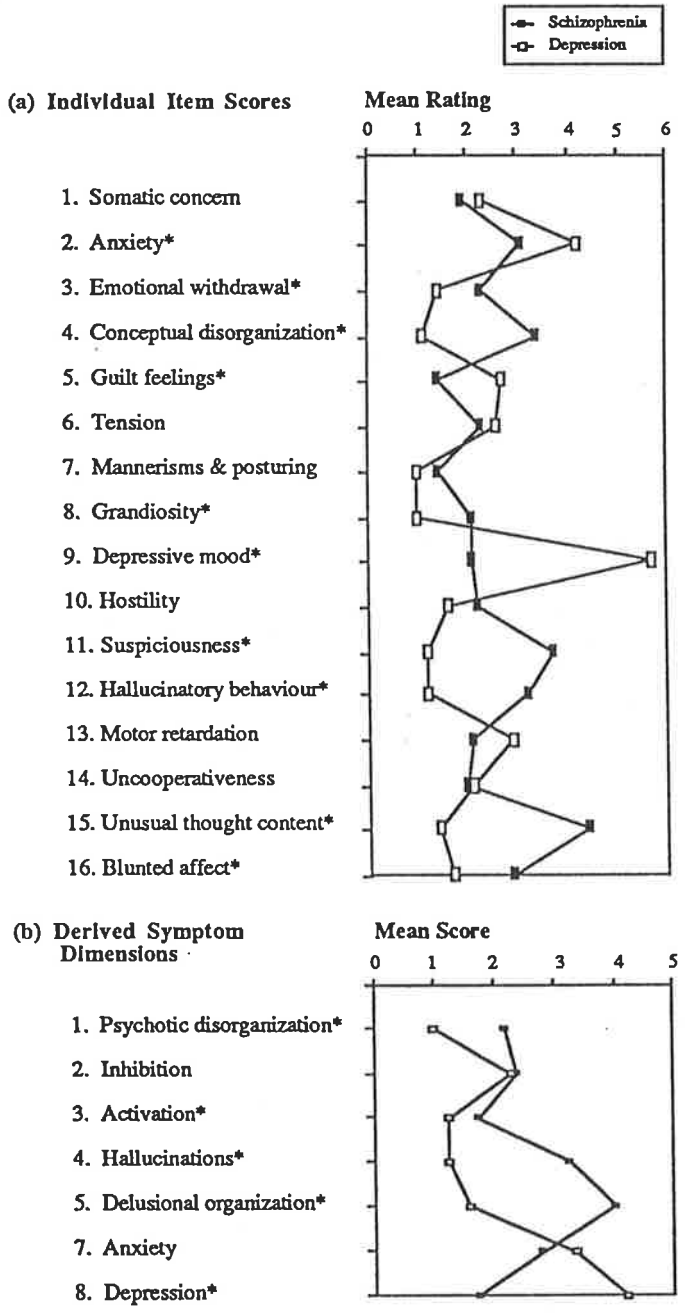
	SCHIZOPHRENIA	DEPRESSION	χ^2
MARITAL STATUS			
Never Married	14	3	χ^2=7.746
Married at some time	8	16	1 df
			p=.0054
COMPLICATED PREGNANCY AND/OR BIRTH			
Present	0	1	χ^2=0.000
Absent	16	15	1 df
			p=NS
DEVELOPMENTAL MOTOR AND/OR SPEECH DELAY			
Present	5	0	$\chi^2$4.066
Absent	11	17	1 df
			p=.0437
CHILDHOOD NEUROTIC OR BEHAVIOURAL PROBLEMS			
Present	10	3	χ^2=3.880
Absent	8	14	1 df
			p=.0489
PREVIOUS PSYCHIATRIC HOSPITALISATIONS			
None	7	8	χ^2=0.190
One or more	17	12	1 df
			p=NS
PREVIOUS SUICIDE ATTEMPTS			
None	15	10	χ^2=0.279
One or more	9	10	1 df 1
			p=NS
ADMISSION STATUS			
Voluntary	12	18	χ^2=3.958
Detained	7	1	1 df 1
			p=.0466

At the time of testing, the average duration of hospitalisation was 4.9 days for the schizophrenic group (range <1 to 13) and 2.5 days for the depressed group (range 1 to 7). This difference can be accounted for by the fact that the Hillcrest Hospital sample had been hospitalized somewhat longer (mean 6.4 days; range 2 to 13) than those at the Royal Adelaide Hospital (mean 3.8 days; range <1 to 10).

As expected, the symptom profiles of the two clinical groups were quite different. They are illustrated in Figures 6.1.1. and 6.1.2. Not surprisingly, the schizophrenic group peaked on psychotic symptom items whereas the depressed group peaked on affective symptoms.

In summary, the schizophrenic group differed from the depressed group by virtue of their earlier age at illness onset, lower levels of recent stress and poorer functional level. Schizophrenic subjects were also more likely to have never married, shown developmental milestone delay and to have exhibited neurotic or behavioural symptoms in childhood. The depressed group tended to have made more suicide attempts and, not surprisingly, differed from the schizophrenic subjects in terms of symptom profile. Overall duration of illness was the same in each group. The schizophrenic and control subjects were relatively well matched for age, sex and hand preference, whereas the depressed subjects were significantly older than the controls and may have been more strongly right-hand dominant. This age difference was not unexpected as controls were chosen for their likely age compatibility with the schizophrenic sample in which a lower age range was anticipated.

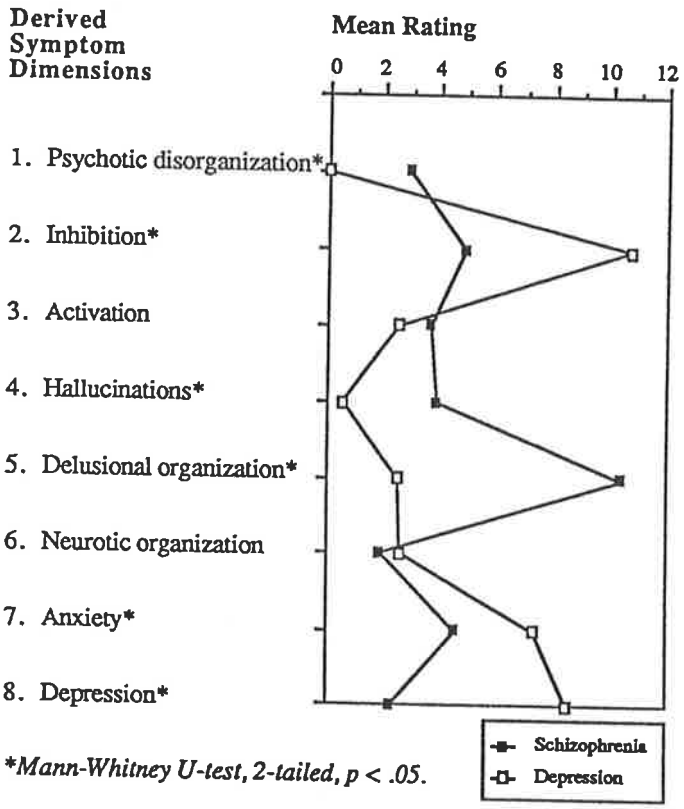
Figure 6.1.1



**Mann-Whitney U-test, 2-tailed, $p < .05$.*

BPRS symptom profile.

Figure 6.1.2



**Mann-Whitney U-test, 2-tailed, $p < .05$.*

PSE symptom dimensions.

6.2 SCHIZOPHRENIA

6.2.1 Tonic arousal.

It was predicted that acutely psychotic schizophrenic subjects would have increased levels of tonic arousal compared to normal controls. To test this hypothesis a comparison was made of log transformed skin conductance levels (SCL) and square root transformed spontaneous response frequencies (NSSCR) between the schizophrenic and control groups using Students' t-test. The data were transformed in this way in order to achieve normalization of the skewed raw SCL and NSSCR data. These analyses were performed on data derived from both hands prior to and during the tone sequence. The results are shown in Tables 6.2.1.1 and 6.2.1.2. One-tailed tests of significance were used in each case owing to the direction of difference predicted. The findings leave no doubt that the schizophrenic subjects had higher levels of tonic arousal than their normal counterparts. All eight statistical tests reached significance in the predicted direction. The NSSCR measure of tonic arousal seemed to be somewhat more robust than SCL in distinguishing the two groups, judging from the level of significance of p for this variable.

Table 6.2.1.1

Comparison of Skin Conductance Levels (log transformed)

between Schizophrenic and Normal Control Groups

Log_{10} SCL (μS)

		SCHIZOPHRENIA			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
Pre-Tone:	Left	24	.865	.074	35	.703	.055	.040
	Right	24	.883	.067	35	.703	.052	.018
Tones:	Left	24	.899	.072	35	.733	.058	.039
	Right	24	.921	.065	35	.723	.052	.010

*Student's t-test, one-tailed

Table 6.2.1.2

Comparison of Number of Spontaneous Skin Conductance Responses

(√ transformed) between Schizophrenic and Normal Control Groups

√NSSCR (N/Min)

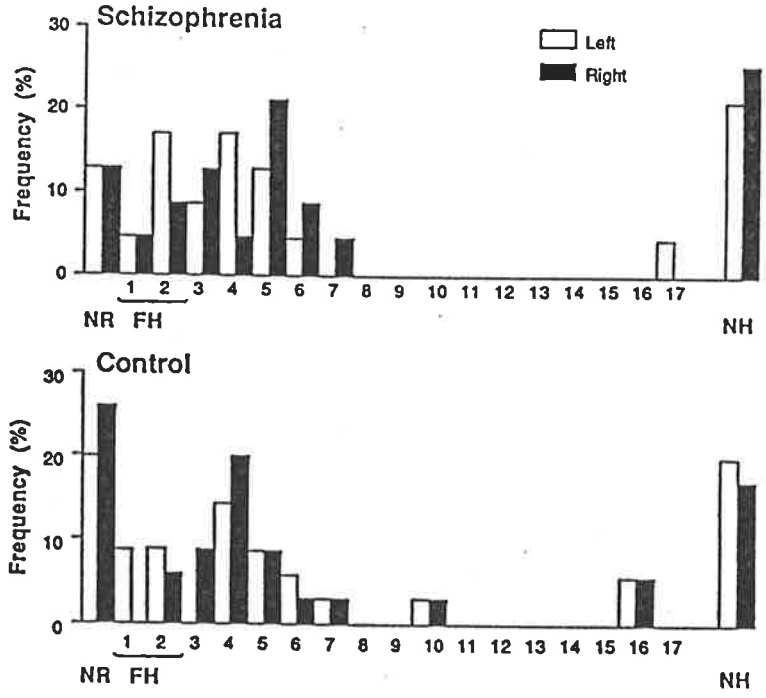
		SCHIZOPHRENIA			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
Pre-Tone:	Left	24	1.360	.197	35	.821	.143	.014
	Right	24	1.538	.197	35	.768	.139	.001
Tones:	Left	24	1.409	.172	35	.937	.085	.010
	Right	24	1.531	.174	35	.972	.078	.003

*Student's t-test, one-tailed

6.2.2 Orienting Activity.

One prediction consistent with the sensory gating hypothesis of acute schizophrenic psychosis was that of increased orienting activity in the schizophrenic group compared to normal controls. The first test of this prediction was to examine the proportions of non-responders versus non-habituators in each group. The histograms in Figure 6.2.2.1 which show the distributions of trials to habituation suggest that there were fewer non-responders in the schizophrenic group, consistent with the hypothesis, whereas the proportions of non-habituators look about the same.

Figure 6.2.2.1



Distribution of trials to habituation.

Non-responders were combined with fast habituators to create an 'under-responder' group which was compared with a late- or non-habituator ('over-responder') group in schizophrenic and control subjects using χ^2 analysis (Table 6.2.2.1). This yielded no significant differences for either the left or right hands.

Table 6.2.2.1

Distributions of Under-responders and Over-responders in Schizophrenia Compared to Normal Controls

	SCHIZOPHRENIA	CONTROL	
LEFT HAND			
Non-Responders and Fast Habituators	8	13	χ^2 =0.000 df=1 p=NS
Non-/Late Habituators	6	9	
RIGHT HAND			
Non-Responders and Fast Habituators	6	11	χ^2=0.004 df=1 p=NS
Non-/Late Habituators	6	8	

Similarly, a comparison of the number of orienting responses between schizophrenic and control subjects for left and right hands (Table 6.2.2.2) revealed no significant differences.

Table 6.2.2.2

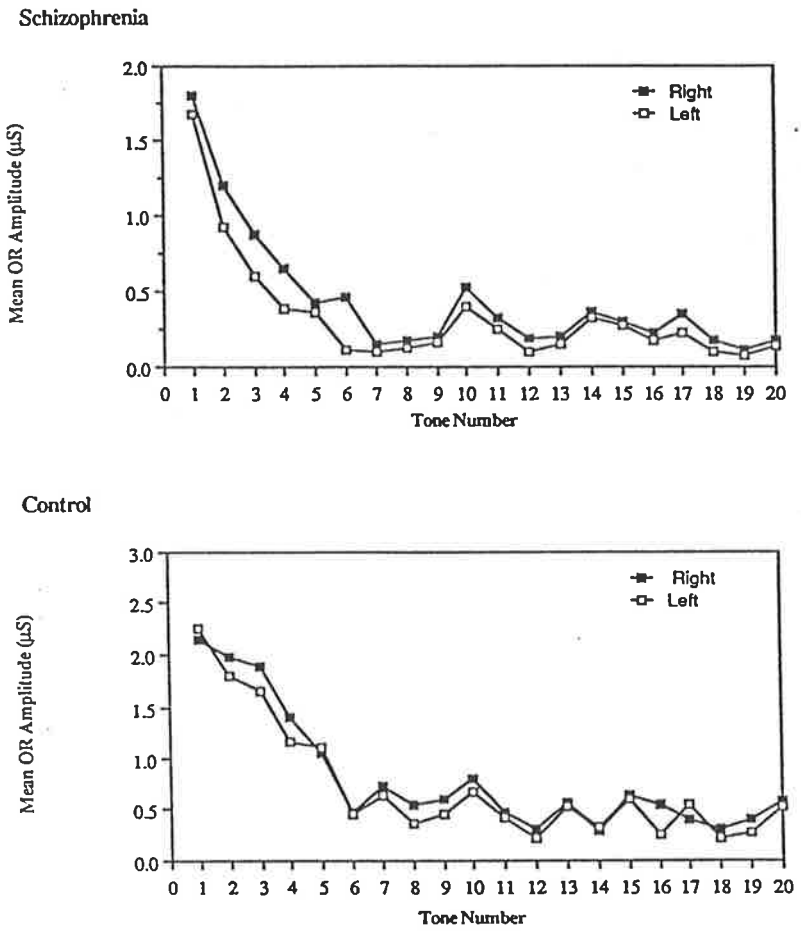
Comparison of Number of Orienting Responses
Between Schizophrenic and Normal Control Groups

Mean Number of ORs

	Schizophrenia	**Control**	Mann-Whitney U-test
Left	6.04	6.31	U = 405.5 z = -.2253 p = NS
Right	6.63	5.71	U = 367.5 z = -.8170 p = NS

Having failed to confirm the hypothesis of increased responsiveness in schizophrenia compared to normal controls, an examination of habituation to the tones was undertaken. The central hypothesis in this instance was that the expected higher levels of orienting activity in schizophrenia would be reflected in delayed habituation to the tones. Habituation curves for schizophrenic and normal control subjects are shown in Figure 6.2.2.2.

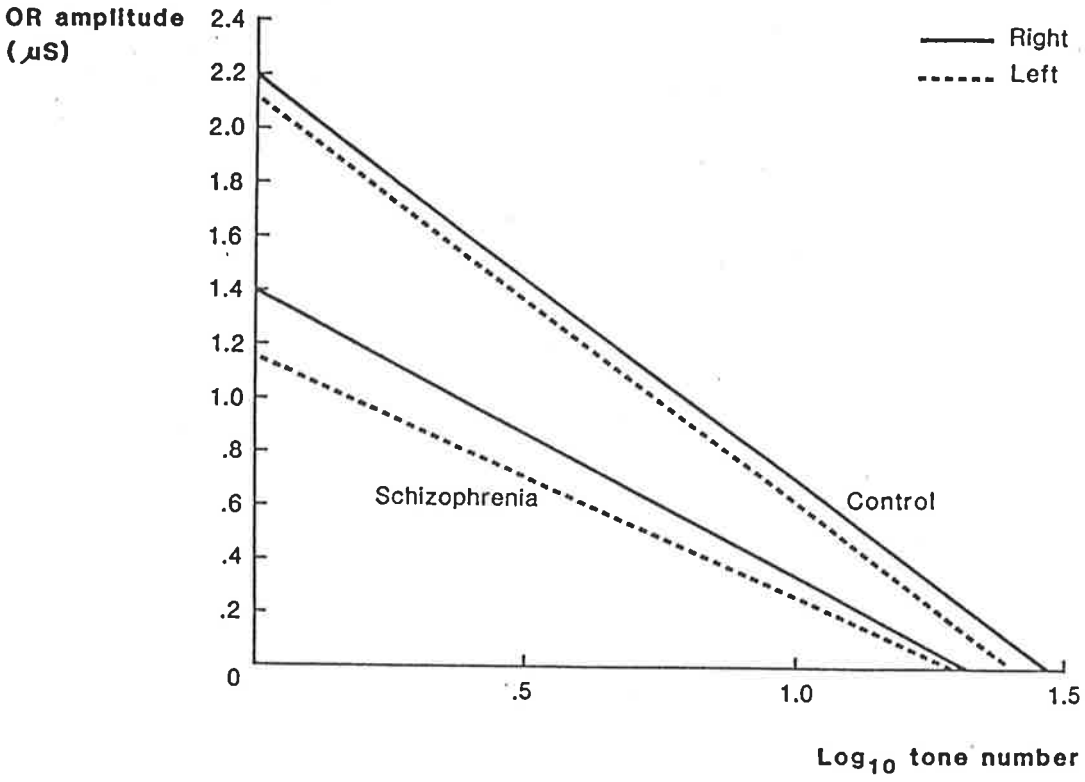
Figure 6.2.2.2



Habituation curves for schizophrenic and control subjects.

These curves suggest that, if anything, the schizophrenic group, contrary to prediction, habituated earlier than the control group rather than later. This is even more striking when the decline in OR amplitudes is plotted against the log of the tone number. An illustration of this, the habituation slopes for each group, can be seen in Figure 6.2.2.3 where the X-axis intercept provides an estimate of the habituation point.

Figure 6.2.2.3



Habituation slopes for OR amplitude decline against $\log_{10}$ tone number (X-axis intercepts).

From inspection of this figure, it appears unlikely that habituation, as represented by the X-axis intercept, differs between the two groups of subjects. This impression was tested by comparing two measures of habituation across the subject groups, namely, (1) the number of trials to habituation as measured by three successive failures to respond and (2) the X-axis intercept as described in Section 5.4.2. As shown in Table 6.2.2.3, neither measure differed significantly between the schizophrenic and control groups.

Table 6.2.2.3

Comparison of Habituation between Schizophrenic and Normal Control Groups

		SCHIZOPHRENIA	CONTROL	Mann-Whitney U-Test
Median Trials to Habituation				
	Left	4.00	4.00	U=139.0 ; z = -.901 p = NS
	Right	5.00	4.00	U=136.0 ; z = -.474 p = NS
Median X-Axis Intercept				
	Left	5.50	5.85	U=374.0 ; z = -.278 p = NS
	Right	4.95	5.60	U=336.5 ; z = -.082 p = NS

Abbreviation of the temporal characteristics of the OR has been associated with increased numbers of ORs and, therefore, one final method of comparing orienting activity between schizophrenic and control subjects would be to examine these variables. This was thought to be of particular interest given the literature reporting fast

recovery times in those premorbidly vulnerable to develop schizophrenia (Section 3.2.1). Comparisons were made of latencies, risetimes and half recovery times for the left and right hands between schizophrenic and control groups. The results are shown in Table 6.2.2.4 where both values for the first OR and mean of all ORs are compared. Log transformations were used to normalize the data. As can be seen, no significant differences were found.

Table 6.2.2.4

Comparison of OR Temporal Variables (log transformed) between Schizophrenic and Normal Control Groups

Log_{10} OR Temporal Variables (Sec).

		SCHIZOPHRENIA			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
First OR								
Left:	Lat	21	.326	.017	28	.320	.013	NS
	Rist	20	.367	.034	26	.333	.029	NS
	Rec t/2	12	.923	.105	8	.909	.114	NS
Right:	Lat	21	.347	.018	26	.351	.016	NS
	Rist	19	.366	.033	25	.333	.026	NS
	Rec t/2	12	.806	.113	7	.801	.148	NS
Mean OR								
Left:	Lat	21	.336	.014	28	.337	.010	NS
	Rist	20	.284	.027	28	.300	.020	NS
	Rec t/2	19	.853	.074	24	.891	.053	NS
Right:	Lat	21	.358	.012	26	.363	.010	NS
	Rist	21	.283	.027	26	.285	.022	NS
	Rec t/2	21	.787	.079	25	.839	.063	NS

*Student's t-test.

In summary, therefore, schizophrenic and control subjects, contrary to prediction, did not differ on any measure of orienting activity. This included comparisons of the proportion of 'under-responders' versus 'over-responders', the number of ORs, rate of habituation and the temporal parameters of the OR.

6.2.3 Response amplitude.

It was predicted that stimulus-elicited and spontaneous skin conductance responses would be greater in amplitude in schizophrenia compared to normal controls. Comparisons were therefore made in these variables between the two groups of subjects. Amplitude figures were first log transformed in order to normalize the data. The results are summarised in Tables 6.2.3.1 and 6.2.3.2.

Table 6.2.3.1

Comparison of OR Amplitudes (log transformed)
Between Schizophrenic and Normal Control Groups

Log_{10} OR Amplitude (μS)

		SCHIZOPHRENIA			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
First OR Amp:	Left	20	.376	.047	26	.369	.065	NS
	Right	19	.407	.042	25	.364	.063	NS
Mean OR Amp:	Left	20	.261	.036	28	.320	.040	NS
	Right	21	.298	.037	26	.320	.045	NS

*Student's t-test

It is obvious from inspection of these results that neither OR amplitudes nor SSCR amplitudes differ significantly between schizophrenic and normal control subjects. This was the case for either hand, first OR and mean OR amplitudes and, in the case of SSCRs, whether before or during the tone sequence.

Table 6.2.3.2.

Comparison of SSCR Amplitudes (log transformed) between Schizophrenic and Normal Conrol Groups

Log_{10} SSCR Amplitude (μS)

		SCHIZOPHRENIA			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
Pre-Tone:	Left	20	.114	.017	21	.116	.021	NS
	Right	20	.146	.021	21	.120	.021	NS
Tones:	Left	22	.140	.024	32	.163	.034	NS
	Right	22	.156	.025	32	.133	.020	NS

*Student's t-test

These findings suggest that there is no greater capacity allocation to the limited-channel sequential processor in schizophrenia compared to normal controls.

6.2.4 Lateral Asymmetry.

It was predicted that in schizophrenia right-greater-than-left asymmetries would occur, relative to controls, in tonic arousal (SCL, NSSCR), response amplitudes (OR and SSCR amplitudes) and orienting activity (number of ORs and habituation point). These predictions were in keeping with the theory of dominance of right hemisphere activation relative to left (i.e. underactive left hemisphere-specialized processing) in schizophrenia.

Tonic arousal measures were examined first by comparing left-sided SCL and NSSCR (both prior to and during the tone sequence) with those on the right side using the Wilcoxon matched-pairs test. As shown in Table 6.2.4.1, there was no significant difference between left-and-right-sided SCL in either the schizophrenic or the control group. However, the NSSCR was significantly greater on the right than on the left side in the schizophrenic group but not in the normal control group.

Another way of examining tonic arousal asymmetry is to first compute a laterality index as follows:

$$\frac{2\,(R-L)}{R+L}$$

where R is the right-sided skin conductance variable and L is the corresponding left-sided variable. The index thus ranges from -2 to +2 and is positive when right is greater than left and negative when the asymmetry is in the opposite direction. The laterality index thus enables asymmetries to be compared across groups.

Table 6.2.4.1

Lateral Asymmetry of Tonic Arousal Measures: Within Group Comparisons

		SCHIZOPHRENIA				CONTROL			
		MEDIAN		Wilcoxon Matched-pairs		MEDIAN		Wilcoxon Matched-pairs	
		Left	Right	z	p*	Left	Right	z	p
SCL: (μS)	Pre-Tone	8.26	8.70	-.486	NS	5.50	5.46	-.164	NS
	Tones	8.06	9.15	-.543	NS	6.32	5.82	-.162	NS
NSSCR: (N/min)	Pre-Tone	1.80 <	2.50	-1.821	.034	0.25	0.40	-.803	NS
	Tones	2.13 <	2.90	-1.941	.026	1.13	0.93	-.103	NS

*One-Tailed

Table 6.2.4.2 shows the results of comparisons between the two subject groups of laterality indices based on SCL and NSSCR. Student's t-test was appropriate as all laterality index data is normally distributed. It can be seen that there was no satistically significant difference between the two groups and, in particular, the NSSCR asymmetry in schizophrenia noted in the within-group comparisons (Table 6.2.4.1) passed undetected by this method of statistical analysis.

Table 6.2.4.2

Lateral asymmetry of Tonic Arousal Measures: Comparison of Laterality Indices Across Groups

$$\text{Laterality Index} = \frac{2\,(R-L)}{R + L}$$

		SCHIZOPHRENIA			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
SCL:	Pre-Tone	24	+0.041	0.061	35	+0.004	0.074	NS
	Tones	24	+0.053	0.060	35	-0.016	0.073	NS
NSSCR:	Pre-Tone	24	+0.140	0.139	35	-0.034	0.131	NS
	Tones	24	+0.163	0.090	35	+0.117	0.142	NS

*Student's t-test

Asymmetry of response amplitudes was examined in a similar way. Left- and right-sided SSCR and OR amplitudes were first compared within the subject groups using the Wilcoxon matched-pairs test as shown in Table 6.2.4.3. In contrast to normal controls it can be seen that in the schizophrenic group there is a consistent right-greater-than-left amplitude asymmetry both in SSCR and OR.

When laterality indices were computed using the amplitude data (according to the method described above in relation to tonic arousal) there emerged a clear difference in amplitude asymmetry between the schizophrenic and normal control groups.

Table 6.2.4.3

Lateral Asymmetry of Response Amplitudes: Within Group Comparisons

Amplitude (μS)

	SCHIZOPHRENIA				CONTROL			
	MEDIAN		Wilcoxon Matched-pairs		MEDIAN		Wilcoxon Matched-pairs	
	Left	Right	z	p*	Left	Right	z	p
SSCR Amp:								
Pre-Tone	.21	< .29	-1.397	.081	.18	.33	-.028	NS
Tones	.27	< .35	-2.256	.012	.26	.21	-.931	NS
OR Amp:								
First OR	1.18	< 1.40	-2.036	.021	1.00	1.20	-.616	NS
Mean OR	.68	< .85	-2.233	.013	1.05	1.19	-.579	NS

* One-Tailed

Although the difference in laterality index failed to reach statistical significance for the SSCR amplitude prior to the tone sequence, there was a group difference for this variable during the tones. As far as OR amplitude asymmetries were concerned, there was a clear difference in the laterality index between schizophrenic and normal subjects, in the predicted direction, on the basis of the first OR amplitude and also the mean OR amplitude. These results are summarized in Table 6.2.4.4. Distributions of the laterality indices for schizophrenic and control groups are shown in Figure 6.2.4.1.

Table 6.2.4.4

Lateral Asymmetry of Response Amplitudes: Comparison of Laterality Indices Across Groups

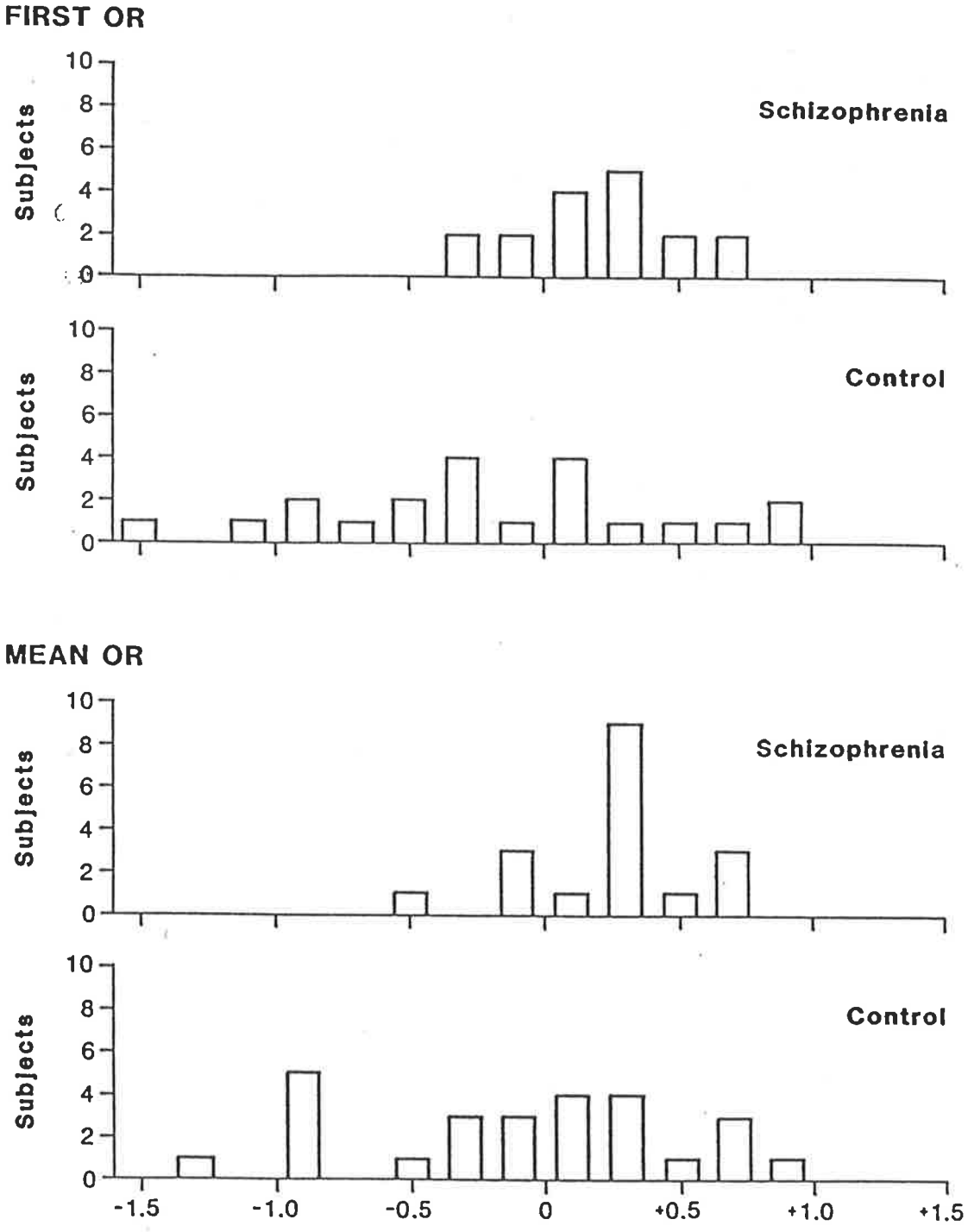
$$\textbf{Laterality Index} = \frac{2\,(R-L)}{R + L}$$

	SCHIZOPHRENIA			CONTROL			p*
	N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
SSCR Amp:							
Pre-Tone	19	+0.016	0.097	19	-0.023	0.127	NS
Tones	22	+0.137	0.091	31	-0.099	0.097	.048
OR Amp:							
First OR	19	+0.216	0.079	22	-0.172	0.140	.011
Mean OR	20	+0.306	0.077	25	-0.114	0.126	.004

*Student's t-test, one-tailed.

Asymmetries of orienting activity were also examined using within-group and between-group comparisons. There were no asymmetries within the control group. In the case of schizophrenia, however, the number of ORs and the number of trials to habituation was significantly greater on the right than the left side, as predicted. Paradoxically, the other index of habituation, the X-intercept, showed the opposite asymmetry, namely left greater than right. These results are shown in Table 6.2.4.5.

Figure 6.2.4.1



Laterality indices for orienting response amplitude asymmetries: first and mean ORs in schizophrenic and control groups.

Table 6.2.4.5

Lateral Asymmetry of Orienting Activity: Within Group Comparisons

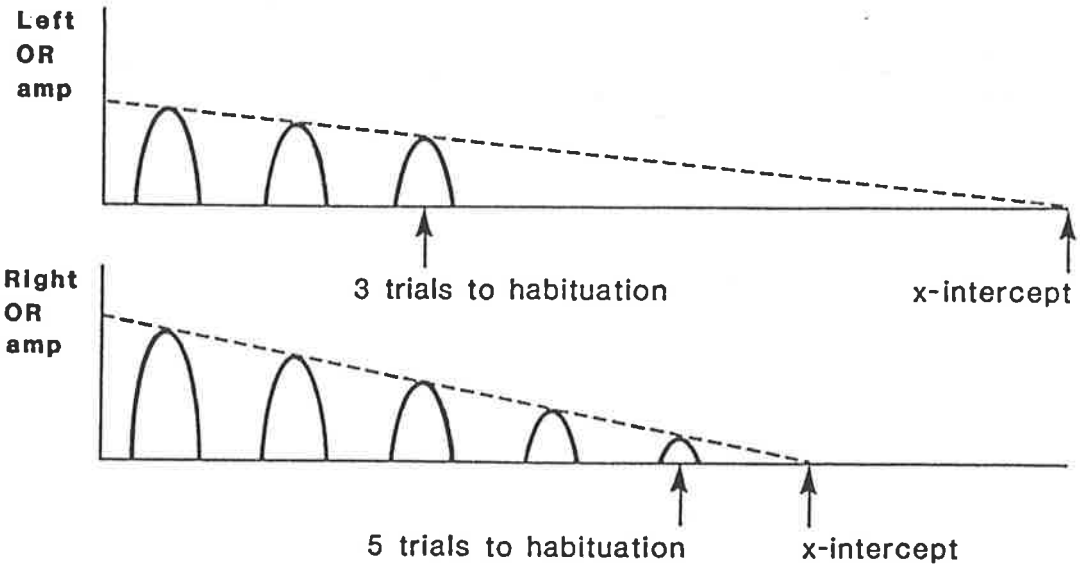
	SCHIZOPHRENIA				CONTROL			
	MEDIAN		Wilcoxon Matched-pairs		MEDIAN		Wilcoxon Matched-pairs	
	Left	Right	z	p*	Left	Right	z	p
Number of ORs	4.0	< 4.5	-2.446	.007	4.0	4.0	-.592	NS
Trials to habituation	4.0	< 5.0	-2.023	.022	4.0	4.0	-.210	NS
X-Intercept	5.50	4.95	-2.243	.025**	5.70	4.40	-.445	NS

* One-tailed

** Two-tailed test: direction of asymmetry opposite to that predicted.

If these are valid findings then they suggest that the *rate* of OR habituation as indicated by the X-intercept is *slower* on the left than the right in schizophrenia but the actual *cessation* of responding occurs *earlier* on the left than the right as indicated by the relatively fewer trials to habituation on the left, and this is mirrored in the fewer number of ORs on that side as well. A schematic representation of these findings is given in Figure 6.2.4.2

Figure 6.2.4.2



Schematic representation of asymmetries in number of ORs, trials to habituation and habituation rate as measured by the X-intercept for schizophrenic subjects. These patterns are consistent with the data in Table 6.2.4.5 and the OR amplitude asymmetries previously documented.

This pattern appears to be one in which the smaller left-sided ORs decline in amplitude more slowly than on the right with repeated presentations of the stimulus but then seem to 'cut out prematurely' - that is, before the habituation point predicted by the slope of the amplitude decline.

When the same data are examined in terms of laterality indices (see Table 6.2.4.6), the laterality index of the number of ORs differs significantly between the schizophrenic and control groups in the predicted direction. In contrast, the laterality indices of trials to habituation and the X-intercept did not differ significantly.

Table 6.2.4.6

Lateral Asymmetry of Orienting Activity: Between Group Comparisons

$$\text{Laterality Index} = \frac{2(R-L)}{R+L}$$

	SCHIZOPHRENIA			CONTROL			p*
	N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
Number of OR's	24	+0.108	0.044	35	-0.113	0.121	.047
Habituation:							
Trials to habituation	15	+0.159	0.075	20	+0.133	0.139	NS
X-Intercept	19	+0.096	0.041	25	-0.050	0.160	NS

*Student's t-test, one-tailed

6.2.5 Symptomatology.

6.2.5.1 The symptom dimension which was here assumed to be a manifestation of sensory gating failure was that of activation. The first of the symptom-related hypotheses was that there would be a positive correlation between activation and both tonic arousal (SCL, NSSCR) and orienting activity (i.e. increased number of ORs, delayed habituation, shorter temporal variables). There were two measures of activation, one based on the PSE and the other based on the BPRS. Spearman correlation coefficients were computed between each of these symptom measures in turn and the relevant skin conductance variables. No significant correlations emerged between activation symptoms and any of the measures of tonic arousal with either the BPRS or PSE scales. Similarly, none of the measures of orienting activity bore a significant correlation with activation symptoms except for that between the BPRS scale and the number of left-sided ORs ($\rho = .45$, $p < .05$). In view of the fact that this is an isolated finding it is likely to be due to chance alone and can therefore be ignored.

Laterality indices were computed according to the formula 2 (R-L)/(R+L)) for the estimates of tonic arousal (SCL, NSSCR), and orienting activity (number of ORs and habituation rate). Spearman correlation coefficients were then computed between these indices and the PSE and BPRS activation scales. None of these correlations reached statistical significance.

It is thus clear that the hypotheses based directly on the notion of sensory gating failure in schizophrenia have not been confirmed. The relationships which were predicted between activation symptoms and tonic arousal, orienting activity and right-greater-than-left asymmetry of both these skin conductance variables have not been found.

6.2.5.2 The next set of hypotheses centred on the symptom dimension of psychotic disorganization. Again there were two estimates of this dimension, one using the PSE and the other the BPRS. On inspection of the latter it emerged that only one schizophrenic subject scored on the BPRS item 'mannerisms and posturing' and this was a rating of 'mild'. In contrast, the other BPRS item which made up the psychotic disorganization scale, 'conceptual disorganization', overwhelmingly accounted for the scores obtained on this dimension. It was therefore decided to ignore the 'mannerisms and posturing' item and so the BPRS psychotic disorganization score was made up entirely of the clinical rating of 'conceptual disorganization'. The full PSE psychotic disorganization scale which comprised many items was retained as described in Appendix B.

The first set of predictions in relation to this symptom dimension was that response amplitude (taken to be an index of the magnitude of the 'call' for capacity allocation in the central channel and, by inference, an indirect estimate of the degree of mismatch between preattentive processes and STS), would correlate positively with severity of psychotic disorganization, the "core" psychotic process.

Table 6.2.5.2.1 summarizes the results of Spearman correlations between scores on the BPRS 'conceptual disorganization' item and the amplitudes of spontaneous and orienting responses. Highly significant positive relationships can be seen between this symptom dimension and spontaneous response amplitudes during the tones. These relationships were maintained although somewhat weakened during the tone sequence. The correlations between conceptual disorganization and the OR amplitudes reached statistical significance only on the left side. These relationships are illustrated graphically in Figure 6.2.5.2.1.

Table 6.2.5.2.1

Statistically Significant Spearman Correlation Coefficients
between Conceptual Disorganization (BPRS item)
and Amplitudes of Spontaneous and Orienting Responses

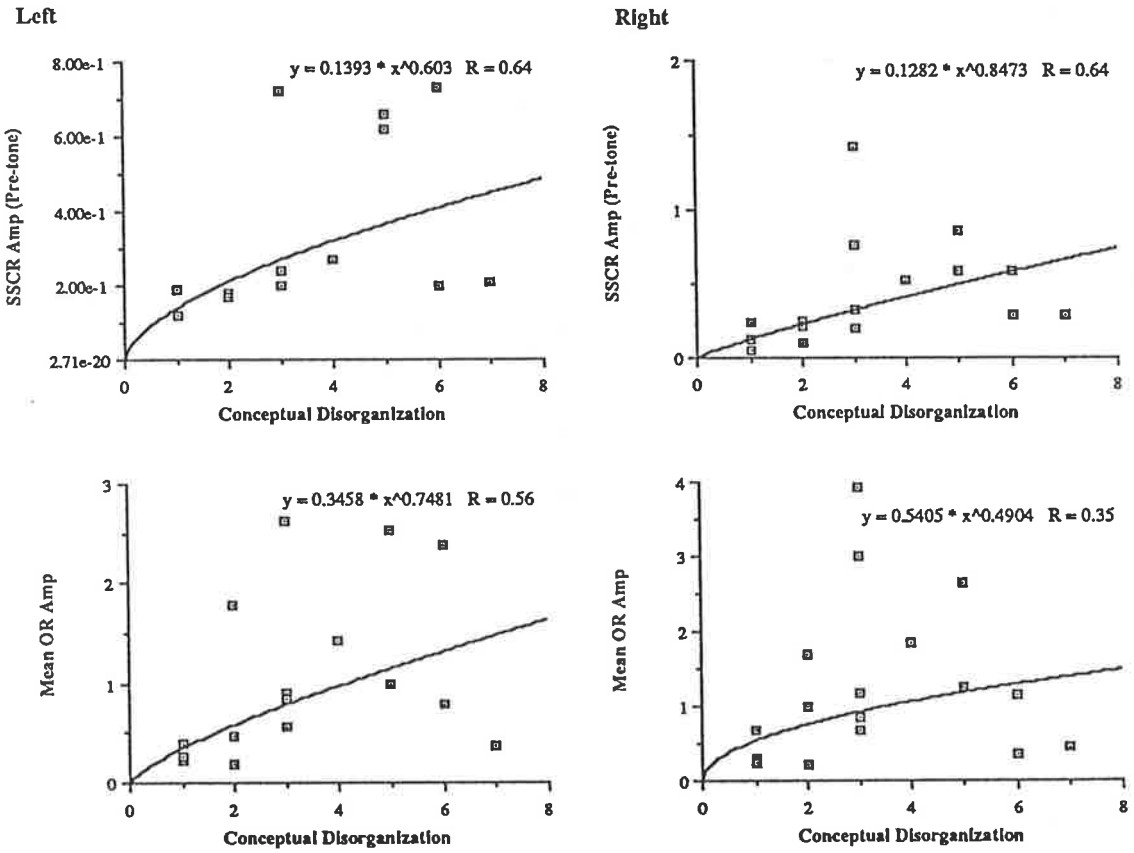
	Spearman ρ	
	Left	Right
SSCR Amplitude:		
Pre-tone	.75***	.64**
Tone	.50*	.56*
OR Amplitude:		
First OR	.47*	-
Mean OR	.48*	-

*** $p < .005$

** $p < .01$

* $p < .05$

Figure 6.2.5.2.1



Relationship between response amplitude and 'conceptual disorganization' (BPRS).

In contrast, the PSE scale of psychotic disorganization yielded only one statistically significant relationship and that was with pre-tone spontaneous response amplitude on the right side (Spearman ρ =.47, $p<.05$). Given that this was a single finding among eight statistical computations, the result may have been due to chance.

The secondary hypothesis under this section was that degree of psychotic disorganization would correlate with tonic arousal. Table 6.2.5.2.2 lists the Spearman correlation coefficients between the BPRS measure 'conceptual disorganization' and tonic arousal (SCL, NSSCR). No significant correlations were obtained with SCL but all of those between 'conceptual disorganization' and NSSCR were positive and significant at the $p<.05$ level. Again, the PSE measure of psychotic disorganization showed no statistically significant correlation with any of the tonic arousal measures.

Table 6.2.5.2.2

Statistically Significant ($p<.05$) Spearman Correlation Coefficients between Conceptual Disorganization (BPRS item) and Tonic Arousal Measures.

	Spearman ρ	
	Left	Right
SCL:		
Pre-tone	-	-
Tone	-	-
NSSCR:		
Pre-tone	.48	.46
Tone	.40	.52

6.2.5.3 In this section the relationships are examined between skin conductance variables and the group of symptoms thought to reflect the compensatory or corrective processes referred to as restricted attention and organization. It was proposed that the symptom dimensions which reflected these processes were inhibition (negative symptoms) and hallucinations/delusions respectively. Again, scales for these were derived from the PSE and BPRS ratings (see Appendix B). In addition to measuring symptom severity on these dimensional scales, three ratio (quotient) scales were derived from these dimensions using the following formula:

$$\text{Quotient Scale} = \frac{X}{Y+X}$$

The first quotient scale was the Inhibition Quotient (IQ) in which X = the score on the inhibition dimension and Y = the score on the activation dimension. This was thought to have a certain degree of face validity on the basis of the fact that many of the PSE items on the inhibition scale were polar opposites to corresponding items on the activation scale (e.g. 36 anergia and retardation vs 42 ideomotor pressure : 130 slow speech vs 131 pressure of speech : 128 blunted affect vs 123 hypomanic affect). Indeed the inhibition-activation relationship was conceived as a bipolar dimension when the present method of handling PSE data was developed. The IQ was therefore employed as a method of combining the activation and inhibition dimensions to form a bipolar scale: the higher the score, the more the inhibition symptoms 'outweigh' the activation symptoms and vice versa. Two IQ scales were constructed, one based on the PSE ratings and the other on the BPRS.

The second and third quotient scales were the Hallucination Quotient (HQ) and the Delusion Quotient (DQ). In the former, X = the score on the hallucination dimension and Y = the score on the psychotic disorganization dimension. In the DQ, X = the score on the delusion dimension and Y = the psychotic disorganization score.

There was an important theoretical reason for deriving these quotient scales. It was postulated that hallucinations and delusions represented proposed 'corrective' or 'compensatory' processes of perceptual and ideational organization, respectively, which arise in response to the 'core psychotic process' represented symptomatically by the psychotic disorganization dimension. A similar quotient has been described and used by Karson and Bigelow.[1] Referred to as the paranoid quotient, they used the ratio BPRS Item 4/(Item 11 + Item 4) to quantify paranoid symptoms in schizophrenia and thereby to distinguish paranoid from non-paranoid schizophrenia. They found that this method was more discriminatory than that obtained from examining either of the constituent items alone.[1] It was decided to adapt and extend this concept in the present study and do so separately in relation to hallucinations and to all delusions combined, not just those of paranoid type. Hence two HQ scales were derived, one based on the BPRS, the other on the PSE. Likewise, two DQ scales were derived on the basis of the symptom dimensions constructed from these two rating instruments.

I The first group of hypotheses to be tested were that the compensatory processes represented by the inhibition, hallucination and delusion dimensions would be *inversely* related to the magnitude of 'calls' for capacity allocation in the central channel as measured by response amplitude.

Table 6.2.5.3.1 lists the Spearman correlation coefficients between the two measures of inhibition symptoms, the dimension and the quotient, and the amplitudes of spontaneous and orienting responses. It can be seen that, as predicted, all of the correlations which reached statistical significance were negative. It is also apparent that the BPRS measure of this symptom group (motor retardation + blunted affect) produced higher correlation coefficients than the PSE measure. Some of these correlations are illustrated in Figure 6.2.5.3.1.

Table 6.2.5.3.1

Statistically Significant Spearman Correlation Coefficients between Inhibition Symptoms and Response Amplitudes

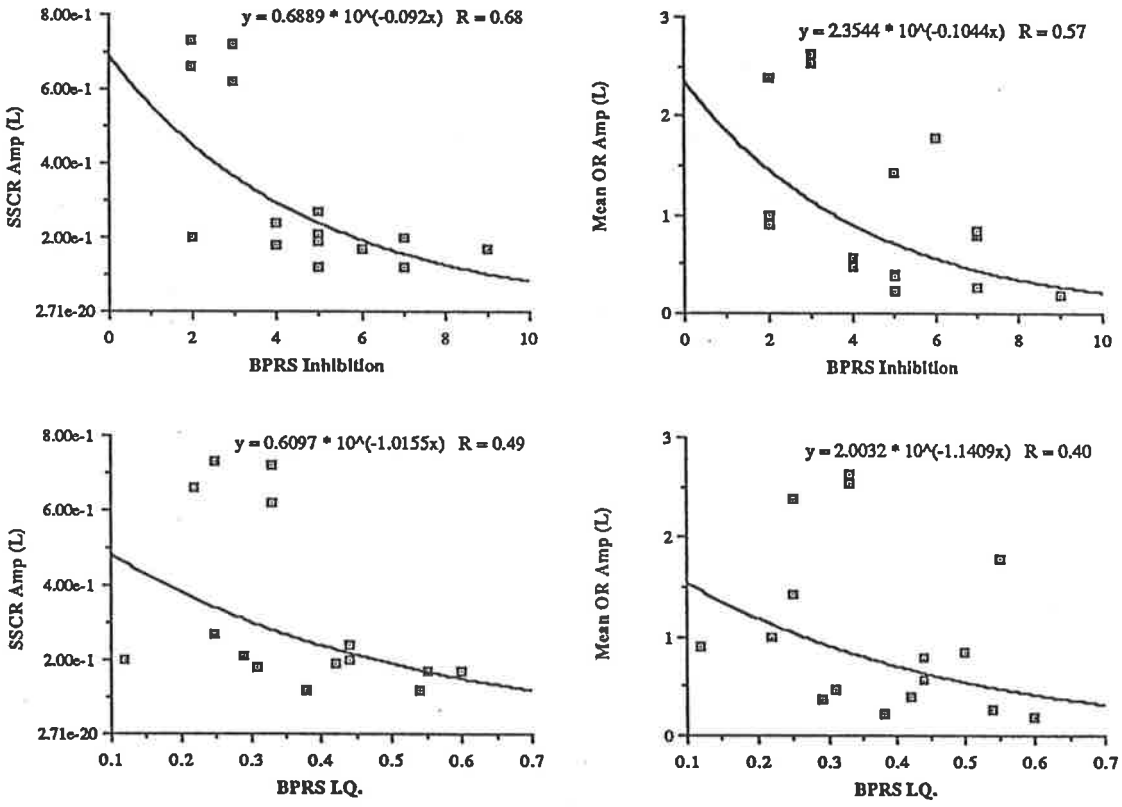
Spearman ρ

		SSCR Amplitude (pre-tone)		**OR Amplitude** First		**OR Amplitude** Mean	
		L	R	L	R	L	R
Inhibition Dimension	BPRS	-.72****	-.60***	-.50**	-.50**	-.57***	-.43**
	PSE	-.38*	-	-.35*	-.42**	-	-.32*
Inhibition Quotient+	BPRS	-.60***	-.44**	-	-.38*	-.40*	-
	PSE	-.48**	-	-	-.49**	-	-.48**

**** $p \leq .005$
*** $p \leq .01$
** $p \leq .05$
* $p \leq .10$

+ $IQ = \frac{\text{Inhibition}}{\text{Activation + Inhibition}}$

Figure 6.2.5.3.1



Relationship between BPRS measure of inhibition and response amplitudes.

Hallucinations were examined in a similar way and the results are displayed in the following table.

Table 6.2.5.3.2

Statistically Significant Spearman Correlation Coefficients

Between Hallucinations and Response Amplitudes

Spearman ρ

		SSCR Amplitude (pre-tone)		**OR Amplitude** First		**OR Amplitude** Mean	
		L	R	L	R	L	R
Hallucination Dimension	BPRS	-	-.45**	-.45**	-.67****	-.37*	-.63****
	PSE	-.39*	-.49**	-.46**	-.67****	-.39*	-.64****
Hallucination Quotient+	BPRS	-.64****	-.66****	-.62****	-.67****	-.56**	-.66****
	PSE	-.59***	-.64****	-.43**	-.52**	-.42**	-.55***

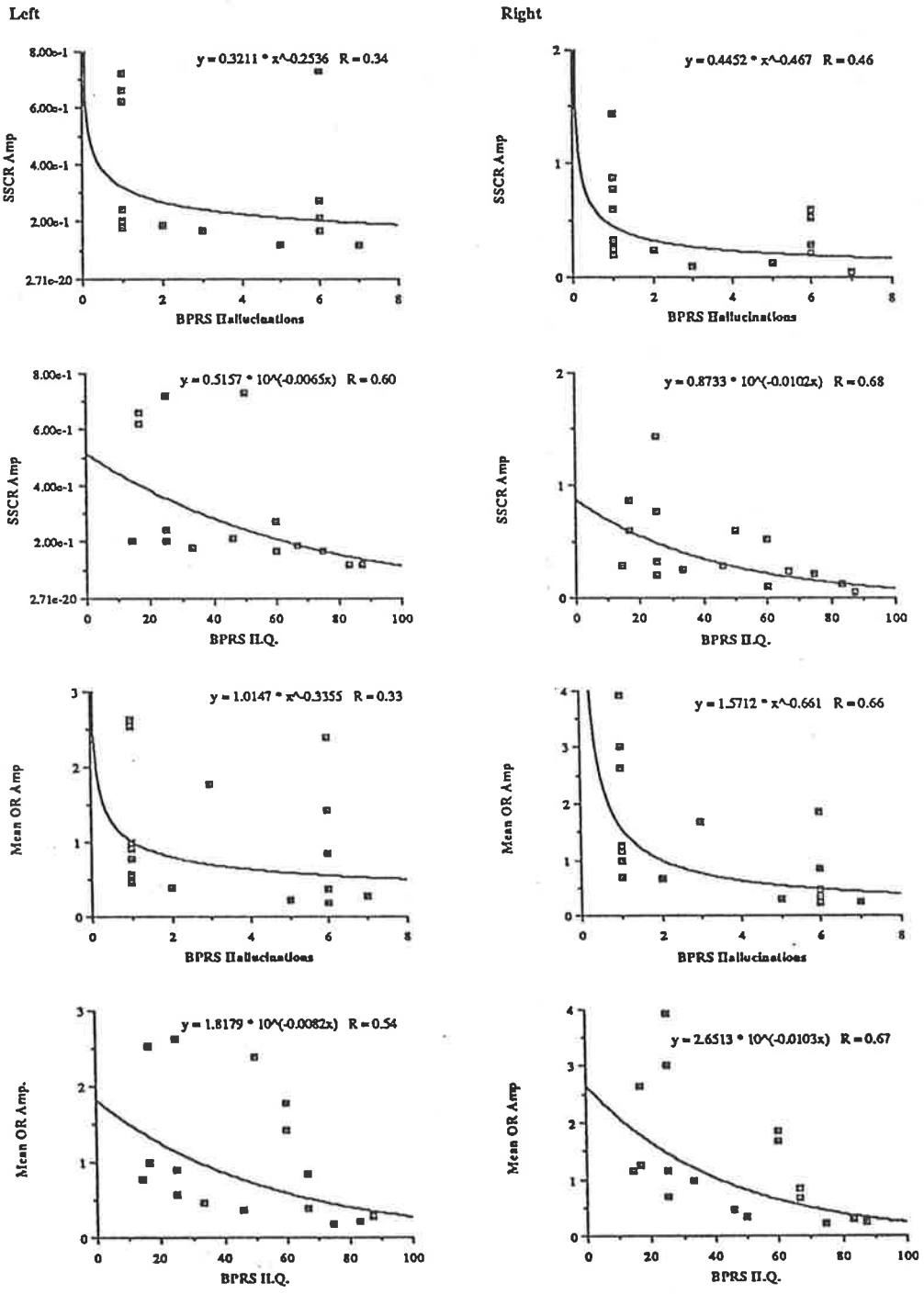
**** $p \leq .005$
*** $p \leq .01$
** $p \leq .05$
* $p \leq .10$

$^{+}$ $HQ = \frac{\text{Hallucinations}}{\text{Psychotic disorganization + Hallucinations}}$

These results provide fairly convincing evidence for the predicted inverse relationship between hallucinations and response amplitudes. Indeed the relationship appears to be a much stronger one than that between the inhibition dimension and response amplitude. In this instance also, the PSE measures appear to produce correlations about as robust as those found with the BPRS measures, in contrast to the previous correlations with inhibition symptoms. This would, perhaps, have something to do with the relative homogeneity of the PSE hallucination scale in contrast to the PSE scale of inhibition (and psychotic disorganization) compared to their BPRS counterparts. Some of the correlations listed in the above table are also displayed graphically in Figure 6.2.5.3.2 where two features become immediately obvious. One is the probable curvilinear relationship between the measures of hallucinations and response amplitude. The other is the suggestion that these relationships are more robust on the right side than on the left. This stands in contrast to the case with inhibition symptoms where, although somewhat less obvious, there appears to be a stronger relationship between the symptom scores and left-sided response amplitudes.

The BPRS and PSE delusion scales, when subjected to similar analyses, failed to reveal any significant correlations with response amplitude when the simple dimensional method was used in computing the Spearman correlation coefficients. In contrast, the BPRS delusion quotient scale showed the predicted inverse relationship with response amplitudes as shown in Table 6.2.5.3.3. However, this was not the case with the PSE delusion quotient scale.

Figure 6.2.5.3.2



Relationships between BPRS measures of hallucinations and response amplitudes on the left and right sides.

Table 6.2.5.3.3

Statistically Significant Spearman Correlation Coefficients between BPRS Delusion Quotient and Response Amplitudes

Spearman ρ

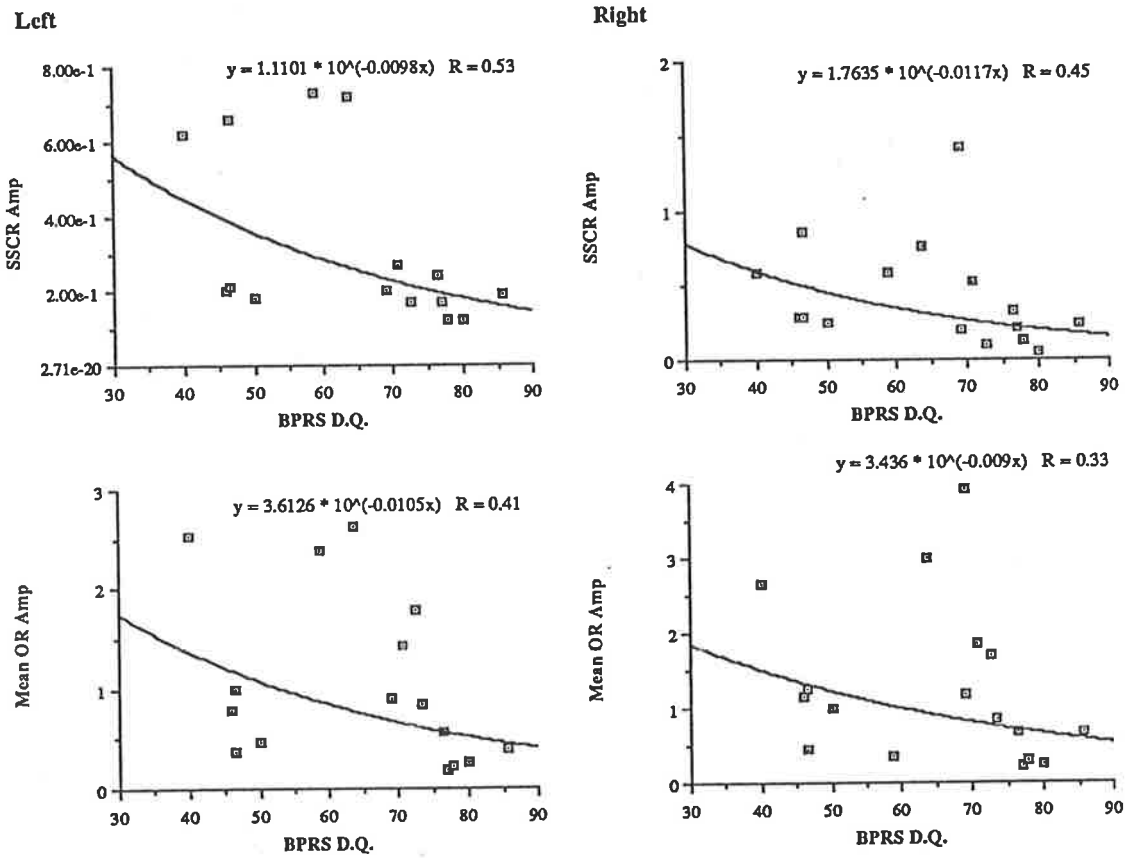
	SSCR Amplitude (pre-tone)		**OR Amplitude** First		Mean	
	L	R	L	R	L	R
BPRS Delusion Quotient[+]	-.60**	-.58**	-54*	-.56*	-.53*	-.49*

** $p \leq .005$
* $p \leq .05$

[+] DQ = $\frac{\text{Delusions}}{\text{Psychotic Disorganization + Delusions}}$

These relationships are also illustrated in Figure 6.2.5.3.3. Obviously the correlation between amplitude and delusions is considerably weaker than that found in relation to hallucinations and the inhibition symptom dimension.

Figure 6.2.5.3.3



Relationships between the BPRS delusion quotient scale and response amplitudes on the left and right sides.

II The second set of hypotheses in this section follows on from the view that the "core" psychotic process in schizophrenia, psychotic disorganization, is indirectly linked to increased tonic arousal. Any processes which act to correct or compensate for this primary process should, therefore, have the effect of lowering tonic arousal. The three groups of symptoms under examination in this section should thus be inversely related to SCL and especially NSSCR if the latter is, as suspected, the better index of tonic arousal.

Table 6.2.5.3.4

Strategically Significant Spearman Correlations Between the Three Compensatory Symptom Groups and Tonic Arousal Levels (SCL and NSSCR)

		Spearman ρ			
		SCL		**NSSCR**	
		L	R	L	R
Inhibition Dimension:	BPRS	-.51**	-.44**	-	-
	PSE	-	-.35*	-.38**	-.54****
Inhibition Quotient:	BPRS	-.43**	-	-.44**	-.44**
	PSE	-	-.29*	-.38**	-.44**
Hallucination Dimension:	BPRS	-.39**	-.43**	-	-
	PSE	-.51**	-.53***	-	-
Hallucination Quotient:	BPRS	-.50**	-.51**	-	-.45**
	PSE	-.68****	-.67****	-	-.37*
Delusion Dimension:	BPRS	-	-	-	-
	PSE	-	-	-	-

**** P≤ .005
*** P≤ .01
** P≤ .05
* P≤ .10

The above table lists the Spearman correlation coefficients between the three symptom groups in question and the two indices of tonic arousal, SCL and NSSCR. The most obvious feature is the total absence of any relationship between delusions and either index of arousal. In contrast, the various hallucination scores were each inversely related to SCL but not to NSSCR; the two negative correlations with the latter, together, barely amount to more than a chance finding. Lastly, the inhibition symptom measures show fairly consistent inverse correlations with both SCL and NSSCR suggesting that this symptom group is more closely linked with reduced tonic arousal than the hallucination group of symptoms.

III Next, orienting activity was examined in relation to the three 'compensatory' symptom groups. Spearman correlations were computed between all of the symptom measures and the number of ORs, trials to habituation and the X-intercept. No consistent statistically significant relationships were found. In examining the correlations between symptoms and the temporal variables of the OR, some significant relationships emerged but these appeared to be sporadic and, apart from the fact that all were positive, no definite pattern emerged. A series of step-wise multiple regression analyses was therefore performed in which the symptom measures were each used in turn as the dependent variable and mean latencies, risetimes and half-recovery times for the left and right sides (i.e. 6 variables) were entered as the independent or predictable variables. Only five of the 12 regression analyses yielded a statistically significant result. Of these, only one regression equation involved more than one independent variable. Levels of statistical significance occurred at no better than the .05 level and, as with the individual Spearman correlations mentioned above, the direction of all correlation coefficients was positive. The one temporal variable which seemed to be positively related to the symptom measures more frequently than any other was risetime. Thus, no more could be concluded

than that the 'compensatory' symptoms may have a weak positive relationship to temporal variables of the OR, particularly risetime.

IV Laterality indices (LI) were computed for arousal measures (SCL, NSSCR), response amplitude or capacity allocation measures (OR and SSCR amplitudes) and measures of orienting activity (number of ORs, trials to habituation and X-intercepts). These were examined in relation to symptoms using Spearman correlation analysis.

Contrary to expectation, significant *positive* correlations were obtained between the LI of tonic SCL and several of the symptom measures. On the other hand there were some significant *negative* correlations between the LI of NSSCR and the symptom measures as shown in the following table.

Table 6.2.5.3.5

Statistically Significant Spearman Correlations Between the Laterality Indices [2(R-L)/(R+L)] of Tonic Arousal Measures (SCL, NSSCR) and Symptoms

Spearman ρ

		LI of SCL (Pre-tone)	LI of NSSCR (Tone)
Inhibition Dimension:	BPRS	.51**	-.58****
	PSE	-	-.34*
Inhibition Quotient:	BPRS	.43**	-.37*
	PSE	-	-
Hallucination Dimension:	BPRS	-	-.40**
	PSE	.35*	-.40**
Hallucination Quotient:	BPRS	.33*	-
	PSE	.55***	-
Delusion Dimension:	BPRS	.33*	-
	PSE	.53***	-
Delusion Quotient:	BPRS	.31*	-
	PSE	-	-

**** P≤ .005
*** P≤ .01
** P≤ .05
* P≤ .10

This suggests that the compensatory symptoms, particularly the PSE measures of hallucinations and delusions, are associated with a trend in SCL asymmetry towards R > L, whereas the same symptoms, particularly those of inhibition and hallucinations, are associated with a trend in NSSCR asymmetry in the opposite direction, namely L > R.

There were no significant relationships between the LI of the OR amplitudes and any of the symptom groups except for the Inhibition Quotients (BPRS: $\rho = -.41$, $p < .05$ for the first OR, $\rho = -.48$, $p < .05$ for the mean OR amplitude. PSE: $\rho = -.30$, $p < .10$ for the first OR, $\rho = -.46$, $p < .05$ for the mean OR amplitude). In contrast, the PSE measures of inhibition symptoms bore strong inverse relationships with the other measure of capacity allocation asymmetry, that based on SSCR amplitudes. These results are shown in the following table.

Table 6.2.5.3.6

Statistically Significant Spearman Correlations Between the Laterality Indices [2(R-L)/R+L)]of Spontaneous Response Amplitudes and Symptoms

Spearman ρ

		LI Spontaneous Response Amplitudes	
		Pre-tone	Tone
Inhibition Dimension:	BPRS	-	-
	PSE	-.42**	-.47**
Inhibition Quotient:	BPRS	-	-
	PSE	-.57***	-.56***

*** P≤ .01
** P≤ .05

Finally, a laterality index which was calculated on the basis of left and right X-intercepts provided a measure of asymmetry in habituation rate. This index showed, relatively consistently, significant inverse correlations with all three of the compensatory symptom groups. The Spearman correlation coefficients which express these relationships are shown in Table 6.2.5.3.7. These correlations indicate a relationship between these symptom groups and a reduction in the tendency for right-sided ORs to habituate *later* than those on the left side, as measured by the differential rates of decline of OR amplitudes bilaterally

Table 6.2.5.3.7

Statistically Significant Spearman Correlations between the Laterality Index [2(R-L)/(R+L)] of Habituation Rate as Measured by the X-intercept

		Spearman ρ
		LI of X-intercept
Inhibition Dimension:	BPRS	-.63***
	PSE	-
Inhibition Quotient:	BPRS	-.61***
	PSE	-
Hallucination Dimension:	BPRS	-.42*
	PSE	-
Hallucination Quotient:	BPRS	-.57**
	PSE	-.64****
Delusion Dimension:	BPRS	-
	PSE	-
Delusion Quotient:	BPRS	-.55**
	PSE	-.45**

**** $p \leq .005$
*** $p \leq .01$
** $p \leq .05$
* $p \leq .10$

6.2.6 Factor analysis.

Having tested all of the hypotheses related to schizophrenia, it was decided to check the central *a priori* psychophysiological constructs employed in the above analyses using statistical techniques. It will be recalled that the constructs used in relation to skin conductance measurements were tonic arousal (SCL, NSSCR), response amplitudes as indices of the magnitude of the 'call' to the central channel (OR and SSCR amplitudes), orienting activity (number of ORs, habituation rate, temporal variables) and lateral asymmetry expressed as laterality indices based on several of the above skin conductance variables. A second reason for performing factor analysis was that of data reduction in order that the effects of age, sex and medication status on electrodermal activity could be more readily checked.

All of the skin conductance data for each subject in the study (schizophrenia, depression, normal control) was pooled (N=79) and combined with data from a further group of psychiatric inpatients (N=17) who had been tested in the skin conductance protocol but were subsequently rejected on diagnostic criteria. The diagnoses of the latter group are listed in Table 6.2.6.1. This gave a grand total of 96 subjects for whom electrodermal data were available.

Table 6.2.6.1

DSM-III Diagnoses of Extra Subjects*

	N
Bipolar Disorder: Manic type	5
Schizo-affective Disorder	5
Paranoia	2
Atypical Bipolar Disorder	2
Atypical Psychosis	1
Post-traumatic Stress Disorder: Chronic	1
Schizotypal Personality Disorder	1
	17

*A diagnosis of Schizo-affective Disorder was made if the subject met DSM-III criteria for schizophrenia and for major affective disorder concurrently.

All 36 of the skin conductance variables used in the preceding analyses were subjected to factor analysis using varimax rotation. The total subject pool (N = 96) was used. This yielded nine factors, the first four of which accounted for 63.6% of the variance. The variables which comprised these factors are shown in Table 6.2.6.2.

Table 6.2.6.2

Results of Factor Analysis Showing the First 4 Factors (Eigen value ≥ 3.0) and the Variables which Comprised these Factors Together with their Factor Loadings

	Factor 1 "Laterality"	Factor 2 "Tonic Arousal"	Factor 3 "Response Amplitude"	Factor 4 "Orienting"
Eigen Value	8.29	6.59	4.93	3.10
Percent of Variance	23.0	18.3	13.7	8.6
Factor Loadings:				
*LI SSCR Amp: Pre-tone	**.834**	.105	.171	.030
*LI SSCR Amp: Tones	**.869**	.127	.006	.003
*LI OR Amp: First OR	**.819**	.034	-.144	.046
*LI OR Amp: Mean OR	**.838**	-.015	-.107	.044
*LI SCL: Pre-tone	**.803**	-.063	-.146	-.129
*LI SCL: Tones	**.826**	-.059	-.081	-.077
*Left SSCR Amp: Pre-tone	-.217	.007	**.838**	.222
*Right SSCR Amp: Pre-tone	.223	-.024	**.848**	.185
*Left SSCR Amp: Tones	**-.605**	-.046	**.512**	.072
*Right SSCR Amp: Tones	-.219	.051	**.770**	.169
Left OR Amp: First OR	-.297	.009	.309	**.840**
Right OR Amp: First OR	.095	.023	.123	**.931**
*Left OR Amp: Mean OR	-.250	-.061	**.635**	**.652**
*Right OR Amp: Mean OR	.181	-.101	**.440**	**.725**
*Left NSSCR: Pre-tone	.052	**.909**	.026	.055
*Right NSSCR: Pre-tone	.115	**.891**	-.033	.063
*Left NSSCR: Tones	-.035	**.815**	.048	-.037
*Right NSSCR: Tones	.021	**.870**	.027	-.111
Left No. ORs	.054	**.460**	-.014	**.454**
Right No. ORs	.130	**.491**	.027	**.484**
Left Mean Rec t/2	.076	**-.491**	.214	-.066
Right Mean Rec t/2	-.177	**-.437**	.140	-.036

Factor 1, called the 'laterality factor', loaded heavily on six laterality indices and had a somewhat weaker and negative loading on one response amplitude variable. Factor 2 was called 'tonic arousal' because it quite clearly reflected "readiness to respond" in terms of both its strong positive loading on the four frequency of spontaneous response variables and the two frequency of elicited response (i.e. OR) variables. It also loaded negatively on half-recovery time, so that indices of "readiness to respond" appeared to be associated with a variable which reflects "openness to the environment" or "mobilization for goal-directed behaviour" (see Chapter 3). Factor 3 was quite obviously a response amplitude factor and could thus be interpreted to reflect the 'call' to the central channel for the allocation of sequential processing capacity. Factor 4 was also largely an amplitude factor but since the loadings are those of OR magnitude and number of ORs it was referred to as an "orienting" factor.

It can thus be seen that the factor analysis reproduced three factors which quite unequivocally correspond to three of the four principal skin conductance concepts forming the foundation of the present psychophysiological approach to schizophrenia. These were laterality, tonic arousal and response amplitude (capacity allocation). Orienting activity as measured by number of ORs, habituation rate and temporal variables was not reflected in any one of the factors yielded by the present analysis. Although SCL variables did not appear in the tonic arousal factor, it was still regarded as legitimate to link Factor 2 with the tonic arousal concept because a previous study using a different set of subjects indicated that NSSCR was a better predictor of readiness to respond to orienting stimuli than SCL.[2].

It was then determined to test some of the findings of the present study using this particular factor structure. In attempting to check the relationship between symptom groups and the first three factors yielded by the above analysis it was anticipated that some

of the schizophrenic subjects would be excluded from the statistical tests owing to missing values for certain variables. Factor analysis was therefore performed a second time with the following modifications to the data. First, only those variables marked with an asterisk in Table 6.2.6.1 were entered into the analysis. All other variables were excluded. Second, where there had been no SSCRs and/or no ORs, amplitudes had previously been entered into the data bank as missing values. This was changed so that where no SSCRs and/or ORs were present, the corresponding values for amplitude were entered into the data bank as zero instead of as a missing value. Similarly, where laterality indices were previously entered as missing values owing to unilateral or bilateral absence of response, the entry was changed to zero for bilateral response absence, + 2.00 for right-sided response in the absence of the left-sided response and - 2.00 for vice versa. The technique of mean substitution was used for any other missing values. In all, these changes affected eight of the 24 schizophrenic subjects.

Factor analysis with varimax rotation was repeated on the entire subject pool (N = 96) and, as expected, the same three factors (and only three factors) emerged as in the first analysis. Together they accounted for 71.4% of the variance. The factors and their loadings are shown in Table 6.2.6.3.

Within the *schizophrenic* group, factor scores were then computed for each factor using the Anderson-Rubin method.[3] Next, three sets of step-wise multiple regression analyses were performed. In the first set, the factor one (amplitude) score was used as the dependent variable and the five symptom dimensions of psychotic disorganization, activation, inhibition, hallucinations and delusions were entered as the independent or predictor variables. Two analyses were performed, one using the BPRS-derived symptom dimensions and the other employing those derived from the PSE as the predictor variables. The latter failed to yield a significant result but the analysis

Table 6.2.6.3

Results of Factor Analysis Using the Restricted Range of Variables

	Factor 1 Amplitude	Factor 2 Laterality	Factor 3 Tonic Arousal
Left SSCR Amp: Pre-tone	**.844**	-.142	.186
Right SSCR Amp: Pre-tone	**.819**	.204	.157
Left SSCR Amp: Tones	**.675**	**-.448**	-.023
Right SSCR Amp: Tones	**.876**	-.051	.107
Left Mean OR Amp	**.875**	-.183	.118
Right Mean OR Amp	**.816**	.179	.136
LI SCL: Pre-tone	-.183	**.740**	-.131
LI SCL: Tones	-.150	**.763**	-.151
LI SSCR Amp: Pre-tone	.076	**.703**	.123
LI SSCR Amp: Tones	-.009	**.794**	.081
LI OR Amp: First OR	-.004	**.698**	.055
LI OR Amp: Mean OR	.054	**.749**	.047
Left NSSCR: Pre-tone	.209	.006	**.914**
Right NSSCR: Pre-tone	.191	.114	**.915**
Left NSSCR: Tones	.078	-.079	**.929**
Right NSSCR: Tones	.097	.036	**.930**

based on BPRS ratings yielded a regression equation based solely on the inhibition symptom dimension which was strongly *inversely* related to the Factor 1 score (Multiple R = .61, R^2 = .37, F = 10.143, p = .0054). A similar set of analyses using the Factor 2 (laterality) score as the dependent variable failed to yield a statistically significant result. Likewise, when the Factor 3 (tonic arousal) score was used as the dependent variable the PSE-based symptom dimensions did not yield a significant result, unlike those derived from the BPRS. The latter yielded a regression equation based solely on the psychotic disorganization dimension which was *positively* related to the Factor 3 score (Multiple R = .55, R^2 = .30, F = 7.414, p = .0145).

Individual Spearman correlation coefficients computed between the factor scores and the various symptom dimensions which had not appeared in any of the

regression equations gave no further information except for significant inverse correlations ($p < .05$) between Factor 1 (amplitude) scores and all four hallucination measures ($\rho = -.43, -.53, -.45, -.43$). The Factor 2 (laterality) scores were inversely correlated only with the PSE measures of the inhibition dimension and the inhibition quotient ($\rho = -.50$, $p = .010$ and $\rho = -.51$, $p = .009$ respectively).

All of the above findings are consistent with and help to confirm the results of earlier analyses in which individual skin conductance variables, taken as indices of particular psychophysiological concepts (capacity allocation, laterality, tonic arousal), were examined in relation to symptomatology.

6.2.7 Effects of age, sex and drug status.

The factor analysis described in the preceding section was used as a convenient data reduction method for examining the effect of the above three variables on electrodermal activity.

First, the entire sample ($N = 96$) of schizophrenic, depressed, normal control and mixed diagnosis groups was examined from this point of view. Pearson correlation coefficients were computed between age and the factor scores for the amplitude, laterality and tonic arousal factors. The only significant result was between age and the amplitude factor score ($r = -.20$, $p < .05$). The effect of sex on the entire sample was examined using Student's t-test. Here a significant result was obtained for the laterality factor with the mean score for males being greater than that for females ($p < .05$). This suggested a tendency towards right-greater-than-left asymmetry in males and a tendency towards the opposite asymmetry for females.

Next, the schizophrenic subjects only were examined ($N = 24$). Owing to the somewhat skewed age distribution Spearman correlation coefficients were computed

between age and each of the three factor scores. Duration of illness was examined in a similar way. The results of these computations failed to reveal the significant inverse correlation between age (or illness duration) and the amplitude factor score which had been obtained for the entire sample. In contrast the laterality factor score was positively correlated with age ($\rho = .41$, $p < .05$) and duration of illness ($\rho = .42$, $p < .05$). Age also showed a positive correlation with the tonic arousal factor score ($\rho = .40$, $p < .05$). The effect of sex was examined using the Mann-Whitney U test and no significant differences were obtained between males and females on any of the three factor scores. The effect of medication was examined in a similar way in which subjects taking antipsychotic drugs (N = 16) were compared with those who were free of such treatment (N = 8). No significant differences emerged on any of the three factor scores which suggests that, in the present sample of acute schizophrenic patients in which the level of antipsychotic medication was kept at the minimum level practicable*, no appreciable effects of antipsychotic drugs on electrodermal response amplitude, lateral asymmetry or tonic arousal could be discerned.

In view of the effect of age and illness duration on the laterality factor score and the effect of age on the tonic arousal factor score, the step-wise multiple regression analyses reported in the preceding section were repeated with the addition of age and illness duration as independent variables together with the symptom dimensions. The results of the analysis with the laterality factor score as the dependent variable revealed illness duration as the sole variable positively related to the laterality factor score whether entered with the BPRS- or PSE-derived symptom dimensions (Multiple R = .51, R^2=.26, F = 5.874, p = .027). Entering age and duration of illness in similar multiple regression analyses with the tonic arousal factor as the dependent variable yielded identical results to the earlier analyses in which these predictor variables had been omitted. Similarly, when individual partial correlations were computed between the factor scores

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*Median duration 4 days; median dosage 500 chlorpromazine equivalence units (Davis, J. M., Comparative doses and costs of antipsychotic medication. *Archives of General Psychiatry,* 33, 858-861, 1976).

and individual symptom dimensions or quotients using age or illness duration as the partial correlate, no substantial differences in the correlations already reported emerged except to increase the magnitude of the correlation between the tonic arousal factor and the BPRS 'conceptual disorganization' measure from $\rho = .42$ ($p < .05$) to $\rho = .58$ ($p < .01$) with age controlled and $\rho = .56$ ($p < .01$) with illness duration controlled.

It was therefore concluded that the effects of age, sex and drug status did not appreciably alter the findings reported so far in relation to schizophrenia, its symptomatology or the electrodermal characteristics which distinguish schizophrenic from non-schizophrenic subjects. The only notable exception was the emergence of a significant relationship between electrodermal asymmetry and duration of illness and, to a lesser extent, age.

6.2.8 Summary of findings.

I Acutely psychotic, recently admitted schizophrenic inpatients show high levels of tonic arousal as measured by SCL and NSSCR compared to normal controls.

II Predictions directly based on the sensory gating hypothesis of schizophrenia were not confirmed. That is, there was no evidence of increased orienting activity in schizophrenia as measured by number of ORs, habituation rate or OR temporal variables.

III Contrary to predictions based on the 'mismatch' theory of the OR, the amplitudes of SSCRs and ORs did not differ between schizophrenic and control groups.

IV There was evidence for right-greater-than-left electrodermal asymmetry in schizophrenia. The electrodermal variables which showed this pattern of asymmetry included the NSSCR (but not SCL) measure of tonic arousal, response amplitude (SSCR and OR) and orienting activity as measured by the number of ORs and, to a lesser extent,

trials to habituation.

V Contrary to predictions based on the sensory gating hypothesis, no significant relationships were found between the activation symptom dimension and either tonic arousal, orienting activity or lateral asymmetry. The dimension of 'conceptual disorganization' correlated *positively* with response amplitudes and with the NSSCR (but not the SCL) measure of tonic arousal. Of the 'corrective' or 'compensatory' symptom dimensions, inhibition was strongly *inversely* related to response amplitude as were hallucinations. Delusions showed less consistent negative relationships with response amplitude. Inhibition was also *inversely* related to tonic arousal (SCL and NSSCR) whereas hallucinations were consistently related, in the same direction, only to the SCL measure of tonic arousal. Delusions showed no correlation with either measure of arousal. As far as tonic arousal asymmetry was concerned, all three of these 'compensatory' symptom groups showed a positive relationship to SCL asymmetry in the direction of right-greater-than-left whereas the inhibition and hallucination groups were related to NSSCR asymmetry in the opposite direction. Inhibition, as measured by the PSE, showed a relationship to SSCR amplitude asymmetry in the left-greater-than-right direction. A similar relationship was found between the inhibition quotients and OR amplitude asymmetries. All of these compensatory symptoms also appeared to be inversely related to the extent to which habituation occurred later on the right than on the left.

VI Factor analysis yielded three factors, the composition of which confirmed three of the four *a priori* psychophysiological constructs forming the basis of the present study. These were response amplitude, laterality and tonic arousal. No factor emerged which was unambiguously consistent with the orienting activity concept. An examination of the relationships between factor scores and symptomatology revealed patterns which

were consistent with the findings reported earlier of the correlations between symptoms and individual electrodermal variables.

VII An exploration of the relationship between the three factors and either sex or medication status revealed that neither of these two variables had a significant effect on the response amplitude, laterality or tonic arousal factors. Although age was inversely related to the amplitude factor, entry of this variable into the relevant statistical analyses did not alter the findings as far as relationships between the amplitude factor and symptomatology were concerned. Since the normal control group was well-matched for age with the schizophrenic group, a repetition of the earlier tests for differences between these two groups whilst controlling for age was not undertaken. Duration of illness and, to a lesser extent, age, were found to be significantly related to the laterality factor, but controlling for these variables produced no appreciable alterations in the previously examined relationship between symptom dimensions and laterality.

6.3 DEPRESSION

6.3.1 Effects of age, sex and drug status.

In view of complex interrelationships between age and sex and electrodermal activity reported in depressive illness[4,5], it was decided to determine the effects of the former on the skin conductance measures in the present sample of depressed subjects before proceeding to test the hypotheses presented in Section 4.2.2. The factor analysis described in the preceding section on schizophrenia was used as a convenient data reduction method for this task.

Age was examined first by computing Spearman correlation coefficients between this variable and each of the amplitude, laterality and tonic arousal factor scores. As had occurred in relation to the total sample of 96 subjects, there was a significant inverse correlation between age and the amplitude factor score ($\rho = -.83$, $p < .001$) but of much greater magnitude than had occurred in relation to the total sample ($r = -.20$, $p < .05$). No other correlation coefficients reached statistical significance.

In examining the effects of sex on the three factor scores, the only significant male-female difference occurred with the laterality factor scores (Mann-Whitney $U = 20.0$, $z = 2.2678$, $p < .05$) and this was in the same direction as that which had been found in the total sample (Section 6.2.7).

Comparison of subjects who had been recently commenced on tricyclic antidepressants ($N = 8$) with those who had not ($N = 12$), using the Mann-Whitney statistic, revealed no significant differences in any of the three factor scores. This finding was in keeping with the literature reviewed in Section 3.4 regarding tricyclic drugs and electrodermal activity in depression.

Since the above analyses failed to reveal the expected association between age

and the tonic arousal factor it was decided to test the relationships between age and the individual variables which comprised the *a priori* tonic arousal construct, namely SCL and NSSCR. Table 6.3.1.1 lists the Spearman correlation coefficients between age and both SCL and NSSCR.

Table 6.3.1.1

Relationships Between Age and the Tonic Arousal Variables SCL and NSSCR for Depressed Subjects (N = 20)

			Spearman ρ	**p**
SCL	Pre-tone	Left	-.68	<.001
		Right	-.60	<.005
	Tones	Left	-.65	<.001
		Right	-.62	<.005
NSSCR	Pre-tone	Left	-.44	<.05
		Right	-.38	<.05
	Tones	Left	-.24	ns
		Right	-.25	ns

From these results it is obvious that the failure to find a relationship between age and the tonic arousal factor was due to the absence of SCL variables in this factor. It can be seen that the relationship between age and NSSCR is weak and since the tonic arousal factor is composed solely of NSSCR data, the absence of a relationship between the factor score and age can be understood.

In summary, it can be stated that in depressed subjects there are strong inverse correlations between age and both response amplitudes and SCL. It is therefore particularly important that data analyses involving these variables should control for age, especially as there are significant age differences between the depressed and normal control groups. There were sex differences in laterality with males showing a tendency towards right-greater-than-left asymmetry and females showing a tendency towards the opposite asymmetry. Finally, there appeared to be no significant effects of recently commenced (days) courses of tricyclic antidepressants and electrodermal variables.

6.3.2 Tonic arousal.

It was predicted that depressed subjects would have lower levels of tonic arousal compared to normal controls. In order to test this hypothesis in relation to SCL, the findings reported in the preceding section made it necessary to take age into account in the data analysis. The appropriate statistical test appeared to be analysis of covariance (ANCOVA) with group (depression vs control) as the independent variable, $\log_{10}$ SCL as the dependent variable and age as the covariate. To test the suitability of this model, the slopes of the regressions of the dependent variable on the covariate were compared for each group. One of these regressions also included interaction terms among the independent variable list, accounting for any interaction between the covariate (age) and the two groups of subjects. This was particularly important because, as described in Section 6.1, the depressed group was significantly older than the control. The second regression did not include these interaction terms. The appropriate F statistic showed that there was a significant difference between the two regression models indicating the lack of parallelism between the two regression lines. This finding precluded the use of ANCOVA and, therefore, given the present samples, the hypothesis of lower SCL in depression

could not be tested.

The lack of a parallel relationship between the regressions of the depressed and control groups can be seen in Figure 6.3.2.1. It can be seen that there is a relatively strong, consistent, *inverse* relationship between SCL and age in the depressed group and a much weaker but *positive* relationship between these two variables in the group of normal controls.

The task of comparing NSSCR between the depressed and control groups was comparatively less complicated owing to the lack of relationship between this variable and age. Square root transformations of NSSCR were compared between depressed and control groups using Student's t-test. These results are shown in Table 6.3.2.2 where it can be seen that there was no significant difference between groups on the NSSCR variable.

Table 6.3.2.1

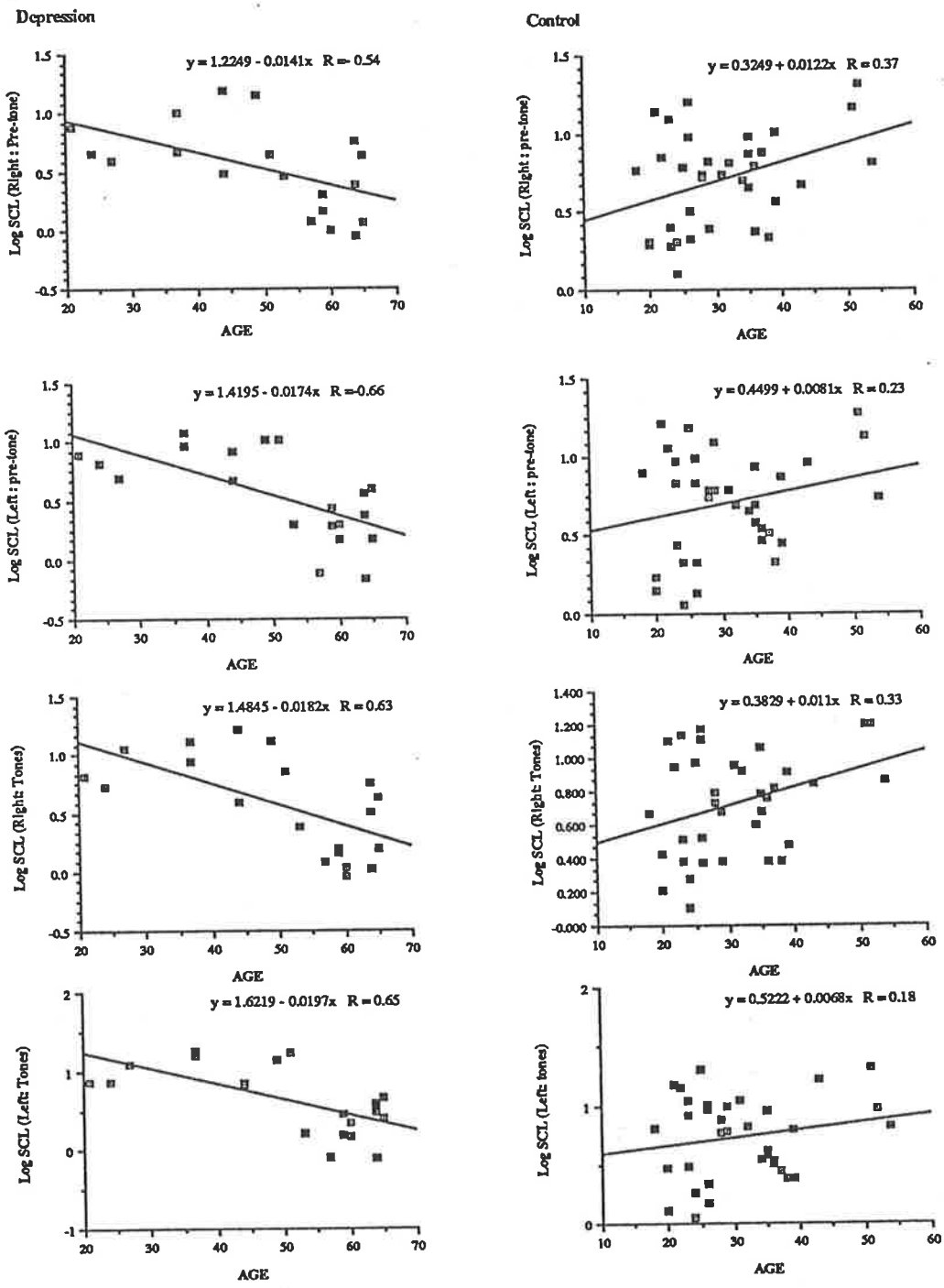
Comparison of Number of Spontaneous Skin Conductance Responses (√ transformed) between Depressed and Normal Control Groups

√ NSSCR (N/Min)

		DEPRESSION			**CONTROL**			**p***
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
Pre-Tone:	Left	20	0.879	0.204	35	0.821	0.143	NS
	Right	20	0.666	0.145	35	0.768	0.139	NS
Tones:	Left	20	1.046	0.257	35	0.937	0.085	NS
	Right	20	1.052	0.222	35	0.972	0.078	NS

*Student's t-test

Figure 6.3.2.1

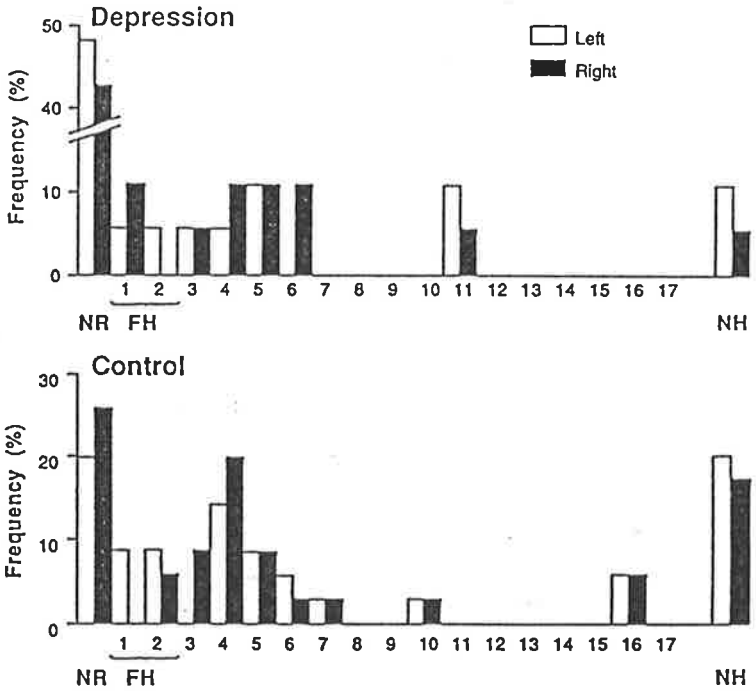


Regressions between log SCL and age for depressed and normal control groups.

6.3.3 Orienting activity.

A reduction in orienting activity was predicted for depressed subjects relative to controls, in keeping with the literature on this subject. The first test of this hypothesis was to examine the proportions of non-responders against non-habituators in each group. The histograms shown in Figure 6.3.3.1 which illustrate the distributions of trials to habituation suggest that there were proportionately more non-responders in the depressed group and hardly any non-habituators.

Figure 6.3.3.1



Distribution of trials to habituation.

Non-responders were combined with fast habituators to create an 'under-responder' group which was compared with a late- or non-habituator ('over-responder') group in depressed and control subjects using χ^2 analysis (Table 6.3.3.1). This revealed that in the right hand measurements of the depressed group the proportion of 'under-responders' was high and that of 'over-responders' was low compared to the control group ($p < .05$, directional). On the left side the same trend was present but failed to reach statistical significance ($p < .10$, directional). The proportion of non-responders in the control group was unexpectedly high, higher than is generally reported for normal subjects. This unusual distribution in the control group may have been responsible for the failure to find non-responsiveness convincingly over-represented in the depressed group.

Table 6.3.3.1

Distribution of Under-responders and Over-responders in Depression Compared to Normal Controls

	DEPRESSION	**CONTROL**	
LEFT HAND			
Non-Responders and Fast Habituators	11	13	$\chi^2 = 2.479$ df = 1
Non- /Late Habituators	2	9	p = NS
RIGHT HAND			
Non-Responders and Fast Habituators	10	11	$\chi^2 = 3.616$ df = 1
Non- /Late Habituators	1	8	p <.05 (Directional)

A comparison of the number of orienting responses between depressed and control subjects for left and right hands (Table 6.3.3.2) revealed significantly fewer responses on the left in depression but only a non-significant trend in the same direction for the right hand ($p < .10$, one-tailed).

Table 6.3.3.2

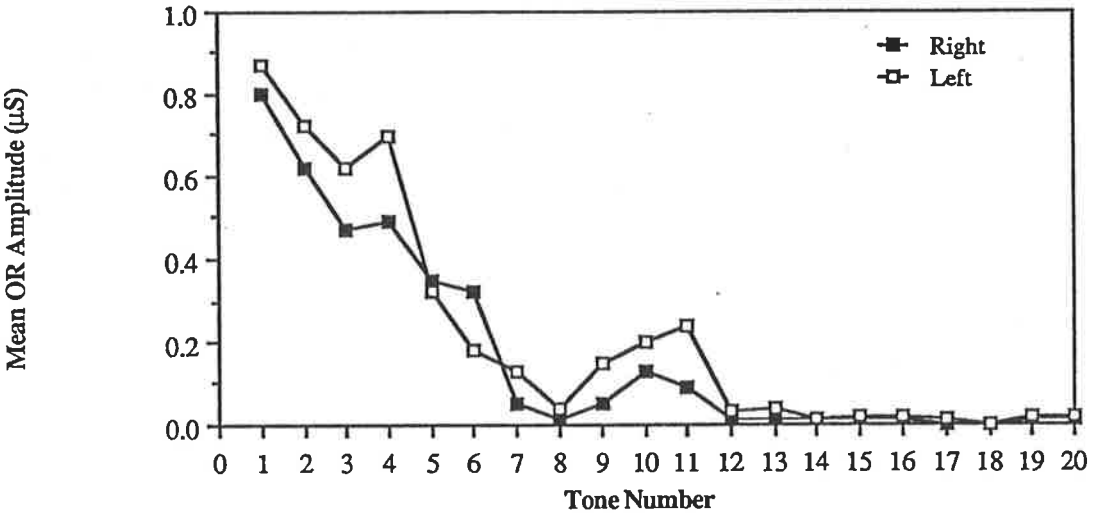
Comparison of Number of Orienting Responses between Depressed and Normal Control Groups

	MEAN NUMBER OF ORs		
	Depression	Control	Mann-Whitney U-test
Left	3.85	6.31	U = 251.0 z = -1.7569 p = .0395 (one-tailed)
Right	3.25	5.71	U = 268.5 z = -1.4527 p = NS

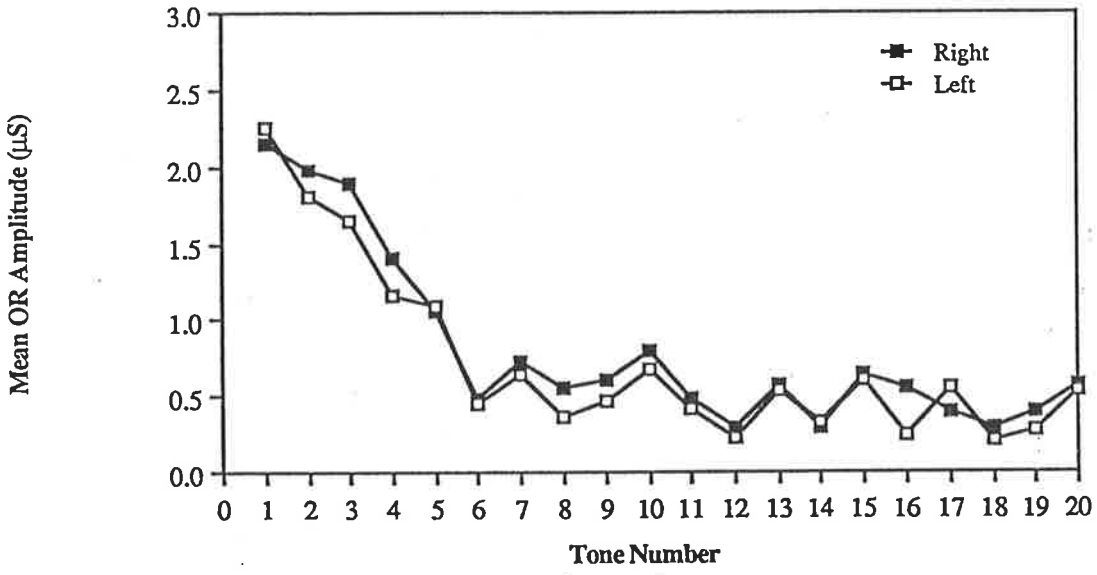
Having found some support for the hypothesis of decreased responsiveness in depression compared to normal controls, an examination of habituation to the tones was undertaken. The hypothesis in this instance was that the expected lower level of orienting activity in depression would be reflected in rapid habituation to the tones. Although the figures are only applicable to 50% (N = 10) of the depressed group owing to non-responsiveness in the remainder, the habituation curve for the depressed group was plotted and is shown in Figure 6.3.3.2 along with that for the normal control subjects.

Figure 6.3.3.2

Depression



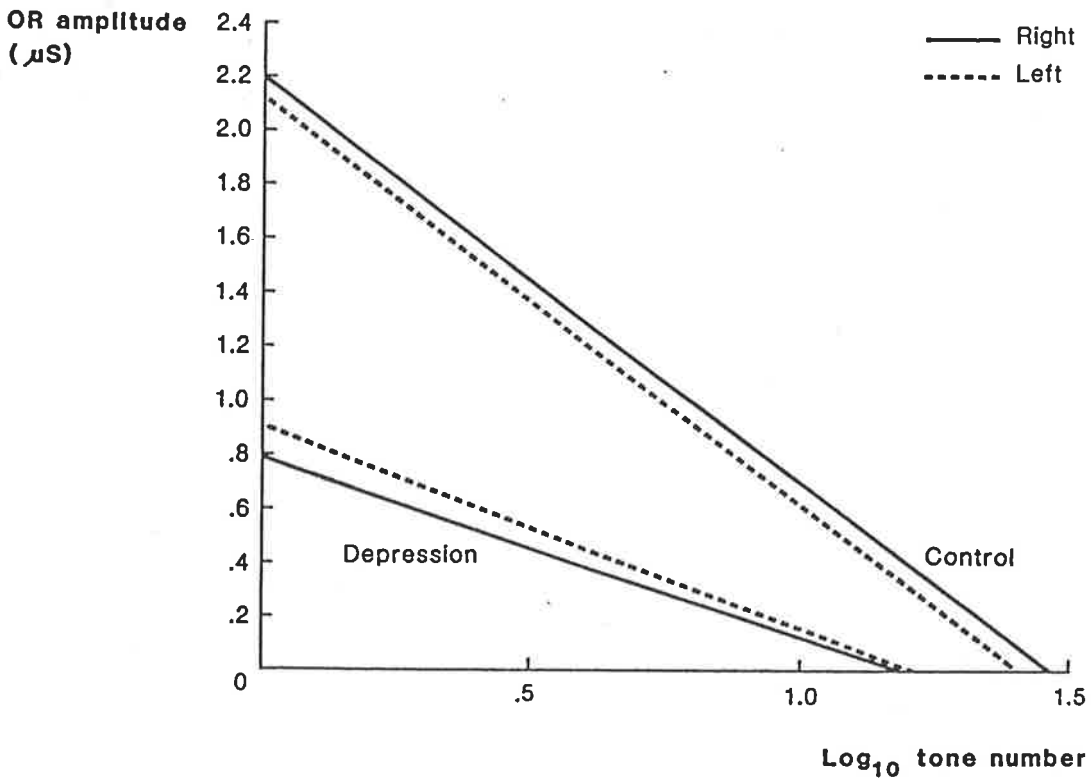
Control



Habituation curves for depressed and control subjects.

These curves suggest that the depressed subjects do indeed habituate earlier than the control group. This can also be seen in Figure 6.3.3. 3 when the decline in OR amplitudes is plotted against the log of the tone number and the X-axis intercept provides an estimation of the habituation point. Although the habituation slope is steeper in normal controls than in depression, the much smaller response amplitudes in the latter group account for the earlier habituation point than appears to occur in the controls.

Figure 6.3.3.3



Habituation slopes for OR amplitude decline against $\log_{10}$ tone number (X-axis intercepts).

To test whether habituation differed between the two groups, two measures of habituation were used, namely (1) the number of trials to habituation as measured by three successive failures to respond and (2) the X-axis intercept as described in Section 5.4.2. As shown in Table 6.3.3.3 neither measure differed significantly between the depressed and control groups.

Table 6.3.3.3

Comparison of Habituation between Depressed and Normal Control Groups

		DEPRESSION	**CONTROL**	Mann-Whitney U-Test
Median Trials to Habituation				
	Left	4.50	4.00	U = 83.5, z = -0.025 p = NS
	Right	4.50	4.00	U = 96.5, z = -0.157 p = NS
Median X-Axis Intercept				
	Left	3.00	5.85	U = 283.0, z = -1.037 p = NS
	Right	2.00	5.60	U = 226.5, z = -1.382 p = NS

It was anticipated that the predicted decrease in the number of ORs in depression would be associated with prolongation of the temporal parameters of the OR. Comparisons were therefore made between the depressed and control groups in terms of mean OR latencies, risetimes and half recovery times for the left and right hands. The

results are summarised in the following table where it can be seen that there are no significant group differences except for the recovery time measured on the left hand and this was in a direction opposite to that predicted.

Table 6.3.3.4

Comparison of OR Temporal Variables (log transformed) between Depressed and Normal Control Groups

Log_{10} OR Temporal Variables (Sec)

		DEPRESSION			CONTROL			p*
		N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
MEAN OR								
Left:	Lat	11	.315	.023	28	.337	.010	NS
	Rist	11	.253	.032	28	.300	.020	NS
	Rec t/2	10	.626	.127	24	.891	.053	.029
Right	Lat	12	.373	.017	26	.363	.010	NS
	Rist	12	.325	.052	26	.285	.022	NS
	Rec t/2	11	.774	.130	25	.839	.063	NS

In summary, therefore, depressed and control subjects showed few differences in terms of orienting activity. Only in the right hand did depressed subjects clearly show more 'under-responders' and fewer 'over-responders' than normal controls.

Only in the left hand did the depressed group show fewer ORs than the controls and no significant differences occurred with respect to habituation or the temporal parameters of the OR. It can be concluded that in the present study the evidence for reduced orienting activity in the depressed group is relatively weak.

6.3.4 Lateral asymmetry.

It was predicted that in depression left-greater-than-right asymmetries would occur, relative to controls, in tonic arousal (SCL, NSSCR), response amplitude, (OR and SSCR amplitude) and orienting activity (number of ORs and habituation point). These predictions were in keeping with the theory of right hemisphere dysfunction or underactivity in affective disorder.

Tonic arousal measures were examined first by comparing left-sided SCL and NSSCR with those on the right side using the Wilcoxon matched-pairs test. As shown in Table 6.3.4.1 there was no significant asymmetry in SCL within the depressed group at rest, but during the tones a significant asymmetry in the predicted direction emerged. With regard to NSSCR there was only a non-significant trend ($p < .10$) towards the predicted asymmetry in the depressed group prior to the tones. No significant asymmetries occurred in the case of normal controls.

Asymmetry in tonic arousal was also examined using the laterality index 2 (R-L)/(R+L). Owing to the effect of sex on electrodermal asymmetry discussed in Section 6.3, two-way analyses of variance were used in which group and sex were entered as the independent variables and the laterality indices based on tonic arousal each comprised, in turn, the dependent variables. The results of these analyses are summarised in Table 6.3.4.2 where it can be seen that sex and not group accounts for the lateral

asymmetries in SCL. There was also a weak ($p < .10$) effect of group on NSSCR asymmetry prior to the tones.

Table 6.3.4.1

Lateral Asymmetry of Tonic Arousal Measures: Within Group Comparisons

	DEPRESSION				CONTROL			
	MEDIAN		Wilcoxon Matched-pairs		MEDIAN		Wilcoxon Matched-pairs	
	Left	Right	z	p*	Left	Right	z	p
SCL (μS)								
Pre-tone	3.69	3.46	- .933	NS	5.50	5.46	-.164	NS
Tones	4.12 >	4.06	-1.904	.028	6.32	5.82	-.162	NS
NSSCR (N/min)								
Pre-tone	0.60 >	0.20	-1.569	.058	0.25	0.40	-.803	NS
Tones	0.84	0.76	- .175	NS	1.13	0.93	-.103	NS

*One-tailed.

Table 6.3.4.2

Effects of Group (Depression vs Control) and Sex on Tonic Arousal Laterality Indices as Indicated by Two-way Analyses of Variance

Values for F (values for p in parentheses)

Laterality Index		**Main Effects**		**Two-way Interactions**
		Group	Sex	
SCL:	Pre-tone	NS	8.61 (.005)	NS
	Tone	NS	7.95 (.007)	NS
NSSCR:	Pre-tone	3.63 (.063)	NS	5.25 (.026)
	Tone	NS	NS	8.38 (.006)

The mean values for the laterality indices according to group and sex are shown in Table **6.3**.4.3. There it can be seen that, as far as SCL is concerned, males tend to have right-greater-than left asymmetries (laterality index >0) and females tend to have asymmetries in the opposite direction (laterality index <0). It is the latter, namely left-greater-than-right asymmetries, that were predicted for affective disorder.

Table 6.3.4.3

Mean Tonic Arousal Laterality Indices [(2 (R-L)/(R+L)] by Group and Sex

SCL

		Depression		**Control**	
Male	*	(1)	+.098	(1)	+.154
		(2)	+.064	(2)	+.126
Female		(1)	-.307	(1)	-.123
		(2)	-.340	(2)	-.136

NSSCR

	Depression		**Control**	
Male	(1)	+.008	(1)	-.099
	(2)	-.523	(2)	-.173
Female	(1)	-.939	(1)	+.022
	(2)	-.200	(2)	+.360

*(1) = Pre-tone
(2) = Tone

In Table 6.3.4.2 it is also apparent that there is a significant two-way interaction between group and sex for the laterality indices based on the frequency of spontaneous responses (NSSCR). This was further examined by testing males and females separately for significant differences in the NSSCR laterality indices between depressed and control subjects. These results are displayed in Table 6.3.4.4 where it can be seen that depressed males have a right-greater-than-left asymmetry compared to normal male controls, at least during the tone sequence. In contrast, depressed females consistently show the opposite asymmetry compared to normal female controls.

Table 6.3.4.4

Comparison of NSSCR Laterality Indices Between Depressed and Control Subjects

Laterality Indices [2(R-L)/(R+L)]

	DEPRESSION			**CONTROL**			**p***
	N	$\bar{X}$	SEM	N	$\bar{X}$	SEM	
MALES							
Pre-tone:	10	+.008	.246	16	-.099	.158	NS
Tone:	10	+.523	.286	16	-.173	.195	.048
FEMALES							
Pre-tone:	10	-.939	.280	19	+.022	.203	.010
Tone:	10	-.200	.130	19	+.360	.191	.022

*Student's t-test, 2-tailed.

Asymmetry of response amplitudes was examined in a similar way. Left- and right-sided SSCR and OR amplitudes were first compared within groups using the Wilcoxon matched-pairs test. There was no significant asymmetry in either the depressed or control groups in terms of either SSCR amplitudes (pre-tone and during tones) or OR amplitudes by this method of analysis. Laterality indices based on these amplitude variables were also examined in two-way analyses of variance with group and sex as the independent variables. There were no significant group effects but a significant effect for sex in the case of SSCR amplitude asymmetry during the tones ($F = 6.61$, $p = .014$) and a trend towards a significant effect of sex on OR amplitude asymmetry ($F = 3.00$, $p = .093$). Both were in the direction of right-greater-than-left asymmetries in males and the opposite direction of asymmetry in females.

Lateral asymmetry of orienting activity was examined in a similar way using both within and between group comparisons of number of ORs, trials to habituation and the X-intercept. No statistically significant differences emerged with any of these analyses.

6.3.5 Symptomatology.

It was predicted that the symptom dimension referred to as inhibition would correlate inversely with tonic arousal and orienting activity and would be associated with a tendency towards left-greater-than-right asymmetry in EDA.

With regard to tonic arousal, partial correlation coefficients were computed between SCL and both the BPRS and PSE measures of inhibition. In these calculations age was entered as the partial correlate owing to its inverse relationship with SCL in

depression (Sections 6.3.1 and 6.3.2). Spearman correlation coefficients were also computed between the two measures of the inhibition symptom dimension and both the NSSCR variables and the tonic arousal factor described in Section 6.2.6. The results of all of these analyses are displayed in Table 6.3.5.1. This shows that, contrary to expectation, there is a consistent *positive* correlation between tonic arousal and inhibition.

Table 6.3.5.1

Relationship between Tonic Arousal Measures and the Inhibition Symptom Dimension in Depression

			INHIBITION DIMENSION	
			BPRS	**PSE**
Partial Correlations (Controlling for age)				
SCL:	Left	Pre-tone	.42**	.37*
		Tone	.46**	.33*
	Right	Pre-tone	.36*	.38*
		Tone	.43**	.44**
Spearman Correlations				
NSSCR:	Left	Pre-tone	.47**	.34*
		Tone	.62***	.45**
	Right	Pre-tone	.50**	.31*
		Tone	.58***	.50**
Arousal Factor Score			.48**	.38*

*** $p \leq .01$
** $p \leq .05$
* $p \leq .10$

Orienting activity as measured by the number of ORs, trials to habituation and the X-intercept was also examined in relation to the inhibition symptom dimension by means of Spearman correlations. No significant correlations were obtained with the trials to habituation variable but the other two measures of orienting activity showed a positive correlation with the inhibition dimension (see Table **6.3**.5.2).

Table 6.3.5.2

Statistically Significant ($p \leq .05$) Correlations between Inhibition and Orienting Activity (i.e., number of ORs and rate of habituation as measured by the X-intercept)

		Spearman ρ	
		INHIBITION DIMENSION	
		BPRS	**PSE**
Number of ORs:	Left	.46	NS
	Right	.46	.43
X-Intercept:	Left	.44	NS
	Right	.51	NS

Asymmetry of EDA in relation to inhibition was examined by means of partial correlations between this symptom dimension and the laterality indices controlling for sex. This method was necessary owing to the previously described sex differences in electrodermal asymmetry in depression. Separate partial correlation coefficients were thus computed between both the PSE and BPRS measures of inhibition and laterality indices based on SCL, NSSCR and spontaneous and orienting response amplitudes as well as the laterality factor described in Section 6.2.6. Not one of these correlations reached statistical significance.

The final set of symptom-related predictions was that the dimension of anxiety would be positively related to tonic arousal, orienting activity and a tendency towards right-greater-than-left skin conductance asymmetry. These hypotheses were examined in the same way that those related to the inhibition symptom dimension were tested as described above.

In the case of tonic arousal, partial corelation coefficients, controlling for age, were computed between SCL and both the BPRS and PSE measures of anxiety. Spearman correlation coefficients were computed between these two symptom measures and the NSSCR variables and the tonic arousal factor (Section 6.2.6). The results for the SCL partial correlations are shown in Table 6.3.5.3. These suggest an *inverse* relationship between anxiety and SCL, a result which runs directly counter to prediction. None of the Spearman correlation coefficients between anxiety and either NSSCR or the arousal factor reached statistical significance.

Table 6.3.5.3

Partial Correlations between SCL and Anxiety Controlling for Age

			Partial Correlation Coefficients	
			ANXIETY	
			BPRS	**PSE**
SCL:	Left	Pre-tone	-.47**	NS
		Tone	NS	NS
	Right	Pre-tone	-.52**	-.38*
		Tone	-.48**	NS

** P ≤.05
* P ≤.10

The relationships between anxiety and orienting activity were examined by computing Spearman correlation coefficients between BPRS and PSE anxiety measures and number of ORs, trials to habituation and the X-intercept. None reached statistical significance.

Similarly, the partial correlations, controlling for sex, between the anxiety measures and the laterality indices based on tonic arousal and amplitude variables also failed to reach statistical significance.

6.3.6 Summary of findings.

I In major depressive disorder, age bears a strong inverse relationship to response amplitude, as represented by the amplitude factor, and to the SCL measure of tonic arousal.

II There is a complex relationship between sex and electrodermal asymmetry. Depressed males tend to have right-greater-than-left tonic arousal skin conductance asymmetries whereas depressed females show tonic arousal asymmetries in the opposite direction. This association is particularly strong for NSSCR.

III There appeared to be no effect of tricyclic antidepressants on any electrodermal variable.

IV In testing the hypothesis that tonic arousal is lower in depressed than control subjects, the SCL variables could not be used owing to a combination of their strong relationship to age (in opposite directions in depression compared to normal controls) and the marked age differences between the depressed and control groups. The NSSCR measure of tonic arousal revealed no significant differences between the groups.

V There was some evidence for decreased orienting activity in depression in

terms of the proportion of 'under-responders' versus 'over-responders' and the number of ORs. However, the support for this hypothesis was relatively weak.

VI Similarly, when taken as a whole, the depressed group yielded slim evidence for a left-greater-than-right asymmetry in tonic arousal. Sex accounted for most of the variance in lateral asymmetry of EDA. It was only in females that the prediction of left-greater-than-right asymmetry was confirmed for tonic arousal in depression. As previously mentioned, depressed males showed the opposite asymmetry. There were no significant differences between depressed and control subjects in terms of lateral asymmetry in either response amplitudes or orienting activity.

VII The symptom dimension of inhibition was positively related to the tonic arousal measures, SCL and NSSCR. The direction of this association was opposite to that predicted. There was also some evidence for a positive relationship between inhibition and orienting activity but not lateral asymmetry in EDA.

VIII Also in a direction opposite of that predicted, there was some evidence for an inverse relationship between anxiety and the SCL measure of tonic arousal but not that of NSSCR. There was no relationship between anxiety and either orienting activity or EDA asymmetry.

CHAPTER 7

DISCUSSION

7. DISCUSSION

7.1 Introduction.

It might be expected that a research project with a large number of hypotheses would encounter more than a few failures in the confirmation of those hypotheses. This has been the case in the present study although the central theoretical framework which has guided the project appears to have come through the exercise not unscathed but basically intact. It is planned to support the latter assertion and enlarge upon it in the discussion that follows. A discussion of the statistical analyses used in this study is given in Appendix F. Firstly, however, it would be useful to recapitulate the findings, and the summary table on the following pages serves that purpose.

Table 7.1

Summary

	SCHIZOPHRENIA	DEPRESSION
TONIC AROUSAL	4.2.1.1* Increased SCL and NSSCR	4.2.2.1 Not different from controls. Inverse relationship between **age** and SCL
ORIENTING ACTIVITY	4.2.1.2 Not different from controls	4.2.2.2 Reduced compared to controls
RESPONSE AMPLITUDE	4.2.1.3 Not different from controls. Inverse relationship with **age**	Not tested
LATERAL ASYMMETRY	4.2.1.4 Definite R>L asymmetry in: - NSSCR (not SCL) - Orienting activity - Response amplitudes (But significant effect of sex)	4.2.2.3 Equivocal L>R asymmetry. Dominant effect of **sex** on tonic arousal asymmetry - L>R in females - R>L in males No asymmetry in - Orienting activity - Response amplitudes
SYMPTOM-ATOLOGY	4.2.1.5 **Activation** No EDA correlates. **Psychotic Disorganization** Positive correlation with: - response amplitudes - NSSCR (not SCL). **Inhibition** Inverse correlation with: - response amplitudes - NSSCR & SCL Positive correlation with degree of R>L asymmetry in SCL	4.2.2.4 **Activation** Not tested. **Psychotic Disorganization** Not tested. **Inhibition** Positive correlation with: - NSSCR & SCL Relationship to response amplitude not tested

Table 7.1 (Cont.)

	Inverse correlation with degree of R>L asymmetry in NSSCR Probable inverse correlation with degree of R>L asymmetry in response amplitudes Association with later habituation on left than right (i.e., inverse correlation with laterality index of X-intercepts).	Probable positive correlation with orienting activity No relationship to lateral asymmetry.
	Hallucinations Inverse correlation with: - response amplitudes - SCL (not NSSCR) Positive correlation with degree of R>L asymmetry in SCL Inverse correlation with degree of R>L asymmetry in NSSCR Association with later habituation on left than right (i.e., inverse correlation with laterality index of X-intercepts).	**Hallucinations** Not tested.
	Delusions Equivocal inverse correlation with response amplitude No relationship to tonic arousal (SCL, NSSCR) Positive correlation with degree of R>L asymmetry in SCL Association with later habituation on left than right (i.e., inverse correlation with laterality index of X-intercepts).	**Delusions** Not tested.
	Anxiety Not tested.	**Anxiety** Inverse correlation with: - SCL (not NSSCR) Relationship to response amplitude not tested No relationship with orienting activity or lateral asymmetry.
DRUG EFFECTS ON EDA	None detected	None detected

* Numbers signify hypotheses as listed in Chapter 4.

7.2 SCHIZOPHRENIA

7.2.1 Tonic Arousal.

It appears that patients in the midst of an acute schizophrenic psychosis are in a state of high tonic arousal according to both SCL and NSSCR measures. This is consistent with the reports mentioned in Section 3.2.1 of higher tonic arousal in schizophrenic subjects who exhibit ORs compared to normal controls. On the basis of our sketchy understanding of the control of tonic arousal, this state can reasonably be attributed to increased activation of dopaminergic and noradrenergic neural circuits involving the basal ganglia and possibly the influence of greater right hemisphere activation relative to left. This effect of asymmetrical activation of the cerebral hemispheres, on the basis of our understanding of skin conductance control via contralateral inhibitory pathways, is reflected in the right-greater-than-left asymmetry in tonic arousal in the schizophrenic group. As outlined in Chapter 3, this catecholamine-mediated arousal system has been related to the brain's sensory gating mechanism. It is therefore plausible to conclude that these findings are consistent, albeit indirectly, with the hypothesis of sensory gating failure in acute schizophrenic psychosis. In the stage of florid symptoms in other words, there is increased sensory input owing to failure to 'gate-out' stimuli and this is linked with a heightened readiness to respond to those inputs (i.e., heightened arousal).

7.2.2 Orienting Activity.

A more direct test of the sensory gating hypothesis failed, however. This was the inability to demonstrate increased orienting activity in schizophrenia in terms of increased OR frequency, shortened OR temporal variables (especially recovery time) and

delayed habituation. Increased orienting activity would imply augmentation of the 'gating-in' mechanism believed to centre particularly on the amygdala. The failure to obtain this result is somewhat puzzling in light of the association found between high tonic arousal and increased orienting activity in another non-schizophrenic sample.[1]

The stimulus conditions in the present study were conducive to eliciting ORs with greater frequency. The tones, at 91dB were relatively loud and these, combined with the background stimulation of 55 dB white noise, provided relatively intense stimulation that could have been expected to augment tonic arousal and increase the frequency of ORs. As pointed out by Bernstein *et al.*, schizophrenic subjects show increased responding in direct proportion to the intensity of the orienting stimuli.[2] Indeed, non-responders to low-intensity stimuli are known to exhibit ORs at higher levels of stimulus intensity.[3] Although the orienting activity in the schizophrenic group did not exceed that of normal controls, it certainly was greater than that represented in the literature for schizophrenia generally, as discussed in Section 3.2.1. The consensus in the literature had been that schizophrenia was associated with decreased responding. It was pointed out in Chapter 3, however, that the reported high frequency of non-responding may have been an artefact of selection processes. The samples reviewed were predominantly male, chronically ill, institutionalized and on long-term medication. The schizophrenic sample in the present study differed markedly from this. All subjects were acutely ill, recently hospitalized and either drug-free or briefly and relatively lightly medicated. It is not unreasonable to conclude, therefore, that the phenomenon of non-responsiveness is not a primary characteristic of schizophrenia but a secondary phenomenon related to other variables. It is possible that the latter may include environmental factors, drugs, illness duration and individual symptom-related psychophysiological variability, as well as other influences.

The fact that the frequency with which ORs were elicited was less than that which could be expected for the relatively intense stimulus conditions and less than that expected on the basis of the relatively high tonic arousal in the schizophrenic subjects suggests that there may be a fault in the mechanisms responsible either for generating the OR or for its habituation. There is a small amount of support for the latter to be found in the present study. In Section 6.2.4 (see Figure 6.2.4.2) it was reported that on the left side the trials to habituation criterion gave an estimate of habituation point that was less than that derived from the rate of decline of the OR amplitudes. Similar findings (side unspecified) were reported by Zahn and his colleagues.[4,5] One interpretation of this discrepancy between the rate of OR amplitude decline and the point of extinction of the OR is that there has been a 'premature' habituation prior to complete matching between the stimulus and its neural representation or 'map'. In other words, the hypothetical comparator may inappropriately signal that matching has occurred, with consequent extinction of the OR before the neuronal representation of the stimulus has actually been completed. If this is so, it suggests hippocampal dysfunction which, if the lateral asymmetry of this anomalous habituation found in the present study is valid, may be localized to right-sided hippocampal structures.

7.2.3 Response Amplitudes

Of importance to the model of the OR adopted in the present study was the failure to find increased response amplitudes in the schizophrenic group compared to the controls. It was predicted that the mismatch between preattentive mechanisms (PAMs) and short-term memory stores (STS) which was assumed to correlate with response amplitude as an indirect index of the 'call' to the central channel, would be greater in schizophrenia than in normal controls. This prediction was based on the view that PAMs

are dysfunctional in schizophrenia and that this is the primary information-processing abnormality in this disorder. The inverse relationship between response amplitude and age may have been a confounding factor in this regard although this explanation is most unlikely given the satisfactory degree to which the ages of the schizophrenic and normal control groups were compatible. It is likely that the lack of amplitude differences between these two groups is related to the symptom variability in the schizophrenic group. Indeed, the major thrust of the present research was to investigate this variability from the psychophysiological perspective. Thus, any difference between schizophrenia and normal controls in terms of response amplitudes would be likely to emerge only if the schizophrenic group was relatively homogeneous with respect to certain symptoms. Although the present schizophrenic sample is too small to provide adequate symptomatically homogeneous subgroups as an appropriate basis for comparison, it could be predicted that schizophrenic subjects with high levels of psychotic disorganiztion (positive formal thought disorder, disorganized behaviour, few hallucinations and delusions, few negative symptoms) - typical hebephrenic schizophrenia in other words - would show increased response amplitudes compared to both normal controls and more "organized" schizophrenic subjects (e.g., paranoid schizophrenia). This prediction is based on the theory of the OR which forms the basis of the present investigation and is compatible with the findings in regard to symptomatology *(v.i.)*. It is a prediction, however, which awaits confirmation using a larger sample than that of the present study in which symptomatically homogeneous subgroups could be compared.

7.2.4 Lateral Asymmetry.

Consistent with the theory of relative underactivity of the left cerebral hemisphere, electrodermal asymmetries were found in schizophrenic subjects in terms of

tonic arousal (NSSCR only), orienting activity and response amplitudes. The fact that so many different skin conductance variables conformed to this direction of asymmetry (i.e., R>L) suggests that there may be a relatively global phenomenon of activation/inactivation of one hemisphere relative to the other. These results represent seemingly unequivocal confirmation of the findings of Gruzelier and his colleagues and other investigators described in Section 3.2.2. However, this particular direction of asymmetry as found in the present study could be an effect of male-female differences, as was the case in the current depressed group. Schizophrenic males outnumbered schizophrenic females 2:1 in the present study, and an effect of sex was found when lateral asymmetries were examined in relation to sex using the laterality factor scores. Males had a tendency towards R>L asymmetries and females were inclined to show asymmetries in the opposite direction. The fact that the R>L asymmetries reported by others in schizophrenia may, in part, be an artefact due to sex differences is supported by the relevant literature. The samples used in the Gruzelier studies where R>L asymmetries have been consistently reported (see Section 3.2.2) were either exclusively or overwhelmingly (M:F ratios approximately 2:1) male. Indeed, the high frequency of R>L asymmetries in males compared to females is remarked upon in a paper by Gruzelier and Manchanda.[6]

Consequently, conclusions regarding the significance of the currently observed electrodermal asymmetries in schizophrenia are very difficult to make. The present sample (8 females) is rather small to examine these asymmetries separately for each sex. Nonetheless some *post hoc* comparisons have been made and these are summarized in Table 7.2.4.1. The schizophrenic and control groups were each divided according to sex and left-sided electrodermal variables were compared with those on the right side using the Wilcoxon matched-pairs statistic. The female schizophrenic sample (N = 8) was too small for this analysis and, in that case, the number of subjects with R>L

TABLE 7.2.4.1

Comparison of Electrodermal Asymmetries within Schizophrenic and Control Groups Divided by Sex

				Wilcoxon Matched Pairs		
		Female Schizophrenia (N=8)	Male Schizophrenia (N=16)	Female Control (N=19)	Male Control (N=16)
		R>L : L>R			
SCL:	Pre-tone	6 : 2	NS	NS	R>L (p=.098)
	Tone	4 : 4	NS	NS	NS
NSSCR:	Pre-tone	5 : 1	NS	NS	NS
	Tone	5 : 1	NS	NS	NS
SSCR Amp:	Pre-tone	3 : 4	R>L (p=.015)	NS	NS
	Tone	5 : 2	R>L (p=.007)	NS	NS
OR Amp:	First	3 : 2	R>L (p=.039)	NS	NS
	Mean	3 : 3	R>L (p=.001)	NS	NS
No. of ORs		2 : 0	R>L (p=.036)	NS	NS
Trials to habituation		1 : 0	R>L (p=.068)	NS	NS
X-Intercept		2 : 3	L>R (p=.028)	NS	NS

and L>R asymmetries are listed instead. It can be seen that there were no statistically significant results for either the male or female controls. Statistically significant R>L asymmetries were a frequent finding in the male schizophrenic group. There was, however, a substantial proportion in the female schizophrenic group who showed R>L asymmetries as well.

It seems fairly clear from these figures that an important but not the only source of variance with regard to lateral asymmetries in EDA of schizophrenic subjects may be that of sex differences. These findings provide a timely caveat with respect to conclusions which may be drawn regarding functional hemisphere asymmetries in schizophrenia that are based on skin conductance measurements in which the effect of sex difference is not taken into account. The R>L asymmetries reported in schizophrenia would otherwise be interpreted as an effect of increased tonic arousal, given the role of the right hemisphere in governing this variable, and/or relative underactivity of selective or sequential information processing operations which involve focused attention, a function for which the left hemisphere is said to be particularly adept. However, given the demonstrable role of sex differences, conclusions made along these lines must be made with due caution until the interaction between sex and illness-related lateralized hemisphere dysfunction can be elucidated further.

7.2.5 Symptomatology.

7.2.5.1 Activation.

There was an absence of significant correlation between any skin conductance variable and the symptom dimension postulated to be more or less a manifestation of sensory gating dysfunction, namely activation. This may be a reflection of the effects of several non-specific symptom items comprising this dimension combined with a degree of over-inclusiveness with respect to its constituent items.

7.2.5.2 Psychotic Disorganization.

Fundamental to the model of the OR adopted to explore the psychophysiology of schizophrenia were the measures of response amplitudes (both spontaneous and elicited) and their relationships to the various symptom dimensions. The psychotic disorganization dimension was postulated to represent closely the "core" psychotic process and to be a more or less direct manifestation of the proposed primary information processing abnormality in schizophrenia, namely, dysfunctional preattentive grouping with consequent "pigeonholing" (i.e., sequential processing) disorder. Disruption in the preattentive mechanisms (PAMs), it was proposed, would lead to increased mismatch between PAMs and STS in direct proportion to the severity of the psychotic disorganization symptom dimension. It was postulated that the degree of mismatch between PAMs and STS would be reflected in the magnitude of the "call" to the central channel for the allocation of processing capacity and an index of this would be the amplitude of the OR. Therefore, psychotic disorganization symptoms should correlate positively with response amplitudes.

Support was found for this concept. The BPRS measure 'conceptual

disorganization' was related to amplitude measures in this way. A similar correlation with the PSE dimension referred to as psychotic disorganization was not obtained. It is possible that this is due to the more heterogeneous nature of the symptoms on this PSE dimension (see Appendix B) whereas the BPRS measure was a fairly uncomplicated index of positive formal thought disorder alone. The BPRS 'conceptual disorganization' item was also positively related to tonic arousal as measured by NSSCR. These findings are thus consistent with a neural process which involves high arousal and relatively high levels of mismatch between PAMs and STS and which is closely related to the symptom dimension of conceptual disorganization.

It is assumed that this collection of interrelated phenomena represents the primary psychotic process which is activated in acute schizophrenic psychosis and that a set of secondary phenomena come into operation in reaction to this process and serve a compensatory or corrective function.

7.2.5.3 Inhibition

Probably the most important and widely used of these secondary compensatory processes is represented by the dimension of inhibition or so-called negative symptoms. This, it is thought, represents a process of restricted or narrowed attention with much incoming stimulation "gated out" or attenuated. It can be viewed as an attempt to handle the disorganization experienced as a result of dysfunctional PAMs by the simple quantitative means of restricting stimulus entry or closing the attentional 'filter'.

As predicted, there was a significant inverse relationship between this symptom dimension and response amplitudes and with both measures of tonic arousal (NSSCR and SCL). These findings substantially held for both the BPRS and the PSE measures of inhibition. The direction of these correlations is opposite to that found for the

dimension of psychotic disorganization and this is consistent with the proposal that one set of processes is acting to counter or correct the other.

The finding of an inverse relationship between inhibition and the degree of R>L asymmetry in NSSCR and response amplitudes is difficult to interpret in the light of the finding of sex differences in lateral asymmetry of EDA. To complicate matters further there was a correlation in the opposite direction between inhibition and degree of R>L asymmetry in SCL. This implies that the lateral control of SCL and responsiveness, in terms of response frequency and size, may be by independent mechanisms. The fact that the identical sets of relationships were found in relation to the hallucination dimension *(v.i.)* helps to support the concept of separate control mechanisms for absolute electrodermal levels and electrodermal responsiveness (frequency and amplitude), at least as far as laterality is concerned.

It is of interest, however, that these relationships between inhibition and electrodermal response asymmetry were in the direction *away from* the asymmetry which distinguished the schizophrenic group from normal controls. Whether this can be interpreted as a "normalizing" process on this basis is an intriguing speculation which cannot be directly tested in the present study. However, some indirect support for this view comes from the finding of an association between the inhibition dimension and a tendency for habituation to occur later on the left than the right, a measure based on differential rates of OR amplitude decline. This could imply an association between inhibition and a shift towards greater utilization of a sequential (i.e., left hemisphere) information processing mode. However, a L>R asymmetry in this variable (the X-intercept laterality index) characterized the schizophrenic group from normal controls at the outset which renders the association between inhibition and this variable sufficiently ambiguous to preclude any firm conclusion along these lines.

The most important finding, from the theoretical point of view, was that of the inverse relationship between inhibition and response amplitude. This was consistent with the model in which it was proposed that inhibition represented the symptom manifestation of a process of restricted attention or narrowing of the "attentional filter" by which the psychotogenic mismatch between PAMs and STS was quantitatively reduced by means of a reduction in the amount of sensory input. Such a reduction in the quantity of incoming stimuli, by reducing the degree of mismatch between PAMs and STS, has presumably attenuated the 'call' to the central channel and this has resulted in reduced response amplitudes proportionate to the severity of inhibition symptoms. These relationships, being in the opposite direction to those obtained between the same SC variables and psychotic disorganization, reinforce the view that inhibition represents the outward manifestations of compensatory operations which help to counter the psychotic disorganization process.

7.2.5.4 **Hallucinations.**

The relationships between the hallucination dimension and the skin conductance variables were virtually identical to those obtained in the case of the symptom dimension of inhibition. There was an inverse relationship between hallucinations and tonic arousal as measured by SCL (but not NSSCR, unlike that for inhibition). There were also very strong inverse correlations with response amplitudes.

The observed relationships between hallucinations and degree of lateral asymmetry in EDA were also identical with those found for inhibition symptoms. In this, the same reservations must be held for the hallucination dimension as for that of inhibition. The confounding factor of sex differences in lateral asymmetry puts a valid interpretation of these findings beyond reach.

The finding of inverse correlations between hallucinations and the response amplitude variables was as important from the theoretical point of view as it had been for the inhibition symptom dimension. It was proposed that hallucinations represented a secondary, compensatory process whereby the psychotogenic mismatch between primarily disordered PAMs and the STS was reduced through the operation of perceptual bias on the preattentively processed inputs. Perceptual bias, it was proposed, reduced mismatch by selecting stimulus features and conjoining them on the basis of the contents of the STS.

Under the conditions of sensory overload for which indirect evidence in acute schizophrenic psychosis has been found here (i.e. high tonic arousal), it is proposed that the operation of perceptual bias in this way would give rise to the phenomenon of illusory conjunctions in accordance with Treisman's theory.[6] It was proposed that these illusory conjunctions formed the nidus for the development of hallucinations, the content of which would be based on STS contents determining the nature of the perceptual bias. In combination with the processes of restricted attention (inhibition symptoms) these illusory conjunctions would be further processed in the central channel (serial processing) culminating in their full elaboration as well-formed hallucinations. The latter aspects in this sequence could not, of course, be tested in the present study. The concern here was with the operation of perceptual bias on primarily 'ungrouped' or disordered preattentively processed inputs by which order or coherence was *imposed* on those inputs in a pattern consistent with the contents of STS. There would thus be a *qualitatively* based reduction in mismatch between PAMs and STS. This, in turn, would reduce the magnitude of the 'call' to the central channel for the allocation of processing capacity which would be indexed as a reduction in OR amplitude. The latter reduction, the theory predicts, would be in proportion to the severity of hallucinations. This is exactly what was found. In brief, the findings are consistent with the theory that hallucinations reduce mismatch

between PAMs and STS (hence the inverse correlation with OR amplitude) by organizing inputs in terms of STS content through the vehicle of perceptual bias, in combination with restricted attention and under conditions of sensory overload. The formation of hallucinations, in other words, represents a qualitative reduction in mismatch between PAMs and STS by organization of the inputs whereas the processes responsible for inhibition quantitatively reduce this mismatch by restricting the amount of stimulus input. The organizing function of hallucinations in this context is particularly striking on inspection of the comparatively more robust correlations between response amplitudes and the hallucination *quotient* which is an index expressing the ratio of organization (i.e. hallucinations) to (psychotic) disorganization.

The reduction in arousal and, if valid, the shift away from R>L lateral assymetry associated with hallucinations and inhibition, when considered in the light of the accompanying reduction in response amplitudes, suggests that these processes may indicate a shift towards greater dominance of left hemisphere activity and possibly a greater efficiency in sequential processing operations - that is, capacity allocation/utilization - in the central channel.

7.2.5.5 Delusions.

This symptom dimension and that of hallucinations together comprise the organizing phenomena among the so-called secondary or corrective processes. The predicted relationship between delusions and skin conductance variables met with comparatively weak confirmation. There was no relationship with tonic arousal and the predicted inverse correlation with response amplitudes only occurred with the delusion quotient (i.e. ratio of delusional organization to psychotic disorganization) and only with the BPRS measure, not that based on the PSE. Those few correlations between lateral

EDA asymmetries were in the same direction as for hallucinations and inhibition. However, the same caveats with regard to interpreting the latter correlations in the light of observed sex differences in lateral asymmetry must apply for delusions as for hallucinations and inhibition.

It was not entirely unexpected that the predictions with respect to delusions should fail to be confirmed. Delusions seem to be more distantly removed from the immediate processing of sensory data in contrast to the dimensions of hallucinations and inhibition. Indeed, this is apparent on inspection of the model of the OR used here. Delusions would appear to be largely within the province of long-term memory stores where they could be viewed more as learned phenomena, not so immediately tied to perception. They would seem to have a more prominent part in the interpretation of perceptions rather than in their construction. Consequently their relationship to skin conductance variables, and the OR in particular, is likely to be more indirect than is the case with hallucinations and inhibition.

7.3 DEPRESSION

7.3.1 Tonic Arousal.

Contrary to the stated hypothesis and contrary to the literature, there was a failure to demonstrate low levels of tonic arousal in depressed subjects relative to controls. There was a very striking inverse relationship between age and SCL in the depressed group and a weaker but positive correlation between these two variables in the control group. These findings, together with the significantly older age of the depressed group compared to controls, made it impossible to determine whether SCL differences occurred between groups while controlling for age in an analysis of covariance. Therefore, as far as SCL was concerned, the only differences found between depressed and control subjects was in the direction of the correlation with age. Since there was no relationship between age and NSSCR, the latter measure of tonic arousal could be compared between the two groups in a more straightforward way. No statistically significant differences emerged, however.

The finding of an inverse relationship between age and SCL is at variance with the literature where a positive correlation between these two variables has generally been reported[7,8]. An explanation of these results does not readily present itself. Given the finding of an association between SCL and inhibition (*v.i.*), an examination of the relationship between this symptom dimension and age was undertaken by means of the Spearman correlation coefficient. For the PSE measure of inhibition, $\rho = -.49$ ($p = .013$), but no significant correlation emerged for the corresponding BPRS scale. This suggests that, in terms of psychomotor slowing, withdrawal and the remaining symptoms comprising the PSE inhibition dimension, younger depressed subjects are more severely affected than older subjects. Since this does not accord with general clinical impressions,

it may be that the present depressed sample is atypical in terms of its composition of severely depressed relatively young people. Half the present sample was between the ages of 55 and 65. The remaining 50% contained subjects as young as 21 years. It may be that the exclusion of more severely depressed younger people who, incidentally, tend not to be heavily represented in typical samples of major depressive disorder, would have yielded a different result with regard to the association between SCL and age.

The failure to find lower tonic arousal levels in depressed compared to control subjects is also somewhat surprising given the relatively widespread reports of this phenomenon in the litreature. It is possible that the experimental conditions in the present protocol may have accounted for this. The level of stimulation (55dB white noise with 91dB tones over almost 30 minutes) may have had an arousing effect on the depressed subjects to push their SCL and NSSCR scores above what would otherwise have occurred. In support of this explanation is the observation (not reported in Chapter 6) that tonic arousal in the depressed group actually tended to increase during the testing procedure, whereas the schizophrenic and control groups showed some degree of adaptation to the test procedure.

Another possible explanation for the current absence of low tonic arousal in depression is that the sample could have contained a disproportionately large number of agitated patients in whom tonic arousal has been reported as high (Section 3.3.3). It is not possible to resolve this question owing to the absence of a satisfactory means of examining the effects of agitation in the present sample in a way that makes realistic comparison with other investigations possible.

7.3.2 Orienting Activity.

The evidence for reduction in orienting activity in depression was mixed.

Low levels of orienting activity were anticipated on the basis of the view that depression represents, in part, a low arousal state of withdrawal or disengagement from the environment. It was here assumed that this state is one of a lack of responsiveness to external stimuli, possibly due to the 'gating-out' of stimulus inputs. This 'gating-out' phenomenon was believed to underly the expected lack of orienting activity in the present sample of depressed subjects.

There was no unequivocal pattern of reduced ORs or earlier habituation, although there were trends in this direction. The nature of these findings could have been a product of an idiosyncracy of the control sample. The rate of non-responsiveness was quite high in the latter group, 20% on the left side and 26% on the right. This is more than double the usual rate for normal controls (5-10%). Clearly, if the present control group had more closely resembled typical normal samples with respect to this variable, then the hypothesis of reduced orienting activity in depression would very likely have met with more substantial confirmation. In comparison to the schizophrenic group, at least, depressed subjects tended to show fewer ORs (Mann-Whitney U test: left side, $p < .10$; right side $p < .05$).

7.3.3 Lateral Asymmetry.

Evidence for the predicted L>R asymmetry in EDA in depression was very flimsy indeed. Most striking was the pronounced effect that sex differences had on the lateral asymmetry of tonic arousal measures. There was a definite L>R trend in tonic arousal asymmetry in female depressed subjects and an opposite direction of lateral asymmetry in depressed males. These findings contrast with the general lack of consistent SC asymmetry related to sex in the normal control groups. No lateral asymmetry of orienting activity or response amplitudes in relation to sex was observed in the depressed

group.

When these findings are considered along with somewhat similar results obtained in the schizophrenic group and the absence of lateral asymmetry in normal controls, it suggests that there may be a sex-related dynamic shift in hemisphere organization occurring in relation to psychopathological states that is not diagnosis-specific. Perhaps, in response to the primary pathological neural processes involved in psychiatric illnesses, certain adjustments are made in terms of hemisphere-related information processing strategies and these strategies differ depending on the sex of the patient. There have been reports of differential lateral asymmetries in cognitive functions in men and women. Although this subject cannot be reviewed here, it has been suggested that males are more strongly left-hemisphere lateralized than females for verbal abilities and may be more right lateralized than females for spatial abilities.[9] It may therefore be the case that males and females differ in the cognitive style or processing strategy with which they react to the primary neurophysiological perturbations of mental illness.

The results of the present study could be interpreted to suggest that psychopathogenic alterations in neural processes occurring in men tend to produce a shift in information processing strategies away from the largely left-hemisphere based sequential operations towards the more global, holistic, parallel processing operations which are linked with right hemisphere activation. On the other hand, mental illness-related effects on psychological state occurring in women may tend to induce a shift in processing strategies in the opposite direction. The occurrence of such dynamic processing shifts in relation to both schizophrenia and depression would be consistent with the view that these sex-related phenomena are independent of diagnosis.

7.3.4 Symptomatology.

In striking contrast to the expected findings, there was a *positive* rather than a negative relationship between both measures of tonic arousal (SCL and NSSCR) and the symptom dimension of inhibition (PSE and BPRS scales). In other words, the greater the psychomotor slowing, withdrawal, blunted affect and so on, the higher the level of tonic arousal.

This finding obviously runs counter to one's intuitive understanding of the relationship between tonic arousal and depression given the literature reporting low SCL in depression. It also appears, at first glance, to be at variance with the literature relating electrodermal activity to symptomatology in depression (e.g. Noble and Lader[10]). It would have thus been expected that the more severe the depression (as measured here by the inhibition dimension), the lower should be the level of tonic arousal. If the present findings are valid, then this intuitive understanding of the expected direction of psycho-physiological correlation is false.

In other unpublished research projects* we have found a significant *positive* correlation between the PSE inhibition dimension used here and post-dexamethasone serum cortisol concentrations (in the 1 mg overnight dexamethasone suppression test) in a diagnostically heterogeneous sample of psychiatric inpatients (N = 52). We have also demonstrated, in a sample of inpatients with major depressive disorder (N = 21), significant *positive* correlations between the PSE inhibition dimension and both platelet ^{3}H imipramine binding (Bmax and Kd) and urinary MHPG** concentrations. In fact,

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* Collaborative research projects between the Department of Psychiatry at the University of Adelaide and the Division of Clinical Chemistry at the Institute of Medical and Veterinary Science, South Australia.
** 3-Methoxy-4-hydroxyphenylglycol.

Table 7.3.4.1

Spearman Correlations between Tonic Arousal and Platelet ^{3}H-imipramine Binding (Bmax and Kd) and Urinary MHPG Correlations

			Spearman ρ (N = 14)		
			Platelet ^{3}H-imipramine binding		**Urinary MHPG concentration**
			B max	Kd	
SCL:	Pre-tone	Left	.52*	.46*	NS
		Right	.55*	.64**	NS
	Tones	Left	.56*	.49*	NS
		Right	.58*	.64**	NS
NSSCR:	Pre-tone	Left	NS	NS	NS
		Right	NS	NS	NS
	Tones	Left	NS	NS	NS
		Right	NS	NS	NS

** $p \leq .01$
* $p \leq .05$

14 of the subjects in the latter study were concomitantly studied in the present project. The results for these 14 subjects of the correlational analyses between tonic arousal and the above biochemical variables are shown in Table 7.3.4.1.

It can be seen that urinary MHPG appears unrelated to either measure of tonic arousal and the NSSCR measure is not significantly related to the platelet ^{3}H-imipramine binding indices. In contrast there is a significant positive correlation between SCL and both platelet ^{3}H-imipramine binding indices. Although only a small sample, the consistency of this relationship between ^{3}H-imipramine binding and SCL together with the fact that Kd, a variable which has not been related to clinical phenomena, correlated so strongly with SCL, indicates that these findings cannot be overlooked or attributed to chance.

There are thus recurring *positive* relationships between inhibition symptoms and physiological variables (i.e. serum cortisol concentrations, urinary MHPG, platelet ^{3}H-imipramine binding, tonic arousal) and even a modest positive correlation between tonic arousal and platelet-imipramine binding. The consistency of these findings helps to support the validity of the present results in which, contrary to the original hypothesis, the inhibition dimension was positively related to tonic arousal.

The most obvious explanation for the present findings in relation to EDA is that the symptom dimensions are simply measuring global severity of psychopathology and are thus reflecting a non-specific relationship between number of symptoms and tonic arousal. If this were the case, a positive relationship between total symptom score and tonic arousal would be expected. However, such a relationship was not found in the depressed group and neither was it found in the schizophrenic group.

It therefore seems reasonable to accept, for the present, the validity of the

positive relationship between inhibition and tonic arousal or autonomic activation. It also seems appropriate to accept the findings, repeatedly reported in the literature, of low tonic arousal in depression as a *trait* variable (see Section **3.3**.1). Certainly the tonic arousal levels in the depressed subjects of the present study were among the lowest for the entire sample even though statistical significance was not achieved in terms of this variable. The position is therefore taken that there is a premorbid 'down-regulation' of the mechanisms controlling autonomic activity/tonic arousal as a trait characteristic in persons vulnerable to major depressive disorder. It is further asserted that this remains a feature of an actual clinical episode of major depression, small but important state-dependent variations in this trait characteristic notwithstanding.

In recent years there has begun to grow a need to re-evaluate our understanding of affective disorder as *primarily* one of depressed mood, 'vegetative' changes, psychomotor slowing, withdrawal, disengagement from the environment and so on. The impetus for this re-evaluation comes in large part from the renewal of emphasis on the place of anxiety in affective disorder. At a practical clinical level, this is most apparent in the well-documented therapeutic response of certain anxiety states to antidepressant drugs. Of these, probably the most spectacular and well known is the control of 'endogenous' panic attacks by antidepressants. But others such as agoraphobia, obsessive-compulsive disorder and even post-traumatic stress disorder are included as anxiety states which may improve with antidepressant drugs. Also of interest in this context is the frequent but often overlooked occurrence of autonomic anxiety, including panic attacks, in the course of major depressive disorder. The converse is also not an infrequent finding, namely, the development of severe depressive states in the context of primary anxiety disorders.

At risk of adopting an extreme unitary approach to psychopathology, it may

not be inappropriate to view major affective disorders as primarily 'anxiety' disorders. Of course, the psychoanalytic movement has emphasised the primacy of such phenomena as separation anxiety and castration anxiety in the development of depressive illness. It may be that the biological approach to affective disorder is, by a different route, in the process of rediscovering the primacy of 'anxiety' (or autonomic arousal) in relation to depressive illness. Could the primary abnormality of a clinical episode of affective disorder be one of an upsurge in premorbidly 'down-regulated' biogenic amine-mediated autonomic activity ('anxiety' or 'arousal') which for some reason is associated with what may be a defensive response serving to retard psychomotor activity and disengage from the environment? If this is so, then the inhibition symptom dimension could be viewed to reflect proportionately this upsurge in autonomic output, which, nevertheless, remains small in an overall sense compared with normal subjects who do not show the trait of 'down-regulated' tonic arousal/autonomic activation.

This relationship obviously stands in contrast to the findings in relation to schizophrenia. In the latter illness, the results of the present study were consistent with a compensatory arousal-reducing effect of the process(es) represented by inhibition symptoms which countered the "core psychotic" process associated with increased tonic arousal. Thus, inhibition symptoms in schizophrenia and in primary affective disorder may be reflecting two quite different underlying pathological processes in each case.

These speculations, however, go beyond the limits of the data available in the present study. Answers to the questions implicit in these hypothetical explanations would require further studies involving different research methodologies.

CHAPTER 8

CONCLUSIONS

It would obviously be unwise to draw firm conclusions from the results of the present study. The work has raised more questions than it has answered, so that it would be quite inappropriate even to begin to propose definitive conclusions as to the nature of schizophrenia or depression. A more modest appraisal of the present work, as far as schizophrenia is concerned, would be that it represents a tentative proposal for a model of schizophrenia within an information-processing framework in which only a few aspects of that model have here been tested. Not surprisingly, attempts to confirm those hypotheses have met with mixed success, inviting further, more thorough hypothesis-testing and possible revision of the model in the light of that ongoing work.

This is not to shy away, however, from the task of drawing together the results of this study within the context of the model for schizophrenia put forward. With the preceding caveat in mind, it would not be inappropriate to assert that the present findings are consistent with aspects of that model although they obviously do not provide convincing evidence as to the model's validity in all of its ramifications.

It is possible, therefore, to state that the results of the present study are consistent with a view of schizophrenia in which a two-part process is involved in pathogenesis. In the first place, the findings are consistent with a break-down in sensory gating mechanisms in acute schizophrenic psychosis. Unfortunately, the evidence in support of this is indirect, namely, increased tonic arousal and, in particular, increased arousal in proportion to the severity of psychotic disorganization. It may be that increased sensory input, presumably based in part on basal ganglia dysfunction, is sufficient to compromise the ability of the proposed premorbidly dysfunctional PAMs to handle the increased volume of sensory input. In this context, tonic arousal could be viewed as an

intervening variable mediating the effects of environmental stress (e.g. high 'expressed emotion' families) on the presumably vulnerable early stages of perceptual information processing.

Secondly, the vulnerable PAMs, consequent upon increased input, are thought to become overwhelmed and the resulting lack of organization/grouping of inputs being compared with STS contents is augmented. The evidence from the present study which is consistent with this is the finding of increased SC response amplitudes in proportion to 'conceptual'/psychotic disorganization. This conclusion is based on the premise that the greater the mismatch between PAMs and STS (i.e. the more the disruption of the PAMs), the greater will be the 'call' to the central channel for allocation of processing capacity and that this is reflected in the amplitudes of SC responses. The failure to find increased response amplitudes in schizophrenia overall compared to normal controls can be accounted for by the proposed operation of secondary, compensatory operations which serve to correct for the primary abnormality and thus maintain a kind of homeostatic equilibrium.

The present study did not incorporate a specific test of PAMs, particularly that of preattentive grouping. Neither did it directly test the functioning of the central channel (i.e. 'pigeonholing' or sequential processing operations). Tests of these functions require further research. Nevertheless, the findings of the present study, as far as psychotic disorganization in schizophrenia is concerned, are not inconsistent with the model proposed for the OR in schizophrenia. However, one further caveat should be recalled at this point, namely, that these relationships held only for the BPRS 'conceptual disorganization' item (i.e., thought disorder) and not for the corresponding PSE-based

symptom dimension. The latter may well have been too overinclusive compared to the BPRS-based scale so that actual relationships between the SC variables in question and psychotic disorganization went undetected. Alternatively, it may be that positive formal thought disorder alone is the principal symptomatic manifestation of the postulated 'core' psychotic or psychotogenic process presumed to be activated by the combined effects of sensory gating dysfunction and impaired PAMs.

If these two mechanisms together represent the primary pathogenic processes of schizophrenia, each proportionate to the severity of psychotic disorganization or thought disorder, then the processes responsible for hallucinations and negative (i.e. inhibition) symptoms do, indeed, seem to counter their effects. The inverse relationship between response amplitudes and both hallucinations and the inhibition dimension, being in the opposite direction to those obtained between amplitude and psychotic disorganization, provides fairly sound evidence that the underlying processes responsible for the former symptom groups are acting in opposition to those responsible for psychotic disorganization. Although these findings do not provide unequivocal confirmation of the model for schizophrenia set out in Chapter 4, they are consistent with it in the sense that they represent confirmation of predictions based on that model. In other words, there may, of course, be alternative explanations to that provided within the framework of the present model. Nevertheless, the present findings do support the prediction that the operation of perceptual bias on preattentively processed 'inputs' which is proposed to form the basis of hallucinations, and the phenomenon of restricted attention forming the basis of inhibition symptoms, reduce mismatch between PAMs and STS, qualitatively in the case of hallucinations and quantitatively in the case of inhibition.

As a consequence of the reduced mismatch between PAMs and STS brought about by the processes responsible for hallucinations and inhibition symptoms, both of these symptom groups were associated with a reduction in tonic arousal levels. The inverse relationship between these symptoms and tonic arousal when contrasted with the positive correlation between psychotic disorganization and tonic arousal, provide further confirmation that each set of phenomena represent opposing processes.

Delusions, on the other hand, were not associated so clearly with reduced response amplitudes or decreased tonic arousal. This relative failure to confirm predictions based on the proposed model of schizophrenia in relation to delusions should not be surprising. The ideational organization of disordered perceptual inputs, which delusions have been here proposed to represent, is a phenomenon likely to be further removed from the immediate processing of sensory inputs than those which have been presumed to apply with respect to the mechanisms underlying hallucinations and inhibition symptoms. Delusions can be reasonably viewed as *interpretations* of perceptual inputs rather than as constructions of percepts (as are hallucinations) or restrictions of perceptual input (inhibition symptoms). It is therefore reasonable not to expect as close an association between delusions and the SC parameters of perceptual information processing, including sensory gating, as had been obtained with regard to the other secondary/compensatory phenomena, namely, hallucinations and the phenomenon of inhibition.

Tne information-processing picture of schizophrenia which can be built up thus far is of a primary disorganizing process linked to increased arousal (i.e. increased sensory inputs) and increased magnitude of 'calls' to the central channel for the allocation of processing capacity consequent upon dysfunctional PAMs. This primary process is

thought to be countered by secondary, compensatory mechanisms which serve to restore some form of homeostatic equilibrium by restricting the quantity of input (i.e. narrowing of the attentional 'filter') and by imposing order or coherence upon the inputs by means of perceptual organization (hallucinations) through the operation of perceptual bias. These secondary processes are linked with decreased tonic arousal and a reduction in the magnitude of calls to the central channel for capacity allocation.

Interpretation of the findings with respect to lateral asymmetry of skin conductance variables is problematic on two counts. Firstly, there were sex differences which contributed, to some extent, towards the finding of right-greater-than-left asymmetry in these variables in schizophrenia. Secondly, increased tonic arousal itself, as occurred in the schizophrenic group, tends to be associated with this direction of SC asymmetry. However, in the present study no significant positive correlation between tonic arousal and degree of lateral asymmetry was found. In addition, the results suggest that sex, albeit important, is not the only factor in determining the direction of SC asymmetry. Therefore, a tentative conclusion can be drawn that there is some evidence to suggest a direction of SC asymmetry in schizophrenia that is consistent with relative underactivation of left hemisphere functioning. This would be consistent with relative underactivation of sequential processing strategies. This conclusion, in conjunction with the finding of a positive correlation between psychotic disorganization and the magnitude of calls to the central channel for the allocation of sequential processing resources, suggests that such sequential processing capacity is being inadequately or ineffectively utilized and this may be because of the relative disorganization of preattentively processed inputs entering the central channel. If the disordered PAMs hand on inputs to the central channel which are less than

optimally organized (i.e. low signal-to-noise ratio), then sequential processing strategies probably could not operate effectively on those inputs and this may be the basis for underactivation of this left hemisphere-specialized mode of information processing. In this context it is interesting that the relationship between the secondary/compensatory symptoms and degree of lateral SC asymmetry was in a direction away from the R>L asymmetry which characterized the schizophrenic group. However, firm conclusions regarding SC asymmetry in schizophrenia as an index of relative activation/inactivation of hemisphere functioning must await further studies in which the effect of sex differences in SC asymmetry are adequately taken into account. There was also a dissociation between asymmetries in SCL and those in NSSCR which suggests that the lateral control of tonic arousal is not a unitary phenomenon.

As far as major depressive disorder is concerned, when the effect of age was taken into account, tonic arousal levels could not be shown to be significantly lower than in normal controls. Possible reasons for this unexpected finding (age and clinical characteristics of sample, experimental protocol) have been discussed in Chapter 7. Also, there was found only slender evidence for reduced orienting activity in depression. As with the schizophrenic group, there were substantial confounding effects of sex on lateral SC asymmetry so that conclusions with regard to relative hemisphere activation/inactivation in depression could not be made.

The unexpected positive correlation between tonic arousal and inhibition symptoms led to speculation that major depressive disorder may be a state of increased autonomic activation/arousal in persons with a premorbid trait of amine-mediated autonomic down-regulation relative to normal controls such that in spite of increases

proportionate to inhibition symptoms, overall arousal levels still appear lower in depression than in controls as has been widely reported elsewhere.

All of the above conclusions could, no doubt, be criticized for being speculative and too far removed from both the findings themselves and the nature of the data. In defence, however, it needs to be stated that this work has been predominantly a model-building exercise based on very limited tools - namely, sweating hands - and one in which the primary aim was to establish, with crude empirical support, a model for schizophrenia which was reducible to a set of testable hypotheses. It has been said that "asking the right question is perhaps the most important thing we can do."[1] Certainly no clear answers have come from the present project. Nevertheless, it is hoped that a useful step has been taken towards posing the "right question."

APPENDIX A

RATING INSTRUMENTS

P S Y C H O S I S P R O J E C T

NAME: _____ _____ U.R.: _____
Last First

ADDRESS: _____ Rater: _____

_____ Postcode: _____ Subject No [ ][ ][ ] (1 2 3)

TELEPHONE: _____ _____ Hospital: [ ] (4)
Home Work R.A.H. = 1, Hillcrest = 2

ADMISSION DATE: _____

TODAY'S DATE: _____ Birth date: [ ][ ][ ][ ][ ][ ] (5 6 7 8 9 10)

HOSPITAL DAY: _____

---

11 SEX: M 1, F 2. 12. RACE: W 1, B 2, A 3, O 4. 5. Other _____

13-14 AGE: , , , 15 ADMISSION STATUS: Vol. 1. Det. 2. NA

16-17 REFERRAL SOURCE: NA

Self	01	Physician	05	Social service	09
Spouse	02	Psychiatrist	06	Court/Police	10
Family	03	Psychiat. clinic	07	Guardian	11
Friend	04	Non psych. clinic	08	Other	12 _____

18 MARITAL STATUS: Single 1, Married 2, Sep. 3, Div. 4, Widow 5, Cohab. 6. N.A.

19 NUMBER BIOL CHILDREN _____ NA (≥9, write 9)

20 NUMBER ADOP/FOST CHILDREN _____ NA (≥9, write 9)

21 NUMBER BIOL SIBS _____ NA (≥9, write 9)

22 NUMBER ADOP/FOST SIBS _____ NA (≥9, write 9)

23 TWIN Yes 1, No 2, NA 24 HALF SIB Yes 1, No 2, NA

25 SIBLING POSITION _____ NA (≥9, write 9)

26-27 AGE AT FIRST MARRIAGE _____ NA

28 NEVER MARRIED Yes 1, No 2, NA

29 LIVING SITUATION NA

Alone	1	With other relatives	6
With parents	2	With friend(s)/non relatives	7
With spouse + children	3	Hostel/Half-way house/group home	8
With defacto + children	4	Institution/Treatment Facility/ Nursing Home	9
With own children	5		

EDUCATION

		Not Done	In progress	Partial	Completed	
30	Special Ed	1	2	3	4	NA
31	Primary (Years 1-7)	1	2	3	4	NA
32	Secondary (Years 8-12)	1	2	3	4	NA
33	Vocational training	1	2	3	4	NA
34	University/College	1	2	3	4	NA
35	Post graduate Education	1	2	3	4	NA

36-37 LEVEL OF EMPLOYMENT NA

Homemaker	01	Major manager/professional	06
Homemaker - 2nd job	02	Minor manager/professional	07
Student	03	Skilled	08
Self-employed worker	04	Semi-skilled	09
Self-employed entrepeneur	05	Unskilled	10

38 PRESENT EMPLOYMENT STATUS NA

Fully employed	1	Unemployed - seeking	3
Part-time	2	Unemployed - not seeking	4

....2.

PSYCHOSIS PROJECT contd. -2-

39 OCCUPATIONAL REHABILITATION No. 1 In progress 2 Partial 3 Completed 4 NA

40 RETIRED NA

Yes - regular 1
Yes - early 2
Yes - with part-time employment 3
No 4

PLACE OF BIRTH

		Australia	Europe	Asia	Other	Country	
41	Patient	1	2	3	4	_____	NA
42	Mother	1	2	3	4	_____	NA
43	Father	1	2	3	4	_____	NA

44 RELIGION NA

None 1
Protestant 2
Catholic 3
Minority/Other Christian 4
Hebrew 5
Moslem 6
Other 7
_____

45-46 PRECIPITATING STRESS NA

Love relationships 01
Sexual activity 02
Marriage 03
Family 04
Finances 05
Employment 06
School 07
Friendships 08
Court/Police 09
Social mobility 10
Social isolation. 11
Psychological complaints 12
Somatic complaints. 13
Physical Illness 14
None 15

47 DURATION OF PRECIPITATING STRESS NA

Less than 3 mo = 1, 3-12 mo = 2, More than 1 year = 3.

48-49 PRESENT ILLNESS AGE AT ONSET ' ' NA

50-54 DURATION OF ILLNESS (Years) [ ][ ][•][ ][ ] NA

55 DURATION OF PRESENT ILLNESS EPISODE NA

<1 week = 1, 1-3 week = 2, 1-6 mo = 3, 7-12 mo = 4, >1 year = 5.

BIRTH & CHILDHOOD

56 Pathological pregnancy and/or birth Yes = 1, No = 2, NA
57 Motor and/or speech delay Yes = 1, No = 2, NA
58 Childhood neurotic symptoms Yes = 1, No = 2, NA

FAMILY PSYCHIATRIC HISTORY NA

		1st Degree Relatives					Distant Relatives			
		0	?	1	>1		0	?	1	>1
59	Organic brain disease	1	2	3	4	60	1	2	3	4
61	Schizophrenia	1	2	3	4	62	1	2	3	4
63	Other psychoses	1	2	3	4	64	1	2	3	4
65	Bipolar Illness	1	2	3	4	66	1	2	3	4
67	Unipolar depression	1	2	3	4	68	1	2	3	4
69	Alcohol/Drug dependence	1	2	3	4	70	1	2	3	4
71	Neuroses	1	2	3	4	72	1	2	3	4
73	Personality disorder	1	2	3	4	74	1	2	3	4
75	Mental retardation	1	2	3	4	76	1	2	3	4
77	Other	1	2	3	4	78	1	2	3	4
79	Undetermined	1	2	3	4	80	1	2	3	4

SUICIDE ATTEMPTS - FAMILY (Including spouse)

1 Near rel. _____ (>9, write 9) NA
2 Distant rel. _____ (>9, write 9) NA
3-4 Total No. ' ' NA

COMPLETED SUICIDE - FAMILY

5 Near rel. _____ (>9, write 9) NA
6 Distant rel. _____ (>9, write 9) NA
7-8 Total No. ' ' NA
9-10 SUICIDE ATTEMPTS - PATIENT ' ' NA
11 NUMBER OF PREVIOUS PSYCHIATRIC ADMISSIONS ' ' NA

NEUROLOGICAL AND PHARMACOLOGICAL RECORD

Subject No. [ ][ ][ ] (1 2 3)

Hospital: R.A.H. = 1
Hillcrest = 2
[ ] (4)

Today's date: [ ][ ][ ][ ][ ][ ] (5 6 7 8 9 10)

Hospital Day: [ ][ ][ ] (11 12 13)

EXTRA PYRAMIDAL SYMPTOMS

		Absent	Mild	Moderate	Severe	Extreme	
14	Hypertonia/Rigidity	1	2	3	4	5	NA
15	Cogwheeling	1	2	3	4	5	NA
16	Hypotonia	1	2	3	4	5	NA
17	Tremor	1	2	3	4	5	NA
18	Bradykinesia	1	2	3	4	5	NA
19	Akathisia	1	2	3	4	5	NA
20	Acute Dystonia	1	2	3	4	5	NA
21	Tardive Dyskinesia	1	2	3	4	5	NA

MEDICATION

	Type	Dose/24 hours	Equiv.	Duration
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

ANNETT HANDEDNESS QUESTIONNAIRE

Which hand do you use:

1.	To write a letter legibly?.....	L	R	E
2.	To throw a ball to hit a target?.....	L	R	E
3.	To hold a racquet in tennis, squash or badminton?.....	L	R	E
4.	To hold a match whilst striking it?.....	L	R	E
5.	To cut with scissors?.....	L	R	E
6.	To guide a thread through the eye of a needle?..... (or guide needle on to thread)	L	R	E
7.	At the top of a broom while sweeping?.....	L	R	E
8.	At the top of a shovel when moving sand?.....	L	R	E
9.	To deal playing cards?.....	L	R	E
10.	To hammer a nail into wood?.....	L	R	E
11.	To hold a toothbrush while cleaning your teeth?.....	L	R	E
12.	To unscrew the lid of a jar?.....	L	R	E

L = Left hand
R = Right hand
E = Either/both hands.

Note:

Items 1,2,3,4,10 and 11 were used to determine classification of right-, left-, or mixed handedness. All six had to be right for classification as right-handed: all six had to be left for left-handedness: any other combination was classified as mixed. All 12 items were used to score 'degree' of right-handedness.

BRIEF PSYCHIATRIC RATING SCALE (BPRS)

DIRECTIONS: Draw a circle around the term under each symptom which best describes the patient's present condition.

1. SOMATIC CONCERN - Degree of concern over present bodily health. Rate the degree to which physical health is perceived as a problem by the patient, whether complaints have realistic basis or not.
   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

2. ANXIETY - Worry, fear, or over-concern for present or future. Rate solely on the basis of verbal report of patient's own subjective experiences. Do not infer anxiety from physical signs or from neurotic defense mechanisms.

   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

3. EMOTONAL WITHDRAWAL - Deficiency in relating to the interviewer and the interview situation. Rate only degree to which the patient gives the impression of failing to be in emotional contact with other people in the interview situation.

   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

4. CONCEPTUAL DISORGANIZATION - Degree to which the thought processes are confused, disconnected or disorganised. Rate on the basis of integration of the verbal products of the patient; do not rate on the basis of the patient's subjective impression of his own level of functioning.

   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

5. GUILT FEELINGS - Over-concern or remorse for past behaviour. Rate on the basis of the patient's subjective experiences of guilt as evidenced by verbal report with appropriate affect; do not infer guilt feelings from depression, anxiety, or neurotic defenses.

   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

6. TENSION - Physical and motor manifestations of tension, "nervousness", and heightened activation level. Tension should be rated solely on the basis of physical signs and motor behaviour and not on the basis of subjective experiences of tension reported by the patient.

   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

7. MANNERISMS AND POSTURING - Unusual and unnatural motor behaviour, the type of motor behaviour which causes certain mental patients to stand out in a crowd of normal people. Rate only abnormality of movements; do not rate simple heightened motor activity here.

   NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

8. GRANDIOSITY - Exaggerated self-opinion, conviction of unusual ability or powers. Rate only on the basis of patient's statements about himself or self-in-relation-to-others, not on the basis of his demeanour in the interview situation.

BRIEF PSYCHIATRIC RATING SCALE (continued)

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

9. DEPRESSED MOOD - Despondency in mood, sadness. Rate only degree of despondency; do not rate on the basis of inferences concerning depression based upon general retardation and somatic complaints.

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

10. HOSTILITY - Animosity, contempt, belligerence, disdain for other people outside the interview situation. Rate solely on the basis of the verbal report of feelings and actions of the patient towards others; do not infer hostility from neurotic defenses, anxiety nor somatic complaints. (Rate attitude toward interviewer under "uncooperativeness".)

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

11. SUSPICIOUSNESS - Belief (delusional or otherwise) that others have now, or have had in the past, malicious or discriminatory intent toward the patient. On the basis of verbal report, rate only those suspicions which are currently held whether they concern past or present circumstances.

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

12. HALLUCINATORY BEHAVIOUR - Perceptions without normal external stimulus correspondence. Rate only those experiences which are reported to have occurred within the last week and which are described as distinctly different from the thought and imagery processes of normal people.

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

13. MOTOR RETARDATION - Reduction in energy level evidenced in slowed movements and speech, reduced body tone, decreased number of movements. Rate on the basis of observed behaviour of the patient only; do not rate on basis of patient's subjective impression of his own energy level.

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

14. UNCOOPERATIVENESS - Evidence of resistance, unfriendliness, resentment, and lack of readiness to cooperate with the interviewer. Rate only on the basis of the patient's attitude and responses to the interviewer and the interview situation; do not rate on basis of reported resentment or uncooperativeness outside the interview situation.
NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

15. UNUSUAL THOUGHT CONTENT - Unusual, odd, strange, or bizarre thought content. Rate here the degree of unusualness, not the degree of disorganisation of thought processes.

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

16. BLUNTED AFFECT - Reduced emotional tone, apparent lack of normal feeling or involvement.

NOT PRESENT VERY MILD MILD MODERATE MOD. SEVERE SEVERE EXTREMELY SEVERE

Present State Examination

J.K. Wing, J.E. Cooper and N. Sartorius

Cambridge University Press, London, 1974.

INSTRUCTIONS

The instruction manual contains a detailed description of the origins, development and underlying principles of the PSE and a glossary of definitions of symptoms. The examiner must be thoroughly familiar with the manual and glossary and should have had some prior training in the use of the PSE.

Four kinds of question are written into the schedule:

(*a*) *Obligatory (starred) questions*

These must be asked if the interview is conducted at all. Only 54 questions are involved. Thus subjects with no symptoms, who ask clarifying questions of their own and who answer clearly and decisively, can be screened very quickly indeed. Whenever there is any doubt, however, and certainly whenever a symptom needs clarification, the second kind of question should be asked.

(*b*) *Bracketed questions above cut-off points*

These help to define the nature and extent of a symptom and should always be asked if there is any doubt about replies to obligatory questions.

(*c*) *Unbracketed questions below cut-off points*

Once the examiner has proceeded below a cut-off point, he must ask *all* the unbracketed questions in that part of the section.

(*d*) *Bracketed questions below cut-off points*

These serve the same function as similar questions above cut-off points, i.e. they help to define the nature and extent of a symptom. They are used only if there is some other evidence that the symptom is present.

In addition, the examiner himself will usually wish to ask other questions which are not written into the schedule, either general probes or more specific questions, depending on the nature of the patient's replies.

Each symptom is defined to some extent within the schedule itself but the examiner must be completely familiar with the fuller definitions in the glossary. A full discussion of scoring is also included in the glossary, particularly as to how to differentiate (0) from (1), and (1) from (2).

(0) = Examiner satisfied that symptom not present to clinically significant degree during past month.

(8) = Examiner not sure whether symptom present during past month, even though the appropriate questions have been asked, and answered without incoherence or evasion. The symptom cannot be excluded.

(9) = No rating can be made because question not asked or subject does not answer or answer is incomprehensible.

It should be emphasised that using the PSE schedule will not in itself guarantee useful results. The quality of the output of any system depends on the quality of the input.

1. INTRODUCTION

The interviewer should introduce himself briefly, describe the purpose of the interview and explain about any recording equipment. The purpose of the introductory section is to obtain an overall picture of the symptomatology, in the subject's own words.

** To begin with, I should like to get an idea of the sort of problems that have been troubling you during the past month. What have been the main difficulties?

Record the main symptoms spontaneously mentioned.

Means of exploration, if subject gives inadequate information:

If subject's statement too brief	Can you tell me more about that?
If subject has no more to add	What else has been troubling you?
If statements are difficult to understand	Can you explain what you mean by . . . ?
If subject is vague	Could you give an example of . . . ?
If no other response forthcoming	Why did you come to the (hospital)?

RATE PATIENT'S ACCOUNT OF SYMPTOMS.

0 = Subject responds adequately.

1 = Account somewhat inadequate but interview can proceed.

2 = Account seriously inadequate but interview proceeds in an attempt to rate some subjective responses, as well as behaviour, affect and speech. ____ (see 140)

3 = Impossible to continue with interview. Only behaviour, affect and speech sections rated.

REASONS FOR INADEQUACY (TICK AS MANY AS APPROPRIATE).

Denial or guardedness	____	Inattention	____
Incoherence	____	Refusal	____
Irrelevance	____	Patient mute, stuporous, etc.	____
Replies too brief	____	Other, specify	____
Poverty of content of speech	____		

IF (1) OR (2) CARRY ON WITH SECTION 2, UNLESS SUBJECT MENTIONS OR HINTS AT DELUSIONS OR HALLUCINATIONS → SECTION 18.

Cut off

Current treatment, if subject not seen in hospital or clinic
Rate the following if sufficient information has already emerged.
If not, use the suggested question:
May I ask if you are seeing any doctor for your nerves?
Or specify if psychosomatic complaints.

What kind of doctor is he?
Your own GP? A private doctor? Psychiatrist?

0 = No doctor
1 = GP
2 = Private doctor other than GP
3 = Psychiatrist
4 = Hospital out-patient (other than psychiatric)
5 = Other paramedical specialist, or osteopath
6 = Other specify

Are you attending for treatment any person who is not medically qualified, e.g. lay therapist, herbalist, acupuncture, faith healer, Christian Science, church which forbids medical advice?
What were you complaining of at the time?

Specify type of treatment

Complaint

2. HEALTH, WORRYING, TENSION

** Is your physical health good?
(Does your body function normally?)

** Do you feel you are physically ill in any way?
(What is that like? How serious is it?)

RATE SUBJECT'S OWN SUBJECTIVE EVALUATION OF PRESENT PHYSICAL HEALTH (*irrespective of whether physical disease is present*). ☐ (1)

0 = Feels physically very fit.
1 = Feels particular physical complaint but does not say positively feels fit.
2 = Feels unwell but not seriously incapacitated.
3 = Feels seriously incapacitated by physical illness.

** What does your doctor say is wrong?
(Have you had a physical illness recently; colds, influenza, etc.?)

RATE PRESENCE OF PHYSICAL ILLNESS OR HANDICAP, *taking results of recent investigations and physical state examinations into account.* ☐ (2)

0 = No physical illness or handicap present.
1 = Mild but significant physical illness or handicap (e.g. influenza or limp).
2 = More serious physical illness or handicap present but not incapacitating or threatening to life (e.g. deafness or duodenal ulcer).
3 = Physical illness or handicap present which is incapacitating or threatening to life (e.g. blindness or carcinoma).

Specify illness, disabilities and duration:

RATE PSYCHOSOMATIC SYMPTOMS. ☐ (3)
Special projects only

** Have you worried a lot during the past month?
(What do you worry about?)
PROBE: (Money, housing, children, health, work, marriage, relatives, friends, neighbours, other).
(How much do you worry? Are you a worrier?)
If any indication of worry, use further probes:

** What is it like when you worry?
(What sort of state of mind do you get into?)
(Do unpleasant thoughts constantly go round and round in your mind?)
(Can you stop them by turning your attention to something else?)
RATE WORRYING: *A round of painful thought which cannot be stopped and is out of proportion to the subject worried about.* ☐ (4)

1 = Symptom definitely present during past month, but of moderate clinical intensity or intense less than 50% of the time.
2 = Symptom clinically intense more than 50% of the month.

** Have you had headaches, or other aches or pains, during the past month?
(What kind?)
RATE ONLY TENSION PAINS, e.g. *'band round head', 'pressure', 'tightness in scalp', 'ache in back of neck', etc., not migraine.* ☐ (5)

1 = Symptom definitely present during past month, but of moderate clinical intensity, or intense less than 50% of the time.
2 = Symptom clinically intense more than 50% of past month.

** Have you been getting exhausted and worn out during the day or evening, even when you haven't been working very hard?
RATE TIREDNESS OR EXHAUSTION: *Do not include tiredness due to 'flu, etc. = 9.* ☐ (6)

1 = Only moderate form of symptom (tiredness) present; or intense form (exhaustion) less than 50% of the time.
2 = Intense form of symptom (exhaustion) present more than 50% of the past month.

** Have you had difficulty in relaxing during the past month?
(Do your muscles feel tensed up?)
RATE MUSCULAR TENSION: *Do not include a subjective feeling of nervous tension, which is rated later.* ☐ (7)
1 = Symptom definitely present during past month, but of moderate clinical intensity, or intense less than 50% of the time.
2 = Symptom clinically intense more than 50% of past month.

** Have you been so fidgety and restless that you couldn't sit still?
RATE RESTLESSNESS. ☐ (8)
(Do you have to keep pacing up and down?)
1 = Only moderate form of symptom (fidgety, restless) present; or intense form (pacing, can't sit down) less than 50% of the time.
2 = Intense form of symptom (pacing, etc.) present more than 50% of past month.

** Do you tend to worry over your physical health?
RATE HYPOCHONDRIASIS: *Overconcern with possibility of death, disease or malfunction. Re-rate at end of interview if subject constantly reverts to hypochondriacal preoccupation. Consider ratings of symptoms (1) and (3).* ☐ (9)
1 = Symptom present during past month, but not (2).
2 = Subject constantly reverts to hypochondriacal preoccupations during interview.

** Do you often feel on edge or keyed up or mentally tense or strained?
(Do you generally suffer with your nerves?)
(Do you suffer from nervous exhaustion?)
RATE SUBJECTIVE FEELING OF 'NERVOUS TENSION': *There is no need for autonomic accompaniments for this symptom to be rated present.* ☐ (10)
1 = Symptom definitely present during past month, but of moderate intensity, or intense less than 50% of the time.
2 = Intense form of symptom present more than 50% of the past month.

** Do you find that a lot of noise upsets you?
(Do noises sometimes seem to penetrate, or go through your head?)
RATE HYPERSENSITIVITY TO NOISE. ☐
1 = Moderate degree during month.
2 = Severe degree during month.

3. AUTONOMIC ANXIETY

In this section, rate only subjective anxiety with autonomic accompaniments, either free-floating or situational. Do not include worrying or nervous tension. Do not include anxiety due to, e.g., persecutory delusions, except in the special item (no. 13).

(CHECK LIST of autonomic accompaniments:

Blushing	Dry mouth
Butterflies	Giddiness
Choking	Palpitations
Difficulty getting breath	Sweating
Dizziness	Trembling)

** Have there been times lately when you have been very anxious or frightened?
(What was this like?)
(Did your heart beat fast?) *Ask for other autonomic symptoms.*
(How often in the past month?)
RATE FREE-FLOATING AUTONOMIC ANXIETY: *Exclude if due to delusions. Exclude if purely situational.* ☐ (11)
1 = Symptom definitely present, with autonomic accompaniment, during past month, but of moderate clinical intensity, or intense less than 50% of the time.
2 = Symptom clinically intense more than 50% of the time.

** Have you had the feeling that something terrible might happen?
(That some disaster might occur but you are not sure what? Like illness or death or ruination?)
(Have you been anxious about getting up in the morning because you are afraid to face the day?)
(What did it feel like?)
RATE ANXIOUS FOREBODING WITH AUTONOMIC ACCOMPANIMENTS. ☐ (12)
1 = Symptom definitely present, with autonomic accompaniment, during past month, but of moderate clinical intensity, or intense less than 50% of the time.
2 = Symptom clinically intense more than 50% of the time.
RATE AUTONOMIC ANXIETY DUE TO DELUSIONS, *etc. and if necessary defer to end of interview.* ☐ (13)
0 = No anxiety due to delusions or hallucinations.
1 = Subject complains of anxiety but no evidence of anxiety on examination.
2 = Clearly anxious or frightened because of delusions or hallucinations.

CUT OFF IF NO EVIDENCE OF ANXIETY OR IF ANXIETY DUE ONLY TO DELUSIONS → SECTION 4.

Cut off ☐

Have you had times when you felt shaky, or your heart pounded, or you felt sweaty, and you simply had to do something about it?
(What was it like?)
(What was happening at the time?)
(How often during the past month?)
RATE PANIC ATTACKS WITH AUTONOMIC SYMPTOMS:
A panic attack is intolerable anxiety leading to some action to end it, e.g. leaving a bus, phoning husband at work, going in to see a neighbour, etc. (14)
1 = One to four panic attacks during month
2 = Panic attacks five times or more.

Do you tend to get anxious in certain situations, such as travelling, or being alone, or being in a lift or tube train?
(What situations? How often during the past month?)
(CHECK LIST: *Can be presented on separate card and each item rated separately, if needed.*
Crowds (shop, street, theatre, cinema, church).
Going out alone; being at home alone.
Enclosed spaces (hairdresser, phone booth, tunnel).
Open spaces, bridges.
Travelling (buses, cars, trains).) (15)
RATE SITUATIONAL AUTONOMIC ANXIETY.
1 = Has not been in such situations during the past month but aware that anxiety would have been present if the situation had occurred.
2 = Situation has occurred during the past month and patient did feel anxious because of it.

What about meeting people, e.g. going into a crowded room, making conversation?
(CHECK LIST: *Present card if necessary:*
Speaking to an audience.
Eating, drinking or writing in front of other people.
Parties.) (16)
RATE AUTONOMIC ANXIETY ON MEETING PEOPLE.
1 = Has not been in such situations during the past month but aware that anxiety would have been present if the situation had occurred.
2 = Situation has occurred during the past month and patient did feel anxious because of it.

Do you have any special fears, like some people are scared of feathers or cats or spiders or birds?
(CHECK LIST: *Present card if necessary:*
Heights, thunderstorms, darkness.
Animals or insects of any kind.
Dentists, injections, blood, injury.)

RATE ONLY SPECIFIC PHOBIAS, NOT GENERAL SITUATIONAL ANXIETY. (17)
1 = Has not been in such situations during the past month but aware that anxiety would have been present if the situation had occurred.
2 = Situation has occurred during the past month and patient did feel anxious because of it.

Do you avoid any of these situations (specify as appropriate) because you know you will get anxious?
(How much does it affect your life?) (18)
RATE AVOIDANCE OF ANXIETY-PROVOKING SITUATIONS.
1 = Subject tends to avoid such situations whenever possible.
2 = Marked generalisation of avoidance has occurred during past month, e.g. subject has not dared to leave the house or has gone out only if accompanied.
Describe anxiety symptoms and list phobias.

4. THINKING, CONCENTRATION, ETC.

** Can you think clearly or is there any interference with your thoughts?

** Do your thoughts tend to be muddled or slow?
(Can you make up your mind about simple things quite easily?) (Make decisions about everyday matters?)
RATE SUBJECTIVELY INEFFICIENT THINKING *(if due to intrusion of alien thoughts, rate 9).* (19)
1 = Symptom definitely present during the past month, but of moderate clinical intensity, or intense less than 50% of the time.
2 = Symptom clinically intense more than 50% of the past month.

** What has your concentration been like recently?
(Can you read an article in the paper or watch a TV programme right through?)
(Do your thoughts drift off so that you don't take things in?) (20)
RATE POOR CONCENTRATION.
1 = Only moderate form of symptom present during the past month (e.g. can read a short article, can concentrate if tries hard); or intense less than 50% of the time.
2 = Symptom clinically intense (cannot attempt to read or concentrate) more than 50% of the past month.

** Do you tend to brood on things?
(So much that you even neglect your work?) (21)
RATE NEGLECT DUE TO BROODING.
1 = Symptom has caused moderate impairment to work or social relationships.
2 = Marked impairment.

** What about your interests, have they changed at all?
(Have you lost interest in work, or hobbies, or recreations?)
(Have you let your appearance go?)
RATE LOSS OF INTEREST *continuing during the past month.* ☐ (22)
1 = Symptom definitely present during the past month, but of moderate clinical severity or severe loss less than 50% of the time.
2 = Symptom clinically severe more than 50% of the past month.

** Have you become interested in new things at all?
IF EVIDENCE OF EXPANSIVE MOOD OR IDEAS → SECTION 9.
IF ODD IDEAS, EXPLORE FURTHER. PROCEED TO SECTION 15 IF APPROPRIATE.

** Have you suffered any lapses of memory recently? (PROBE ONLY)
IF EVIDENCE OF DISSOCIATION OR ORGANIC MEMORY LOSS → SECTION 16.

ANSWERS TO THESE QUESTIONS MAY SUGGEST THAT OTHER TYPES OF THOUGHT DISORDER ARE PRESENT, IF NOT, CUT OFF → SECTION 5.

Cut off ☐

IF ANY EVIDENCE OF THOUGHT DISORDER:

Are you in full control of your thoughts?
Can people read your mind?
Is anything like hypnotism or telepathy going on?

IF NECESSARY, PROCEED TO SECTION 13.

5. DEPRESSED MOOD

** Do you keep reasonably cheerful or have you been very depressed or low-spirited recently?
Have you cried at all?
(When did you last really enjoy doing anything?)

RATE DEPRESSED MOOD. N.B. *When rating clinical severity of depression remember that deeply depressed people may not necessarily cry. See definition in glossary.* ☐ (23)
1 = Only moderately depressed during past month, or deep depression for less than 50% of the time and tending to vary in intensity.
2 = Deeply depressed for more than 50% of the past month, and tending to be unvarying in intensity.

** How do you see the future?
(Has life seemed quite hopeless?)
(Can you see any future?)
(Have you given up or does there still seem some reason for trying?)
RATE HOPELESSNESS *on subject's own view at present.* ☐ (24)
1 = Hopelessness of moderate intensity but still has some degree of hope for the future (irrespective of time during month).
2 = Intense form of symptom (patient has given up hope altogether).

USE JUDGEMENT ABOUT WORDING.

** Have you felt that life wasn't worth living?
(Did you ever feel like ending it all?)
(What did you think you might do?)
(Did you actually try?)
RATE SUICIDAL PLANS OR ACTS. ☐ (25)
1 = Deliberately considered suicide (not just a fleeting thought) but made no attempt.
2 = Suicidal attempt but subject's life never likely to be in serious danger, except unintentionally.
3 = Suicidal attempt apparently designed to end in death (i.e. accidental discovery or inefficient means).

N.B. *Examiner should judge clinically whether there was intent to end life or not. If in doubt, assume not.*

Cut off ☐

IF EVIDENCE OF BOTH DEPRESSION AND ANXIETY RATE ANXIETY OR DEPRESSION PRIMARY.

If subject suffers from both anxiety and depression, and both have been rated as present, try to decide which is primary.
Which seems worse, the depression or the anxiety? (Use patient's own terms). ☐ (26)
0. Anxiety is primary. Depression appears to be entirely explicable in terms of the limitations placed on the subject by the symptoms of anxiety, e.g. being unable to leave the house, travel, meet people, etc., or being afraid of heart disease because of palpitations.
1. Anxiety and depression both present but seem independent of each other or it is not possible to decide whether one of them is primary.
2. Depression is primary. Anxiety is either a result of the depression (e.g. subject is frightened because of morbid or suicidal ideas) or it takes the form of fears of catastrophe, forebodings about illness or death, dread of having to face the day when first waking in the morning, preoccupation that something awful is going to happen. Panic attacks and situational anxiety, if present, are secondary to depression

Is the depression worse at any particular time of day? (27)
RATE MORNING DEPRESSION *(particularly on waking)*
0 = No depression.
1 = Not specially marked in mornings.
2 = Specially marked in mornings.

6. SELF AND OTHERS

** Have you wanted to stay away from other people?
(Why?)
(Have you been suspicious of their intentions? Of actual harm?) (28)
RATE SOCIAL WITHDRAWAL.
1 = Only passive form of symptom, i.e. subject does not seek company but does not refuse it if offered; or, if active withdrawal, less than 50% of the month.
2 = Actively avoids company (refuses it if offered). Actively withdraws in this way for more than 50% of the month.

** What is your opinion of yourself compared to other people?
(Do you feel better, or not as good, or about the same as most?)
(Do you feel inferior or even worthless?) (29)
RATE SELF-DEPRECIATION.
1 = Some inferiority, not amounting to feeling of worthlessness. If subject considers self to be worthless, this intense form of the symptom is present less than 50% of the time.
2 = Subject considers self to be completely worthless. Symptom present more than 50% of the month.

** How confident do you feel in yourself:
(For example, in talking to others, or in managing your relations with other people?)
RATE LACK OF SELF-CONFIDENCE WITH OTHER PEOPLE. *Consider only competence in social relationships, not competence at mechanical work, etc.* (30)
1 = Moderate lack of self-confidence, or intense lack less than 50% of the month.
2 = Intense lack of self-confidence more than 50% of the month.

** Are you self-conscious in public?
(Do you get the feeling that other people are taking notice of you in the street or a bus or a restaurant?)
(Do they ever seem to laugh at you or talk about you critically?)
(Do you consider people really are looking at you, or is it perhaps the way you feel about it?) (31)
RATE SIMPLE IDEAS OF REFERENCE (NOT DELUSIONS).
1 = Marked self-consciousness only (irrespective of time during month).
2 = Feels that people are criticising or laughing at self but can be reassured.

IF NO EVIDENCE OF GUILT, CUT OFF → SECTION 7.

(IF EVIDENCE OF MISINTERPRETATIONS, DELUSIONS OF REFERENCE OR PERSECUTION → SECTIONS 15B, 15C.)

Cut off

IF EVIDENCE OF GUILT:

Do you have the feeling that you are being blamed for something, or even accused?
What about?
RATE GUILTY IDEAS OF REFERENCE. *Do not include justifiable blame or accusation. Exclude delusions of guilt.* (32)
1 = Subject feels blamed but not accused (irrespective of time during month).
2 = Subject feels accused of some sin or misdemeanour. Not delusional

IF DELUSIONS OF REFERENCE MAY BE PRESENT → SECTION 15B.

Do you tend to blame yourself at all?
(If people are critical, do you think you deserve it?) (33)
RATE PATHOLOGICAL GUILT ONLY.
1 = Subject feels over-guilty about some peccadillo (irrespective of time during month).
2 = Subject feels to blame for everything that has gone wrong even when not his fault, but not delusional.

IF DELUSIONS OF GUILT MAY BE PRESENT → SECTION 15G.

Do you blame anyone else for your troubles?

IF DELUSIONS OF PERSECUTION → SECTION 15C.

7. APPETITE, SLEEP, RETARDATION, LIBIDO

** What has your appetite been like recently?
(Have you lost any weight during the past three months?)
RATE LOSS OF WEIGHT DUE TO POOR APPETITE. (34)
Do not include changes due to physical illness.
1 = Less than 7 lb (15 kg).
2 = 7 lb (15 kg) or more.

** Have you had any trouble getting off to sleep during the past month?
(How long do you lie awake?)
(What happens if you take sleeping tablets?)
(How often does it happen?)

RATE DELAYED SLEEP. (35)
1 = One hour or more delay (irrespective of sleeping tablets).
2 = Two hours or more delay (irrespective of sleeping tablets).
(In either case, ten or more nights during month.)

** Do you seem to be slowed down in your movements, or to have too little energy recently? How much has it affected you?
(Do things seem to be moving too fast for you?)
RATE SUBJECTIVE ANERGIA AND RETARDATION. (36)
1 = Marked subjective listlessness and lack of energy.
2 = Marked retardation and underactivity (Irrespective of time during month).

IF NO APPETITE OR SLEEP DISTURBANCE, AND NO DEPRESSION, CUT OFF → SECTION 8.

Cut off

IF SLEEP DISTURBANCE OR DEPRESSION:

Do you wake early in the morning? (37)
RATE EARLY WAKING *(one hour before usual).*
1 = One hour or more before ordinary time.
2 = Two hours or more before ordinary time.
(In either case, ten or more nights during month.)

Has there been any change in your interest in sex?
RATE LOSS OF LIBIDO WITHIN PRESENT EPISODE OF ILLNESS AND PERSISTING DURING PAST MONTH. (38)
1 = Marked loss of interest and performance.
2 = Almost total loss of libido.

Does the depression or tension get worst just before the start of the monthly period? (39)
RATE PREMENSTRUAL EXACERBATION
0 = No definite exacerbation.
1 = Marked exacerbation.

8. IRRITABILITY

** Have you been very much more irritable than usual recently?
(How do you show it?)
(Do you keep it to yourself, or shout, or even hit people?) (40)
RATE IRRITABILITY.
1 = Keeps irritation to himself.
2 = Shows anger by shouting or quarrelling.
3 = Shows anger by hitting people, throwing or breaking things.

9. EXPANSIVE MOOD AND IDEATION

** Have you sometimes felt particularly cheerful and on top of the world, without any reason?
(Too cheerful to be healthy?)
(How long does it last?) (41)
RATE EXPANSIVE MOOD: *not ordinary high spirits.*
1 = Moderately expansive mood (euphoria with marked element of inappropriateness or excitement, whether recognised by subject or not), present during past month, and persistent for hours at a time.* *Do not include transient high spirits.* Not necessarily described by subject.
2 = Intense form of symptom (elation or exaltation) definitely present during past month and persistent for hours at a time. Described by subject.

** Have you felt particularly full of energy lately, or full of exciting ideas?
(Do things seem to go too slowly for you?)
(Do you need less sleep than usual?)
(Do you find yourself extremely active but not getting tired?)
(Have you developed new interests recently?) (42)
RATE SUBJECTIVE IDEOMOTOR PRESSURE.
1 = Subjective equivalent of flight of ideas. Images and ideas flash through the mind, each suggesting others, at a faster rate than usual. State persists for hours at a time.* Definitely occurred during past month.
2 = As (1) but accompanied by very high energy output and activity which does not seem to make subject tired at the time. Definitely occurred during past month and persisted for hours at a time.*

IF NO EVIDENCE OF EXPANSIVE MOOD AND IDEATION, CUT OFF → SECTION 10.

Cut off

IF EVIDENCE OF EXPANSIVE MOOD AND IDEATION:

Have you seemed super-efficient at work, or as though you had special powers or talents quite out of the ordinary?
Have you felt specially healthy?
Have you been buying any interesting things recently? (43)
RATE GRANDIOSE IDEAS AND ACTIONS.
1 = Subjective feeling of superb health, exceptionally high intelligence, extraordinary abilities, etc. Persistent for hours at a time.* Symptom occurred at some time during the month.
2 = Grandiose ideas have been translated into action during the month, e.g. overspending, gambling, etc., under the influence of grandiose ideas and expansive affect. *Do not include compulsive gambling unless clearly of this type.*

(→ GRANDIOSE DELUSIONS, SECTION 15D IF NECESSARY.)

* *If symptom was more transient but very intense or frequently repeated, it may still be included.*

10. OBSESSIONS

These symptoms are usually experienced as occurring against conscious resistance (see definition in glossary).

** Do you find that you have to keep on checking things that you know you have already done?
(Like gas taps, doors, switches, etc.)
(Do you have to touch or count things many times or repeat the same action over and over again?)
(What happens when you try to stop?)
RATE OBSESSIONAL CHECKING AND REPEATING. ☐ (44)

1 = Symptom of moderate intensity or, if severe, present less than 50% of the time.
2 = Symptom present in severe degree, more than 50% of the past month.

** Do you spend a lot of time on personal cleanliness, like washing over and over even though you know you are clean? What about tidiness?
(Do you get worried by contamination with germs?)
(Do you have other rituals?)
(What happens when you try to stop?)
RATE OBSESSIONAL CLEANLINESS AND SIMILAR RITUALS. ☐ (45)

1 = Symptom of moderate intensity or, if severe, present less than 50% of the time.
2 = Symptom present in severe degree, more than 50% of the past month.

** Do you find it difficult to make decisions even about trivial things?
(Do you constantly have to question the meaning of the universe?)
(Do you get awful thoughts coming into your mind even when you try to keep them out?)
(What happens when you try to stop?)
RATE OBSESSIONAL IDEAS AND RUMINATION. ☐ (46)

1 = Symptom of moderate intensity or, if severe, present less than 50% of the time.
2 = Symptom present in severe degree, more than 50% of the past month.

11. DEREALISATION AND DEPERSONALISATION

** Have you had the feeling recently that things around you were unreal?
(As though everything was an imitation of reality, like a stage set, with people acting instead of being themselves?)
(What is it like? How do you explain it?)
RATE DEREALISATION. ☐ (47)

1 = Moderately intense form of symptom definitely occurred during the past month, and persisted for hours at a time. Things appear colourless and artificial, people appear lifeless and seem to act rather than being themselves.

2 = Intense form of symptom occurred during the past month and persisted for hours at a time, e.g. whole world appears like a gigantic stage set, with imitation instead of real objects and puppets instead of people. (If delusional, do not rate here but symptom 90.)

** Have you yourself felt unreal, that you were not a person, not in the living world?
(Or that you were outside yourself, looking at yourself from outside?)
(Or that you look unreal in the mirror?)
(Or that some part of your body did not belong to you?)
(How do you explain it?)
RATE DEPERSONALISATION ☐ (48)

1 = Moderately intense form of the symptom definitely occurred during the past month and persisted for hours at a time. Subject feels himself unreal, a sham, a shadow.
2 = Intense form of symptom definitely occurred during the past month and persisted for hours at a time. Subject feels he is dead, not a person, living in a parallel existence, a hollow shell, even that he does not exist. (If delusional, do not rate here but symptom 90.)

12. OTHER PERCEPTUAL DISORDERS (NOT HALLUCINATIONS)

** Do you ever get the feeling that something odd is going on which you can't explain?
(Or that familiar surroundings seem strange? How do you explain it?)
RATE DELUSIONAL MOOD: *The subject feels that his familiar environment has changed in a way which puzzles him and which he may not be able to describe clearly. The feeling often accompanies delusion formation.* ☐ (49)

1 = Symptom definitely present. No delusions have actually been formulated, though patient may feel that various delusional explanations are possible.
2 = Full delusional elaboration has occurred.

** Does your imagination sometimes play tricks on you?

** Is there anything unusual about the way things look or sound, or smell, or taste?
(Does your body function normally?)
(Is your own appearance normal?)

CONTINUE BELOW CUT-OFF IF NECESSARY, EVEN IF (49) NOT PRESENT.

IF NO PERCEPTUAL ABNORMALITY → SYMPTOM 54.

Cut off ☐

IF THERE IS ANY HINT OF PERCEPTUAL ABNORMALITY, CONTINUE BEYOND CUT-OFF POINT AND ALSO CONSIDER LATER SECTIONS. RATE ONLY BASIC EXPERIENCE, NOT DELUSIONAL ELABORATION.

In what way? Do sounds seem unnaturally clear or loud, or things look vividly coloured or detailed?
(How do you explain this?)
RATE HEIGHTENED PERCEPTION: *e.g. subject intensely aware of cracks in a wall, details of a wallpaper pattern, colours in a picture. Sounds heard with exceptional clarity, music appears particularly beautiful.* ☐ (50)

1 = Subject unable to describe the symptom precisely, but examiner thinks it is likely to have been present at some time during the past month.
2 = Subject describes symptom. Definitely present at some time (even if only briefly) during the past month.

Do things seem dark or grey or colourless?
(How do you explain it?)
RATE DULLED PERCEPTION: *The reverse of symptom (50). Things look, sound and taste dull, flat, colourless and uninteresting.* ☐ (51)

1 = Subject unable to describe the symptom precisely, but examiner thinks it is likely to have been present at some time during the past month.
2 = Subject describes symptom. Definitely present at some time (even if only briefly) during the past month.

Does the appearance of things or people change in a puzzling way: e.g. distorted shapes or size or colour?
(How do you explain it?) ☐ (52)
RATE CHANGED PERCEPTION.

1 = Subject unable to describe the symptom precisely, but examiner thinks it is likely to have been present at some time during the past month.
2 = Subject describes symptom. Definitely present at some time (even if only briefly) during the past month.

Do you think your own appearance is normal?
(Conviction that nose is too large, teeth misshapen, body crooked, etc. Ask questions here if convenient but rate symptom (89).)

Does your experience of time seem to have changed?
(Does it go too fast or too slowly, or do you seem to live through experiences exactly as you have had them before?)
RATE CHANGED PERCEPTION OF TIME, INCLUDING ☐ (53)
DEJA VU.

1 = Subject unable to describe the symptom precisely, but examiner thinks it is likely to have been present at some time during the past month.
2 = Subject describes symptom. Definitely present at some time (even if only briefly) during the past month.

Do you feel you have lost your emotions in some way?
(That you are empty of all feeling, incapable of reacting emotionally?)
(Is this a definite change, or have you always been like that?)
(How do you explain it?)
RATE LOST EMOTIONS: *Rate only subjective loss of affect, i.e. subject can remember being able to react emotionally, though this might have been months or even years ago.* ☐ (54)

1 = Symptom definitely present during the past month but less than 50% of the time.
2 = Symptom present more than 50% during the past month.

13. THOUGHT READING, INSERTION, ECHO, BROADCAST

IF QUESTION HAS NOT BEEN COVERED IN SECTION 4 ASK:

** Can you think quite clearly or is there any interference with your thoughts?
(Are you in full control of your thoughts?)
(Can people read your mind?)
(Is anything like hypnotism or telepathy going on?)

IF NO EVIDENCE OF THOUGHT READING, etc., CUT OFF → SECTION 14.

Cut off ☐

IF ANY EVIDENCE, ASK QUESTIONS BELOW:

(These symptoms are often recorded as false positives. The examiner must be satisfied that the subject is not simply assenting to a question he does not understand, but genuinely recognises the experience and can describe it so that the examiner recognises it.) It is particularly important to know the relevant sections of the Instruction Manual well before rating these symptoms.

Are thoughts put into your head which you know are not your own?
(How do you know they are not your own?)
(Where do they come from?)
RATE THOUGHT INSERTION: *Include only thoughts recognised as alien. Do not include delusional elaboration, only basic experience. (Exclude hallucinations.)* ☐ (55)

1 = Symptom described clearly, but subject thinks it may be due to 'own unconscious thoughts' etc., i.e. not certainly alien.
2 = Symptom described clearly and thoughts described as alien, i.e. inserted into mind from elsewhere (even if subject does not know from where). Not hallucinations.

Do you ever seem to hear your own thoughts spoken aloud in your head, so that someone standing near might be able to hear them?
(Are your thoughts broadcast, so that other people know what you are thinking?)
(How do you explain it?)

RATE THOUGHT BROADCAST. (56)

1 = Hears own thoughts 'spoken' aloud but not broadcast. Subject must really hear them aloud in his head. If in doubt rate (8) or (0).
2 = Thoughts transferred or broadcast so that others can share subject's thoughts even when they are not in the same room. (Do not include 'thoughts being read' unless this is an explanation of thought broadcast. The subject must actually experience his thoughts being available to others.)

Do you ever seem to hear your own thoughts repeated or echoed?
(What is that like? How do you explain it?)
(Where does it come from?)

RATE THOUGHT ECHO OR COMMENTARY. (57)

1 = Thought echo. If any doubt, rate (8) or (0).
2 = Subject experiences alien thoughts related to his own thoughts, i.e. associations or comments on his own thoughts. Not hallucinations.

Do you ever experience your thoughts stopping quite unexpectedly so that there are none left in your mind, even when your thoughts were flowing freely before?
(What is that like?)
(How often does it occur? What is it due to?)

Do your thoughts ever seem to be taken out of your head, as though some external person or force were removing them?
(Can you give an example?)
(How do you explain it?)

RATE THOUGHT BLOCK OR WITHDRAWAL. (58)

1 = Thought block. Do not include if due to anxiety or lack of concentration; only if it occurs totally unexpectedly when thoughts are flowing freely. One single occasion is not sufficient for rating. *Be very critical in rating this symptom.*
2 = Delusional explanation that thoughts are withdrawn.

Can anyone read your thoughts?
(How do you know? How do you explain it?)

RATE DELUSION OF THOUGHTS BEING READ: *Only if subject does not mean that people can infer his thoughts from his actions. (Do not include subject reading thoughts of other people → 76.)* (59)

1 = 'Partial' delusion. Subject entertains the possibility that thoughts might be read but is not certain about it. Exclude if subcultural explanation.
2 = Full delusion. Exclude if subcultural explanation. The term 'thought reading' is commonly used to mean the ability to tell what someone is thinking from the way they behave – this use should be excluded.

14. HALLUCINATIONS

USE JUDGEMENT ABOUT WORDING.

** I should like to ask you a routine question which we ask of everybody. Do you ever seem to hear noises or voices when there is no one about, and nothing else to explain it?
(Do you ever seem to hear your name being called?)

** Is that true of visions or other unusual experiences, which some people have?
(Touch, taste, smell, temperature, pain, etc.)

IF NO EVIDENCE FOR HALLUCINATIONS OF ANY SENSE, CUT OFF → SECTION 15.

Cut off

IF EVIDENCE FOR NON-AUDITORY HALLUCINATIONS ONLY → SUBSECTIONS 14B and 14C

14A. AUDITORY HALLUCINATIONS

IF ANY EVIDENCE THAT AUDITORY HALLUCINATIONS MIGHT BE PRESENT:

Do you hear noises like tapping, or music? (What is it like?)
Does it sound like muttering or whispering?
Can you make out the words?

RATE NON-VERBAL AUDITORY HALLUCINATIONS. (60)

1 = Music, tapping, car engines, etc. Do not include tinnitus.
2 = Muttering, whispering but subject cannot make out any words at all.

What does the voice say?
(Write down examples of typical verbal hallucinations.)
(If accusatory: Do you think that it is justified? Do you deserve it?)
Do you hear your name being called?

RATE VERBAL HALLUCINATIONS BASED ON DEPRESSION OR ELATION OR VOICE CALLING SUBJECT. (61)
Content is congruent with mood; e.g. 'He's dirty', in context of depression, or 'Go to Westminster', in elated subject who thinks he is Prime Minister. Include voice calling subject (e.g. calling name) or saying single words only. Be careful to distinguish from delusions of reference in which people whom the subject can see are thought to be talking about him.

RECORD EXAMPLES.

1 = Voice calling name, or single words only.
2 = Other verbal hallucinations; congruent with depressed mood.
3 = Other verbal hallucinations; congruent with elated mood.

Do you hear several voices talking about you?
Do they refer to you as 'he' (she)?
(What do they say?)
(Do they seem to comment on what you are thinking, or reading, or doing?)
RATE VOICE(S) DISCUSSING SUBJECT IN THIRD PERSON OR COMMENTING ON THOUGHTS OR ACTIONS (NOT BASED ON DEPRESSION OR ELATION). ☐ (62)
Do not include muttering or whispering if subject cannot make out words. Exclude 'dissociative' hallucinations (symptom 64). Do not include voice calling name or affectively based verbal hallucinations (symptom 61). There may be one voice commenting on subject's thoughts or actions, or several voices discussing the subject in the third person.
RECORD EXAMPLES.

1 = Hears a voice or voices commenting on thoughts or actions in third person (e.g. 'Now he's going to go to bed' or 'Why would he think a thing like that?'). (2) not present.
2 = Hears voices talking about him/her in third person (e.g. 'I think he's a homosexual, don't you?' 'Yes, he wears a pink pullover, that's a sign of it.'). (1) may also be present.

Do they speak directly to you?
(Are they threatening or unpleasant?)
(Do they call you names?)
Do they give orders? (Do you obey?)
RATE VOICE(S) SPEAKING TO SUBJECT (NOT BASED ON DEPRESSION OR ELATION). ☐ (63)
Include voice(s) speaking directly to subject, whether accusing, threatening, giving orders or giving information. Exclude voice(s) calling name or based on depression or elation (symptom 61), or commenting on subject's thoughts or actions (symptom 62). Exclude 'dissociative' hallucinations (symptom 63).
RECORD EXAMPLES.

1 = Pleasant, supportive or neutral voice(s), not based on affect. No hostile voices.
2 = Hostile, threatening or accusing voice(s), thought to be undeserved and not based on affect.

N.B. If single isolated words, even with neutral affect, include under 61 (1).

Can you carry on a two-way conversation with —?
(You can reply, and then — replies to you, and you reply again, just as in an ordinary conversation?)
(Do you see anything, or smell anything at the same time as you hear the voice?)
(Who is it you are talking to?)
(What is the explanation?)
(Do you know anyone else who has this kind of experience?)
RATE 'DISSOCIATIVE' HALLUCINATIONS (VERBAL AND/OR OTHER) ☐ (64)

The subject can hold a two-way conversation with a presence (variously described as a person, ghost, spirit, god, etc.) which may also be sensed in other ways, e.g. visually or by touch or smell. Often connected with people with whom the subject has had strong affective ties. Visual hallucinations can occur alone. There is usually a strong subcultural colouring, e.g. the subject belongs to a religious sect or to a subcultural group which sanctions hallucinatory experiences, or the subject has been under the influence of someone who is involved with such practices. Exclude hypnogogic hallucinations.
RECORD EXAMPLES.

1 = 'Dissociative' hallucinations present. Subject belongs to subcultural group or sect in which such experiences are sanctioned.
2 = 'Dissociative' hallucinations present. Subject does not belong to subcultural group as in (1). If not known, rate (1).

Are these voices in your mind or can you hear them through your ears? ☐ (65)
Scoring:

1 = Subject hears both pseudo-hallucinations (within mind) and true hallucinations (through ears).
2 = Subject hears pseudo-hallucinations only.
3 = Subject hears true hallucinations only.

How do you explain the voice?
RECORD EXPLANATION.

14B. VISUAL HALLUCINATIONS

IF QUESTION HAS NOT BEEN COVERED IN SECTION 12 OR 14A, ASK:

** Have you had visions, or seen things other people couldn't see?

IF NO EVIDENCE, HERE OR ELSEWHERE, FOR VISUAL HALLUCINATIONS CUT OFF → SECTION 15.

Cut off ☐

IF ANY EVIDENCE OF VISUAL HALLUCINATIONS:

With your eyes or in your mind?
What did you see?
Were you half asleep at the time?
Has it occurred when you were fully awake?
Did you realise you were 'seeing things'?
Did the vision seem to arise out of a pattern on the wallpaper or a shadow?
How do you explain it?

RATE VISUAL HALLUCINATIONS: *in clear consciousness including pseudo-hallucinations. Exclude 'dissociative' visual hallucinations (symptom 64).* (66)

1 = Formless visual hallucinations – flashes of light, shadows, etc.
2 = Formed visual hallucinations – people, objects like a 'fiery cross', faces, etc.

RATE DELIRIOUS VISUAL HALLUCINATIONS. (67)

14C. OTHER HALLUCINATIONS

IF QUESTIONS HAVE NOT BEEN COVERED IN PREVIOUS SECTIONS:

** Is there anything unusual about the way things feel, or taste, or smell?

** Does your body function normally?

IF NO EVIDENCE FOR OTHER HALLUCINATIONS CUT OFF → SECTION 15A.

Cut off

IF ANY EVIDENCE FOR OTHER HALLUCINATIONS:

Do you sometimes notice strange smells that other people don't notice?
(What sort of thing?)
(How do you explain it?)

RATE OLFACTORY HALLUCINATIONS: *Exclude delusion that patient himself smells.* (68)

1 = Simple olfactory hallucination. Not delusionally elaborated. Subject smells oranges, death, a burnt smell, scent, etc., which other people cannot smell. Can offer no explanation.
2 = Delusional elaboration in addition, e.g. gas being put into room.

Do you seem to think that you yourself give off a smell which is noticed?
(What is the explanation?)

RATE DELUSION THAT SUBJECT SMELLS: *Do not include simple preoccupation with body odour, e.g. in anxious subject who sweats a lot.* (69)

1 = Subject irrationally thinks he gives off a smell but is not certain. Not sure that others have noticed it but thinks it possible.
2 = Subject sure that he gives off a smell and that others have noticed it and react accordingly.

Do you ever feel that someone is touching you, but when you look there is nobody there?)
(Have you noticed that food or drink seems to have an unusual taste recently?)

RATE OTHER HALLUCINATIONS AND DELUSIONAL ELABORATION: *Exclude hypochondriacal and nihilistic delusions rated in (90) and (91).* (70)

1 = Sensation of touch, food tastes burnt, etc., but subject puzzled by the experience. No delusional elaboration.
2 = Delusional elaboration in addition, e.g. fantasy lover, food poisoned, etc.

Project no. 1 2

Subject no. 3 4 5

Card no. 6 7

8 9 10

15. DELUSIONS

Definition

Delusions may be of two kinds, primary and secondary. Both kinds are rated together in the following symptoms except where specified. For example, primary delusions are specifically rated in symptom (82). They are defined here for convenience.

Primary delusions are based upon experiences in which a subject suddenly becomes convinced that a particular set of events has a special meaning (e.g. a subject undergoing a liver biopsy suddenly felt he had been chosen by God). The delusion cannot be explained and it is not shared by other members of the subject's cultural or social group.

Secondary delusions are delusional elaborations of primary delusions or other basic phenomena such as derealisation, depersonalisation, perceptual distortions, hallucinations, thought echo, mood changes, etc.

Above cut-off questions, likely to elicit delusions if present, are included in many of the preceding sections. There may also be evidence in the case-record or in the subject's spontaneous account.

IF NO EVIDENCE AT ALL THAT DELUSIONS ARE PRESENT, CUT OFF → SECTION 16.

RECORD IF ANY PSYCHOTIC PHENOMENA PRESENT, OTHER THAN DELUSIONS, USE JUDGEMENT AS TO WHETHER TO PROCEED BEYOND CUT-OFF.

Cut off ☐

IF ANY EVIDENCE FOR DELUSIONS, ASK ALL QUESTIONS NOT IN BRACKETS, AND ANY FURTHER QUESTIONS WHICH SEEM INDICATED.

RATING OF PARTIAL AND FULL DELUSIONS.

In general, all delusions are rated as follows:

1 = Partial delusions, which are expressed with doubt, or as possibilities which the subject entertains but is not certain about. This rating should not be used if it is clear that full delusions have been present during the month, or if the subject has acted as if fully deluded.

2 = Full delusions have been present at some time during the month. Fully convinced. No insight.

A useful question to elucidate the difference between partial and full delusions is as follows:

Even when you seem to be most convinced, do you really feel in the back of your mind that it might well not be true, that it might be imagination?

15A. DELUSIONS OF CONTROL

Definition

The subject's will is replaced by that of some external agency. A simple statement that the radio is controlling the subject is not sufficient. (This statement, alone, should be rated 8.) The subject must describe a replacement of will by some other force.

Do not include feeling that life is planned and directed by fate, or that the future is present already in embryo, or that subject is not very strong-willed, or that voices give subject orders. Do not include simple identification with God or being under God's direction. Do not include subcultural or hysterical possession states or multiple personality (→ 100).

Do you feel under the control of some force or power other than yourself?
(As though you were a robot or a zombie without a will of your own?)
(As though you were possessed by someone or something else?)
(What is that like?)
(Does this force make your movements for you without your willing it, or use your voice, or your handwriting? Does it replace your personality? What is the explanation?)

☐ (71)

RATE DELUSIONS OF CONTROL.

1 = Partial delusions 2 = Full delusions

15B. MISINTERPRETATIONS, MISIDENTIFICATION AND DELUSIONS OF REFERENCE

Definition

Delusions of reference: Do not include simple self-consciousness or feeling that subject attracts comment, even if critical. These are rated under symptom 31.

There must be elaboration: e.g. someone crosses his knees in order to indicate that the subject is homosexual; or the whole neighbourhood is gossiping.

Delusional misinterpretations, etc. This is an extension of the delusion of reference, so that not only do people seem to refer to subject, but situations appear to be deliberately created to test him (exclude situations of medical treatment), or objects appear to have special meanings.

Do people seem to drop hints about you or say things with a double meaning, or do things in a special way so as to convey a meaning?
Does everyone seem to gossip about you?
(Do people follow you about or check up on you or record your movements?)
(How do they do it? Why?)
(Are there people about who are not what they seem to be?) ☐ (72)
RATE DELUSIONS OF REFERENCE.
1 = Partial delusions 2 = Full delusions.

Do things seem to be specially arranged?
(Is an experiment going on, to test you out?)
(Do you see any reference to yourself on TV or in the papers?)
(Do you ever seem to see special meanings in advertisements, or shop windows, or in the way things are arranged?)
(How do you explain this?)
RATE DELUSIONAL MISINTERPRETATION AND MISIDENTIFICATION. ☐ (73)
1 = Partial delusions 2 = Full delusions

15C. DELUSIONS OF PERSECUTION

Is anyone deliberately trying to harm you, e.g. trying to poison you or kill you?
(How? Is there an organisation like the Mafia behind it?)
(Is there any other kind of persecution? How do you explain this?) ☐ (74)
RATE DELUSIONS OF PERSECUTION.
1 = Partial delusions 2 = Full delusions

15D. EXPANSIVE DELUSIONS

Do you think that people are organising things specially to help you? ☐ (75)
RATE DELUSIONS OF ASSISTANCE.
1 = Partial delusions 2 = Full delusions

Is there anything special about you? Do you have special abilities or powers?
(Can you read people's thoughts?)
(Is there a special purpose or mission to your life?)
(Are you especially clever or inventive? How do you explain this?) ☐ (76)
RATE DELUSIONS OF GRANDIOSE ABILITIES.
1 = Partial delusions 2 = Full delusions

(Are you a very prominent person or related to someone prominent, like Royalty?)
(Are you very rich or famous?)
(How do you explain this?)
RATE DELUSIONS OF GRANDIOSE IDENTITY: *(Exclude religious identification.)* ☐ (77)
1 = Partial delusions 2 = Full delusions

15E. DELUSIONS CONCERNING VARIOUS TYPES OF INFLUENCE AND PRIMARY DELUSIONS

Are you a very religious person?
(Specially close to Christ or God?)
(Can God communicate with you? How?)
(Are you yourself a saint?)
(How do you explain this?)
RATE RELIGIOUS DELUSIONS: *Including delusional religious explanations of other experiences. Exclude intense religious belief or purely subcultural beliefs.* ☐ (78)
1 = Partial delusions 2 = Full delusions

How do you explain the things that have been happening? (SPECIFY)
Is there anything like hypnotism, telepathy, or the occult going on?
What is the explanation?
INCLUDE DELUSIONAL EXPLANATIONS IN TERMS OF PARANORMAL PHENOMENA: *e.g. hypnotism, telepathy, magic, witchcraft, etc. Exclude purely subcultural beliefs, → 83.* ☐ (79)
1 = Partial delusions 2 = Full delusions

Is anything like electricity, or X-rays, or radio-waves affecting you?
(In what way? What is the explanation?)
INCLUDE DELUSIONAL EXPLANATIONS IN TERMS OF PHYSICAL FORCES: *e.g. radio, television, X-rays, electricity, transmitters, microphones, machines of various kinds.* ☐ (80)
1 = Partial delusions 2 = Full delusions

DELUSIONS OF ALIEN FORCES PENETRATING OR CONTROLLING MIND (OR BODY). ☐ (81)
Include any delusion, whether rated elsewhere or not, which involves an external force penetrating the subject's mind or body, e.g. rays turn liver to gold, alien thoughts pierce skull or are inserted into mind, hypnotism makes patient levitate, a spirit speaks with subject's voice, a radio transmitter has been implanted into brain and broadcasts thoughts or controls actions, etc.
1 = Partial delusions 2 = Full delusions

Choose a likely delusion, and ask:

How did it come into your mind that this was the explanation?
(Did it happen suddenly? How did it begin?)

RATE PRIMARY DELUSIONS: *Based upon experiences in which subject suddenly becomes convinced that a particular set of events has a special meaning. (See definition on page 214.) Not based on mood or explanation of other abnormal experiences.* (82)

1 = Partial delusions 2 = Full delusions

15F. OTHER DELUSIONS

(Examiner should question as appropriate.)

RATE SUBCULTURALLY INFLUENCED DELUSIONS: *Include only subjects who belong to small groups with definitely idiosyncratic beliefs; small sects, tribes, 'secret societies', etc.* (83)

0 = No significant subcultural influence. For example, an English subject believing he is influenced by TV would be rated (0) since, although the delusion depends on TV being available in England, it is not in any way specific to a small subcultural group.

1 = One or more of the 'delusions' rated earlier could easily be no more than a belief shared by other members of the subject's subcultural group, e.g. the Pentecostal church with the gift of tongues. Voodoo, witchcraft, communicating with God, are other examples of beliefs which may be taken quite literally by groups of people who are not clinically deluded. Rate (1) if subject holds such beliefs without elaborating them further.

2 = As (1), but because of excitement, expansiveness, depression, confusion, intellectual retardation, etc., the subject holds the beliefs with exceptional fervour and conviction, or elaborates them further. Such a subject might well be regarded as abnormal by other members of his own sect or group.

3 = More specific delusional states, e.g. Koro, Witigo, etc.

(Do you have any reason to be jealous of anybody?) (84)

MORBID JEALOUSY.

1 = Partial delusions 2 = Full delusions

(85)

DELUSION OF PREGNANCY.

1 = Partial delusions 2 = Full delusions

SEXUAL DELUSIONS: *Any delusion with sexual content, e.g. fantasy lover, sex changing, etc. Do not include an untrue claim that a subject is married or has children.* (86)

1 = Partial delusions 2 = Full delusions

Have you had any unusual experience or adventures recently?

RATE FANTASTIC DELUSIONS, DELUSIONAL MEMORIES, DELUSIONAL CONFABULATIONS, FANTASTIC DELUSIONS:
Confabulation: Subject makes up delusions on the spot. Very rare.
Delusional memories: Subject seems to be describing actual memories. Describes the same delusions time and again. Not confabulations. Rare, e.g. 'I came down to earth on a silver star.' Fantastic delusions: The commonest of the three, e.g. England's coast melting. (87)

1 = Partial delusions 2 = Full delusions

15G. SIMPLE DELUSIONS BASED ON GUILT, DEPERSONALISATION, HYPOCHONDRIASIS, ETC.

Definition

These symptoms often appear to be based on a depressed mood and are relatively consistent and unelaborated. Do not include more bizarre elaborations of any of them, e.g. having a metal nose = symptom 87, not 89. Having been turned into another specified person = possibly symptom 71, not 90. Liver turned to lead by X-rays = symptoms 80 and 81, not 91. England's coast melting = symptom 87, not 92.

Do you feel you have committed a crime, or sinned greatly, or deserve punishment? (Have you felt that your presence might contaminate or ruin other people?) (88)

RATE DELUSIONS OF GUILT.

1 = Subject has brought ruin to family by being in present condition, or thinks that symptoms are a punishment for not doing better, etc. Does not elaborate as in (2).

2 = Subject says has sinned greatly or committed some terrible crime or brought ruin upon the world. May feel deserving of punishment, even of death or hell-fire, because of it.

(Do you think your appearance is normal?)

RATE SIMPLE DELUSIONS CONCERNING APPEARANCE: (89)
(Nose too large, teeth misshapen, body crooked, etc.)

1 = Strong feeling that there is something wrong with appearance; subject looks old or ugly or dead, skin cracked, teeth misshapen, nose too large, body crooked, etc. Can be reassured temporarily. There may be only one limited preoccupation.

2 = Subject acts accordingly (plastic operations, etc.)

(Is anything the matter with your brain?)

RATE DELUSIONS OF DEPERSONALISATION: *Subject has no head, does not exist, hollow instead of a brain, etc.* (90)

1 = Unable to think, no thoughts in head, feels *as though* he has no brain or as though it does not function at all.

2 = Symptom more intense. Subject has no head, no brain, does not exist.

(Is anything the matter with your body?)
RATE HYPOCHONDRIACAL DELUSIONS: *Subject has incurable cancer, bowels are stopped up, insides are rotting, etc.* (91)

1 = Subject feels body is unhealthy, rotten, diseased, but without the force of (2).
2 = Subject has incurable cancer, bowels are stopped up or rotting away, etc.

(Do you have the feeling that something terrible is going to happen? What?)
RATE DELUSIONS OF CATASTROPHE: *World is about to end, some catastrophe has happened or will occur, everything is evil and will be destroyed.* (92)

1 = Subject feels sense of impending doom; something awful will happen. Non-specific but out of proportion to circumstances.
2 = Delusional conviction that world is about to end or some other enormous catastrophe is about to occur or has occurred. World is dirty, decayed, rotten: i.e. further delusional elaboration of (1).

15H. GENERAL RATINGS OF DELUSIONS AND HALLUCINATIONS

(Include both partial and full delusions.)

CONSIDER BOTH DELUSIONS AND HALLUCINATIONS IN FOLLOWING RATINGS.

RATE SYSTEMATISATION OF DELUSIONS. (93)

Scoring:
0 = No delusions or hallucinations.
1 = Delusions and hallucinations not elaborated into a general system affecting much of the subject's experience. Include encapsulated delusions or isolated hallucinations.
2 = Some systematic elaboration, but substantial areas of the subject's experiences are not affected.
3 = Subject interprets practically all his experience in delusional terms.

RATE EVASIVENESS. (94)

Scoring:
0 = No attempt at concealment suspected.
1 = Examiner suspects that there may be (either) delusions or hallucinations in the background, but the subject is not concealing much of the psychopathology.
2 = Examiner suspects that there is a considerable preoccupation with delusions (even a delusional system) or hallucinations, but the subject tries to conceal them.
3 = No concealment but other delusions or hallucinations probably present. Not elicited because of poor intelligence and education or incoherence or muteness, etc.

OVERALL RATING OF PREOCCUPATION WITH DELUSIONS AND HALLUCINATIONS. (95)

Scoring:
0 = No delusions or hallucinations.
1 = No delusions or hallucinations definitely rated but examiner suspects that they may be present.
2 = Preoccupied with past delusions or hallucinations only. Not actively deluded or hallucinated at present.
3 = Delusions or hallucinations definitely present but subject is not preoccupied with them for much of the time. Can turn attention to other things without difficulty.
4 = Delusions or hallucinations present and take up most of the subject's attention. Preoccupied to the exclusion of many other matters.
5 = Patient can hardly discuss anything but delusions.

RATE ACTING OUT DELUSIONS (96)
(Rate from case-record, etc.)

Scoring:
0 = No delusions or hallucinations.
1 = Subject able to keep delusions or hallucinations to himself, or to confide them only to a few trusted people (sympathetic relatives, friends, doctors, etc.). He does not express them in public nor act upon them. Does not talk out loud to voices.
2 = Subject has acted upon delusions or hallucinations during past month, or expressed them in public (i.e. outside the small circle of people who would be expected to be sympathetic). This has not, however, resulted in severe social disturbance or a social crisis.
3 = As (2) but acting out, or public expression, has resulted in severe social disturbance or a social crisis.

16. SENSORIUM AND FACTORS AFFECTING

** Have you had any lapses of memory recently?
(Have there been any periods in which you completely forgot what happened?)
(What was it like?)
(How do you explain it?)
RATE FUGUES, BLACKOUTS, AMNESIA LASTING MORE THAN ONE HOUR: *irrespective of aetiology.* (97)

1 = less than 12 hours.
2 = 12–24 hours.
3 = more than 24 hours.

** What medicines or drugs do you take?
(Do you take anything for your nerves or your mood?)
(Obtain list of drugs.)
(Who prescribes?)

RATE DRUG ABUSE DURING MONTH. *One category only.* ☐ (98)

1 = Cannabis.
2 = Amytal, etc.
3 = LSD, amphetamine, etc.
4 = Cocaine, heroin, etc.

** May I ask about your drinking habits? How much do you usually drink each day?
(Is alcohol in any way a problem for you? In what way?)

(CHECK LIST: *Present on card if needed.* During the past month have you:
had family problems because of drinking?
missed work because of drinking?
had morning shakes or other withdrawal symptoms?
had blackouts for several hours?
heard voices or seen visions?)

RATE ALCOHOL ABUSE DURING PAST MONTH. ☐ (99)

1 = Agrees alcohol has been a problem but not 2.
2 = Any check-list item applies.

RATE DISSOCIATIVE STATES DURING PAST MONTH: ☐ (100)
'Narrowing of consciousness which serves an unconscious purpose and is commonly accompanied or followed by a selective amnesia', e.g. trance, possession state, fugue, hypersomnia, stupor, etc. Do not include if caused by drugs, alcohol, epilepsy, etc.

1 = Present during the past month, but not at examination.
2 = Present at examination.

RATE CONVERSION SYMPTOMS, *e.g. paralysis, anaesthesia, blindness, tremor, seizures, etc. if mentioned during interview.* ☐ (101)

1 = Present during month, not at examination.
2 = Present at examination.

RATE CLOUDING OR STUPOR AT EXAMINATION ☐ (102)

1 = Clouding: Inadequate comprehension of external impressions, with perplexity, and impairment of attention and orientation.
2 = Stupor: Subject appears comatose but there is no clouding or impairment of consciousness.

IF ANY SUSPICION OF POOR MEMORY OR DISORIENTATION:

May I ask one or two standard questions we ask of everybody?
How old are you?
Can you tell me the year and the month?
What is the name of the Prime Minister?

RATE ORGANIC IMPAIRMENT OF MEMORY. *See glossary for definition.* ☐ (103)

1 = Mild.
2 = Moderate.
3 = Severe.

17. INSIGHT

** Do you think there is anything the matter with you?
(What do you think it is?)
(Could it be a nervous condition?)
(What do you think the cause is?)
(Why did you need to come to hospital?)
(Do you think (*specify delusions or hallucinations*) were part of a nervous condition?)

IF PSYCHOTIC SYMPTOMS (i.e. SYMPTOMS FROM SECTIONS 12–15): ☐ (104)

0 = Full insight (in intelligent subject, able to appreciate the issues involved).
1 = As much insight into the nature of the condition as social background and intelligence allow.
2 = Agrees to a nervous condition but examiner feels that subject does not really accept the explanation in terms of a nervous illness (e.g. gives delusional explanation, the result of persecution, or rays, etc.).
3 = Denies nervous condition entirely.
9 = Psychotic illness not present.

IF NEUROTIC SYMPTOMS (i.e. SYMPTOMS FROM SECTIONS 1–11 ONLY): ☐ (105)

0 = Full insight (in intelligent subject, able to appreciate the issues involved).
1 = As much insight into the nature of the condition as social background and intelligence allow.
2 = Gives physical explanation for neurotic symptoms.
3 = Denies neurotic symptoms entirely.
9 = Neurotic illness not present.

** Of all the problems you have told me about, which one affects you most? How much does it interfere with your work or your relationships with other people?
(Have you actually been out of work, or been unable to do the housework, or go shopping, travelling, etc., during the past month?)
(Have the symptoms impaired your efficiency in any other way?)

RATE SOCIAL IMPAIRMENT DUE TO NEUROTIC CONDITION. ☐ (106)

0 = No neurotic or psychotic symptoms present.
1 = Neurotic symptoms present but little diminution of subject's efficiency or interference with everyday activities.

2 = Neurotic symptoms interfere with subject's efficiency to a moderate extent but are not incapacitating, e.g. subject neglects housework or can't enjoy leisure activities or social relationships, or finds work-efficiency reduced because of worry, tension, irritability, depression, anxiety, etc. Subject does not, however, stop work altogether or completely neglect household.
3 = Subject severely incapacitated by neurotic symptoms: had to have at least a week off work during past month; was housebound for a week or more; was actively withdrawn from all social relationships, etc. The subject does not have to be totally incapacitated for the whole month for this rating to be made, but impairment has to be very severe.
8 = Examiner unsure.
9 = Psychotic condition present.

(If both psychotic and neurotic condition, rate whichever shows more impairment.)

RATE SOCIAL IMPAIRMENT DUE TO PSYCHOTIC CONDITION ☐ (107)

0 = No neurotic or psychotic symptoms present.
1 = Psychotic symptoms present but little diminution of subject's efficiency or interference with everyday activities.
2 = Psychotic symptoms interfere with subject's efficiency to a moderate extent but are not incapacitating, e.g. subject neglects housework or can't enjoy leisure activities or social relationships, or finds work-efficiency reduced. Subject does not, however, stop work altogether or completely neglect household.
3 = Subject severely incapacitated by psychotic symptoms: had to have at least a week off work during past month; was housebound for a week or more; was actively withdrawn from all social relationships, etc. The subject does not have to be totally incapacitated for the whole month for this rating to be made, but impairment has to be very severe.
8 = Examiner unsure.
9 = Neurotic condition, and no psychotic condition, present.

FINAL QUESTION

** Have there been any other things lately that I haven't covered?
Specify;

Note here any points that seem to be important or unusual about the subject or the interview which are not covered in the schedule.

Reconsider schedule to make sure that all obligatory questions have been asked. Also consider whether behaviour, affect and speech ratings can be made or whether further observation or examination is necessary. IF NOT, THIS IS THE END OF THE INTERVIEW.

18–20. BEHAVIOUR, AFFECT AND SPEECH

RATINGS
0 = Symptom absent.
1 = Present in fairly severe degree, or very severe but intermittent during interview.
2 = Present in very severe degree and almost continuous during interview.
8 = Examiner not sure.
9 = Subject not examined, or examination not appropriate.

N.B. If in doubt, rate (0). A rating of (1) means there is no doubt about the symptom being present in fairly severe form.

Behaviour during interview

Self-neglect (cleanliness, shaven, make-up, state of hair and clothes). ☐ (108)

Bizarre appearance (secret documents openly displayed, special clothes or ornaments with symbolic significance, etc. Do not include mannerisms or posturing = symptom 116). ☐ (109)

Slowness and underactivity (sits abnormally still, walks abnormally slowly, delay in performing movements). ☐ (110)

Agitation (fidgety, restlessness, pacing, frequent unnecessary movements). ☐ (111)

Gross excitement and violence (throws things, runs or jumps about, waves arms wildly, shouts or screams). ☐ (112)

Irreverent behaviour (sings, facetious, silly jokes, flippant remarks, unduly familiar). ☐ (113)

Distractibility (stops talking or changes subject due to distraction by trivial noises or events outside the room or turns attention to furniture, etc.). ☐ (114)

Embarrassing behaviour (making sexual suggestions or advances to interviewer; loss of social restraint – scratches genitals, passes loud flatus, etc.). ☐ (115)

Mannerisms and posturing (odd, stylised movements or acts, usually idiosyncratic to the patient, often suggestive of special meaning or purpose: assuming and maintaining uncomfortable or inappropriate postures). ☐ (116)

Stereotypies, etc. (constant repetition of movements or postures such as rocking, rubbing, nodding, grimacing: no special significance). ☐ (117)

Behaves as if hallucinated (non-verbal: as though hears voices or visions: lips move soundlessly, looks round, giggles to self – not just from embarrassment, shyness, etc.). ☐ (118)

Catatonic movements (119)
(Negativism: does the opposite of what he is asked.
Ambitendence: begins to take proffered hand, then withdraws; etc.
Echopraxia: imitates examiner's movement.
Flexibilitas cerea: arm remains where it is put, for at least 15 seconds.
Mitgehen: excessive co-operation in passive movement.
Echolalia: imitates words and phrases with same intonation and inflection of voice.)
(These items can be separately rated in special projects.)

Affect during interview

Observed anxiety (tense worried look or posture, fearful apprehensive look, frightened tone of voice, tremor). (120)

Observed depression (sad, mournful look, tears, gloomy tone of voice, deep sighing, voice chokes on distressing topic). (121)

Histrionic (feelings expressed in exaggerated, dramatic, histrionic manner). (122)

Hypomanic affect (unduly cheerful, smiling, euphoric, elated). (123)

Hostile irritability (unco-operative, irritable, angry, overtly hostile, discontented, haughty, antagonistic). (124)

Suspicion. (125)

Perplexity (puzzlement). (126)

Lability of mood (whether lability of one mood, or changing from one mood to another). (127)

Blunted affect (expressionless face and voice, uniform blunting whatever the topic of conversation, indifference to distressing topics, whether delusional or normal). (128)
1 = Blunting not uniform, e.g. at times responds affectively but at other times is markedly flat; or responds with some evidence of affect, but definitely less than expected.
2 = Severe and uniform blunting.

Incongruity of affect (emotion is shown, but not congruent with topic). (129)

Speech during interview

Slow speech (long pauses before answering, long pauses between words). (130)

Pressure of speech (more copious speech than normal, too rapid speech, very loud voice, too circumstantial speech). (131)

Non-social speech (talks, mutters, whispers out loud, out of context of conversation with examiner). (132)

Muteness (133)
1 = Almost mute, fewer than twenty words in all.
2 = Totally mute.

Restricted quantity of speech (subject frequently fails to answer, questions have to be repeated, restricted to minimum necessary, no extra sentences, no additional comments). (134)

Neologisms and idosyncratic use of words or phrases, e.g. 'One is called "Per-God" and the other is called "Per-the-Devil"', '... miracle-willed through God's "tarn-harn"...', 'Well, there is a frequenting of clairvoyance...': 'Per-God', 'Per-the-Devil' and 'tarn-harn' are neologisms; 'frequenting of clairvoyance' is an example of ordinary words used idiosyncratically. DO NOT RATE THIS SYMPTOM PRESENT UNLESS EXAMPLES ARE WRITTEN DOWN. (135)

Disorder of content of speech

Three types of disordered content are specified: in each case, the effect is to make it very difficult to grasp what the subject means. However, the symptoms are defined in terms of specific components so that it should, in most cases, be possible to say whether one, two, or all three symptoms are present. If in doubt, rate hierarchically, i.e. rate incoherence in preference to flight of ideas and flight of ideas in preference to poverty of speech.

If the patient does not talk enough to give a rateable sample of speech, rate all three symptoms Y.

Incoherence of speech. The subject's meaning is obscured by distorted grammar, lack of logical connection between one part of a sentence and another or between sentences, sudden irrelevances or 'Knight's move', grossly pedantic phrases, answering off the point, etc. For example: (136)

'We've seen the downfall of the radium crown by the Roman Catholics, whereas when you come to see the drinking side of the business, God saw that Noah, if he lost his reason, he got nobody there to look after them.'

'I did suggest to you, that intrinsic or congenital sentiment or refinement of disposition would be so miracle-willed through God's "tarn-harn" as to assume quite the opposite.'

'I believe we live in a world, in an age, where the elements are a force that elders of professionalism hope, not to conquer, but to control.'

'What's your address?' 'It's supposed to be Salisbury near Birmingham.' (*Vorbeireden.*)

DO NOT RATE THIS SYMPTOM PRESENT UNLESS EXAMPLES ARE WRITTEN DOWN.

A rating of 2 means that very little normal speech is present.

N.B. A free flow of delusions is not necessarily incoherent. A subject may talk about delusions quite coherently.

Flight of ideas. Words are associated together inappropriately by sound or rhyme (clang association). Although the original aim of the sentence may quickly be lost, a path can be traced through associations of the white-black-coffin or ring-wrong variety, or through associations with distracting stimuli, e.g. ☐ (137

'How is your appetite?' 'I feel as if I have lost my appetite. I have had an orange. A real juicy orange.' (Sees patient walking past window.) 'She is going for E.C.T. Etcetera treatment or teddy bear's picnic. I call it.'

DO NOT RATE THIS SYMPTOM PRESENT UNLESS EXAMPLES ARE WRITTEN DOWN.

A rating of 2 means that very little normal speech is present.

Poverty of content of speech. The subject talks freely but so vaguely that little information is given in spite of the number of words used: rambles on without coming to a point; may wander far from original theme. Exclude incoherence or flight of ideas. Rate only if severe and always give written example. ☐ (13

Misleading answers. Subject's answers are misleading because answers 'yes' or 'no' to everything, or frequent self-contradictions, or appears to be deliberately misleading. Do not include incoherence, flight of ideas or poverty of speech here. ☐ (13

Re-rate adequacy of interview ☐ (14

0 = Ratings made adequately represent the symptoms present.
1 = Some problem but key symptoms have been rated.
2 = Serious question as to adequacy of interview for rating key symptoms (other than sections 18–20).
3 = *Only* sections 18–20 could be rated.

Check that every box has an entry except those below ticked cut-off points.

Complete coding sheet if one is being used.

APPENDIX B

PRESENT STATE EXAMINATION
AND
BRIEF PSYCHIATRIC RATING SCALE

DIMENSIONAL SCORING METHODS

PRESENT STATE EXAMINATION (PSE)

DERIVED SYMPTOM DIMENSIONS

All items were rated in strict accordance with the PSE manual with the following exceptions:

(1) A rating of 8 was made when:-

either (a) The examiner was not sure whether the symptom was present during the previous month, even though the appropriate questions had been asked, and answered without incoherence or evasion. The symptom could not be excluded

or (b) The examiner was sure that the symptom was present during the previous month, but it was of mild degree and failed to reach a sufficient level of severity to satisfy criteria for a rating of 1.

(Except where otherwise indicated, a rating of 8 was given a score of .5 for the purposes of calculating severity of psychopathology within a given symptom dimension).

(2) Ratings on items 93, 95 and 96 were made in relation to delusions only and not in relation to hallucinations.

SCORING METHOD:

The item scores within each symptom dimension are simply added to give a score for that dimension.

1. PSYCHOTIC DISORGANIZATION (PSE)

	Item	Rating	Score
49	Delusional Mood	0/2/9	0
		8	.5
		1	1
52	Changed Perception	0/9	0
		8	.5
		1	1
		2	2
55	Thought Insertion	0/9	0
		8	.5
		1	1
		2	2
56	Thought Broadcast	0/1/8/9	0
		2	2
58	Thought Blocking or Withdrawal	0/2/9	0
		8	.5
		1	1
102	Clouding	0/2/8/9	0
		1	1
109	Bizarre Appearance	0/9	0
		8	.5
		1	1
		2	2
116	Mannerisms and Posturing	0/9	0
		8	.5
		1	1
		2	2
117	Stereotypies	0/9	0
		8	.5
		1	1
		2	2
118	Behaves as if Hallucinated	0/9	0
		8	.5
		1	1
		2	2
119	Catatonic Movements	0/9	0
		8	.5
		1	1
		2	2
126	Perplexity	0/9	0
		8	.5
		1	1
		2	2
129	Incongruity of Affect	0/9	0
		8	.5
		1	1
		2	2
132	Non-social Speech	0/9	0
		8	.5
		1	1
		2	2
135	Neologisms and Idisyncratic Word use	0/9	0
		8	.5
		1	1
		2	2
136	Incoherence of Speech	0/9	0
		8	.5
		1	1
		2	2
138	Poverty of Content of Speech	0/9	0
		8	.5
		1	1
		2	2

2. INHIBITION (PSE)

	Item	Rating	Score
6	Tiredness or Exhaustion	0/9	0
		8	.5
		1	1
		2	2
19	Inefficient Thinking	0/9	0
		8	.5
		1	1
		2	2
20	Poor Concentration	0/9	0
		8	.5
		1	1
		2	2
22	Loss of Interest	0/9	0
		8	.5
		1	1
		2	2
28	Social Withdrawal	0/9	0
		8	.5
		1	1
		2	2
36	Anergia and Retardation	0/9	0
		8	.5
		1	1
		2	2
38	Loss of Libido	0/9	0
		8	.5
		1	1
		2	2
51	Dulled Perception	0/9	0
		8	.5
		1	1
		2	2
54	Lost Emotions	0/9	0
		8	.5
		1	1
		2	2
102	Stupor	0/1/8/9	0
		2	2
108	Self-Neglect	0/9	0
		8	.5
		1	1
		2	2
110	Slowness and Underactivity	0/9	0
		8	.5
		1	1
		2	2
128	Blunted Affect	0/9	0
		8	.5
		1	1
		2	2
130	Slow Speech	0/9	0
		8	.5
		1	1
		2	2
133	Muteness	0/9	0
		8	.5
		1	1
		2	2
134	Restricted Quantity of Speech	0/9	0
		8	.5
		1	1
		2	2

3. ACTIVATION (PSE)

	Item	Rating	Score
8	Restlessness	0/9	0
		8	.5
		1	1
		2	2
40	Irritability	0/9	0
		8	.5
		1	1
		2	2
		3	3
41	Expansive Mood	0/9	0
		8	.5
		1	1
		2	2
42	Ideomotor Pressure	0/9	0
		8	.5
		1	1
		2	2
43	Grandiose Ideas and Actions	0/9	0
		8	.5
		1	1
		2	2
50	Heightened Perception	0/9	0
		8	.5
		1	1
		2	2
111	Agitation	0/9	0
		8	.5
		1	1
		2	2
112	Gross Excitement and violence	0/9	0
		8	.5
		1	1
		2	2
113	Irreverent Behaviour	0/9	0
		8	.5
		1	1
		2	2
114	Distractibility	0/9	0
		8	.5
		1	1
		2	2
115	Embarrassing Behaviour	0/9	0
		8	.5
		1	1
		2	2
122	Histrionic Affect	0/9	0
		8	.5
		1	1
		2	2
123	Hypomanic Affect	0/9	0
		8	.5
		1	1
		2	2
124	Hostile Irritability	0/9	0
		8	.5
		1	1
		2	2
127	Lability of Mood	0/9	0
		8	.5
		1	1
		2	2
131	Pressure of Speech	0/9	0
		8	.5
		1	1
		2	2
137	Flight of Ideas	0/9	0
		8	.5
		1	1
		2	2

4. HALLUCINATIONS (Perceptual Organization) (PSE)

	Item	Rating	Score
56	Thoughts Aloud	0/2/9	0
		8	.5
		1	1
57	Thought Echo or Commentary	0/9	0
		8	.5
		1	1
		2	2
60	Non-Verbal Auditory Hallucinations	0/9	0
		8	.5
		1	1
		2	2
61	Verbal Hallucinations based on affect, calling name, etc.	0/9	0
		8	.5
		1	1
		2	2
		3	2
62	Voices Discussing or Commenting	0/9	0
		8	.5
		1	2
		2	2
63	Voices Speaking Directly to Subject	0/9	0
		8	.5
		1	2
		2	2
64	Dissociative Hallucinations	0/9	0
		8	.5
		1	1
		2	2
65	Pseudo vs True Hallucinations	0/9	0
		8	.5
		1	2
		2	1
		3	2
66	Visual Hallucinations	0/9	0
		8	.5
		1	1
		2	2
68	Olfactory Hallucinations	0/9	0
		8	.5
		1	1
		2	1
70	Other Hallucinations	0/9	0
		8	.5
		1	1
		2	1

5. DELUSIONAL ORGANIZATION (PSE)

	Item	Rating	Score
49	Delusional Mood	0/1/8/9	0
		2	2
58	Delusion re Thought Withdrawal	0/1/8/9	0
		2	2
59	Delusion of Thoughts Read	0/9	0
		8	.5
		1	1
		2	2
68	Delusional Interpretation Olfactory Hallucination	0/1/8/9	0
		2	2
69	Delusion of Smell	0/9	0
		8	.5
		1	1
		2	2
70	Delusional Interpretation of Other Hallucination	0/1/8/9	0
		2	2
71	Delusion of Control	0/9	0
		8	.5
		1	1
		2	2
72	Delusion of Reference	0/9	0
		8	.5
		1	1
		2	2
73	Delusional Misinterpretation	0/9	0
		8	.5
		1	1
		2	2
74	Delusion of Persecution	0/9	0
		8	.5
		1	1
		2	2
75	Delusion of Assistance	0/9	0
		8	.5
		1	1
		1	1
		2	2
76	Delusion of Grandiose Abilities	0/9	0
		8	.5
		1	1
		2	2
77	Delusion of Grandiose Identity	0/9	0
		8	.5
		1	1
		2	2
78	Religious Delusion	0/9	0
		8	.5
		1	1
		2	2
79	Delusion of Paranormal Phenomena	0/9	0
		8	.5
		1	1
		2	2
80	Delusions of Physical Phenomena	0/9	0
		8	.5
		1	1
		2	2
81	Delusions of Penetration	0/9	0
		8	.5
		1	1
		2	2
84	Morbid Jealousy	0/9	0
		8	.5
		1	1
		2	2
85	Delusion of Pregnancy	0/9	0
		8	.5
		1	1
		2	2
86	Sexual Delusions	0/9	0
		8	.5
		1	1
		2	2
87	Fantastic Delusions	0.9	0
		8	.5
		1	1
		2	2
88	Delusions of Guilt	0/9	0
		8	.5
		1	1
		2	2
89	Delusions of Appearance	0/9	0
		8	.5
		1	1
		2	2
90	Delusions of Depersonal-ization	0/9	0
		8	.5
		1	2
91	Hypochon-driachal Delusion	0/9	0
		8	.5
		1	1
		2	2

5. DELUSIONAL ORGANIZATION (Cont.)

93	*Systematization of Delusions	0/9	0	96	*Acting out Delusions	0/9	0
		8	.5			8	.5
		1	1			1	1
		2	2			2	2
		3	3			3	3
95	*Preoccupation with Delusions	0/8/9	0	104	Insight	0/1/8/9	0
		1	.5			2	1
		2	1			3	2
		3	2	125	Suspicion	0/9	0
		4	3			8	.5
		5	4			1	1
						2	2

*Ratings were made on these items in relation to delusions only. That is, in contrast to the PSE manual, systematization, preoccupation and acting out with respect to hallucinations were not rated.

6. NEUROTIC ORGANIZATION (PSE)

	Item	Rating	Score
9	Hypochon-driasis	0/9	0
		8	.5
		1	1
		2	2
15	Situational Autonomic Anxiety (Phobic)	0/9	0
		8	.5
		1	2
		2	1
16	Social Anxiety (Phobic)	0/9	0
		8	.5
		1	2
		2	1
17	Specific Phobias	0/9	0
		8	.5
		1	2
		2	1
18	Phobic Avoidance	0/9	0
		8	.5
		1	1
		2	2
44	Obsessional Checking and Repeating	0/9	0
		8	.5
		1	1
		2	2
45	Obsessional Cleanliness and Rituals	0/9	0
		8	.5
		1	1
		2	2
46	Obsessional Ideas and Rumination	0/9	0
		8	.5
		1	1
		2	2
47	Derealization	0/9	0
		8	.5
		1	1
		2	2
48	Deperson-alization	0/9	0
		8	.5
		1	1
		2	2
97	Fugues, Blackouts, Amnesia	0/9	0
		8	.5
		1	1
		2	2
		3	2
100	Dissociative States	0/9	0
		8	.5
		1	1
		2	2
101	Conversion Symptoms	0/9	0
		8	.5
		1	1
		2	2
105	Insight	0/1/8/9	0
		2	1
		3	2

Disproportionate Somatic Preoccupation

= (Item 1 score) - (Item 2 score)

(Subjective evaluation of physical health)		-	(Presence of physical illness)	
Rating	Score		Rating	Score
0.9	0		0.9	0
8	.5		8	.5
1	1		1	1
2	2		2	2
3	3		3	3

7. ANXIETY (PSE)

	Item	Rating	Score		Item	Rating	Score
4	Worry	0/9	0	12	Anxious	0/9	0
		8	.5		Foreboding	8	.5
		1	1			1	1
		2	2			2	2
5	Tension	0/9	0	13	Autonomic	0/9	0
	Pains	8	.5		Anxiety	8	.5
		1	1		due to	1	1
		2	2		Delusions	2	2
7	Muscular	0/9	0	14	Panic	0/9	0
	Tension	8	.5		Attacks	8	.5
		1	1			1	1
		2	2			2	2
10	Nervous	0/9	0	21	Neglect	0/9	0
	Tension	8	.5		due to	8	.5
		1	1		Brooding	1	1
		2	2			2	2
11	Free-floating	0/9	0	120	Observed	0/9	0
	Autonomic	8	.5		Anxiety	8	.5
	Anxiety	1	1			1	1
		2	2			2	2

8. DEPRESSION (PSE)

	Item	Rating	Score		Item	Rating	Score
23	Depressed Mood	0/9	0	30	Lack of Self-Confidence	0/9	0
		8	.5			8	.5
		1	1			1	1
		2	2			2	2
24	Hopelessness	0/9	0	31	Simple Ideas of Reference	0/9	0
		8	.5			8	.5
		1	1			1	1
		2	2			2	2
25	Suicidal Plans or Acts	0/9	0	32	Guilty Ideas of Reference	0/9	0
		8	.5			8	.5
		1	1			1	1
		2	2			2	2
		3	3	33	Pathological Guilt	0/9	0
29	Self-Deprecation	0/9	0			8	.5
		8	.5			1	1
		1	1			2	2
		2	2	121	Observed Depression	0/9	0
						8	.5
						1	1
						2	2

BRIEF PSYCHIATRIC RATING SCALE (BPRS)

DERIVED SYMPTOM DIMENSIONS

1.	PSYCHOTIC DISORGANIZATION	=	Item 4 (Conceptual Disorganization) + Item 7 (Mannerisms & Posturing)
2.	INHIBITION	=	Item 13 (Motor Retardation) + Item 16 (Blunted Affect)
3.	ACTIVATION	=	Item 8 (Grandiosity) + Item 10 (Hostility) + Item 14 (Uncooperativeness)
4.	HALLUCINATIONS (Perceptual Organization)	=	Item 12 (Hallucinatory Behaviour)
5.	DELUSIONAL ORGANIZATION	=	Item 11 (Suspiciousness) + Item 15 (Unusual Thought Content)
6.	NEUROTIC ORGANIZATION	=	No items
7.	ANXIETY	=	Item 2 (Anxiety) + Item 6 (Tension)
8.	DEPRESSION	=	Item 5 (Guilt Feelings) + Item 9 (Depressive Mood)

APPENDIX C

INSTRUCTIONS TO SUBJECTS PRIOR TO PSYCHOPHYSIOLOGICAL TESTING

APPENDIX C

INSTRUCTIONS TO SUBJECTS IN PREPARATION FOR PSYCHOPHYSIOLOGICAL TESTING

"For the next half hour I would like you to sit here in the chair and try to relax as much as you can. You may close your eyes if you wish but try not to go to sleep.

I am going to put some earphones on you through which you will hear some sound and some tones. Try to ignore these and remain relaxed. I will turn off the noise after half an hour. During this time try to keep as still as possible.

Do you understand?

Are you comfortable?

Any questions?

Let's begin."

APPENDIX D

LIST OF ABBREVIATIONS USED IN THE TEXT

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AC	Alternating Current
AMP	Amplitude
ANCOVA	Analysis of Covariance
AOR	Amplitude of Orienting Response
ASSCR	Amplitude of Spontaneous Skin Conductance Response
BPRS	Brief Psychiatric Rating Scale
CC-LC	Central Capacity-Limited Channel
dB	Decibel
DC	Direct Current
DQ	Delusion Quotient
DR	Defense Reflex
DSM-III	Diagnostic and Statistical Manual of Mental Disorders, Third Edition
DST	Dexamethasone Suppression Test
EDA	Electrodermal Activity
EEG	Electroencephalogram
FH	Fast Habituator
GSR	Galvanic Skin Response
HQ	Hallucination Quotient
HR	Heart Rate
Hz	Hertz
ID	Index of Definition
IH	Intermediate Habituator
IMPS	Inpatient Multidimensional Psychiatric Scale

IQ	Inhibition Quotient
L	Left
lat	Latency
LI	Laterality Index
LTS	Long-term memory store
M	Molar
mm	Millimetre
MHPG	3-Methoxy-4-Hydroxyphenylglycol
µS	Micro-Siemen
mV	Millivolt
NH	Non-habituator
NOR	Number of Orienting Responses
NR	Non-responder
NSSCR	Number of Spontaneous Skin Conductance Responses
17-OHCS	17-Hydroxycorticosteroids
OR	Orienting Response
PAM	Preattentive Mechanism
PGR	Psychogalvanic Reflex
PSE	Present State Examination
R	Right
rec t/2	Half Recovery Time
ris t	Risetime
SANS	Scale for the Assessment of Negative Symptoms
SAPS	Scale for the Assessment of Positive Symptoms
SC	Skin Conductance
SCL	Skin Conductance Level
SCOR	Skin Conductance Orienting Response

sec	Seconds
SEM	Standard Error of Mean
SSCR	Spontaneous Skin Conductance Response
STS	Short-term Memory Store
Sx	Symptoms
TTH	Trials to Habituation
V	Volts
Yr	Year
XINT	X-Axis Intercept
$\bar{X}$	Mean

APPENDIX E

SCHIZOPHRENIA: AN INFORMATION PROCESSING MODEL

The following literature review and formulation was presented in its first draft, with the writer as sole author, at the Geigy Symposium held in Adelaide in December 1985. The author was invited to submit the paper to the Australian and New Zealand Journal of Psychiatry for publication. In reviewing the manuscript for publication, assistance in evaluating some of the experimental studies reviewed was sought from a psychologist colleague, Dr Jocelyn Wale. The manuscript was thus refined and the model sharpened, although the fundamental ideas remained identical with those articulated in the paper presented at the Geigy Symposium. In acknowledgement of her contribution, Dr Wale was invited to be second author on the paper. In view of her role in this regard, the paper was not included as a chapter in this thesis but was, instead, inserted as an Appendix.

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Abstract:

There is a wealth of literature associating schizophrenia with disorders of information processing and attention. This paper draws together knowledge from experimental cognitive psychology and examines how both research findings and the clinical manifestations of schizophrenia can be accommodated by an information processing paradigm. An attentional model of schizophrenia is proposed in which disorders in the perception of information are related to dysfunction at the level of preattentive processes. This is seen as one crucial difference between schizophrenia and bipolar disorder, both of which demonstrate failures of sensory gating and filter mechanisms in the acquisition and processing of inputs. Commonalities between the two disorders are thus addressed. Certain psychopathological phenomena in schizophrenia, particularly negative symptoms ('inhibition'), hallucinations and delusions, are seen as compensatory operations of a disordered information processing system. The model has heuristic value and is able to account for, and coherently organise, the variability which continues to confound research in schizophrenia.

"It is not yet clear just what sort of entity the concept of dementia praecox actually represents" (Eugen Bleuler, 1911).

The better part of a century having passed since Bleuler[1] wrote the above, we

can confidently say that we now know a great deal about schizophrenia, but are still not clear just what sort of entity it represents. The enduring gap between knowledge and understanding in relation to schizophrenia is one that we believe can be narrowed by posing a set of strategically placed, critically apt questions. Indeed, Zubin *et al* have stated that "asking the right question is perhaps the most important thing we can do".[2] Formulating the "right question", however, first involves unravelling the complex tangle of information about schizophrenia that we possess, by discriminating essential knowledge from the unessential or incidental. This process is dependent upon one's particular conceptual orientation which, in the present case, grew out of the premise that schizophrenia is characterised by disorders of information processing.

The material in this review is united around three principal assumptions.

1. Schizophrenia is a *single* disorder, although there may be more than one aetiology and the condition may unfold in several different ways with contributions from a variety of additional factors.
2. The primary underlying abnormality is one of *attention* with consequent disruption of information processing, both "incoming" information (i.e., perception) and "outgoing" or internal information (i.e., that involved in thinking, speech and action).
3. Much of the complexity and variability in the outward manifestations of schizophrenia and in the range of psychological, neurophysiological, biochemical and, perhaps, even neuroanatomical anomalies reported may be regarded as *secondary* phenomena attributable to the organism's *regulatory* or self-healing capacities. These can be viewed as operating to correct or compensate for the primary attentional disorder and thus to restore some internal equilibrium.

Space precludes a step-by-step defence of each assumption. However, the first two do not run counter to the mainstream of contemporary thinking in psychiatry.

Zubin and his colleagues, for instance, have clearly stated their belief that schizophrenia is "a unitary rather than a multiple disorder".[2] Also, the assumption that the primary abnormality in schizophrenia is one of attention implies a central role for dysfunction in the earliest phases of information processing, and this is in keeping with the findings of much of the research material to be discussed in this paper.

The third assumption is not fundamentally at variance with the familiar physiological principles articulated by Claude Bernard and Walter Cannon. Indeed, the concept of homeostasis is so familiar and integral a part of the conceptual framework of medicine that it is very much taken for granted or overlooked entirely. Consequently, it is all the more surprising and illuminating when it is unexpectedly brought to one's attention in relation to particular diseases. One example is atherosclerosis. The pathogenesis of atherosclerosis is thought to involve the operation of one or more of several possible aetiological factors, but the common early lesion is believed to be a breach in the endothelial lining of the artery wall.[3] This exposes the underlying intima to blood flow. Platelets and monocytes then seal this microscopic gap by adhering to the lesion in a modified inflammatory response. The monocytes migrate into the intima and several chemotactic and mitogenic substances are released. The resulting cellular proliferation leads to expansion of the affected region with encroachment into the vessel lumen if the lesion does not regress. Should the arterial lumen become sufficiently narrowed to compromise blood flow, then the particular sequelae that occur will, of course, depend on the anatomical location of the diseased artery. In effect, these are all processes generally involved in the maintenance of normal arterial wall homeostasis but they are responsible for atherosclerosis as well.[3]

Although we believe that it is useful to search for sets of homeostatic processes in schizophrenia, no simplistic notion of a specific primary "lesion", neuroanatomical or otherwise, is being suggested. Rather, it is proposed that it may be

possible for individual dysfunctional processes, identified in schizophrenia, to be divisible into primary disorder(s) and a series of secondary, corrective or compensatory mechanisms according to the principles of homeostasis. The key to differentiating these various processes and their relationships to each other may well be in the phenomenology and symptomatology of schizophrenia. According to this view, what at first glance apears to be a bewildering degree of variability in the manifestations of schizophrenia is neither random nor an incomprehensible agglomeration of symptoms. It is an orderly, coherent or "lawful" expression of underlying biopsychological processes in each case. Far from being a confounding factor in schizophrenia research, this variability is itself viewed as the key to identifying the disordered biopsychological events that interact in the pathogenesis of schizophrenia. In other words, certain groups of symptoms can be interpreted as the outward expressions of particular primary and secondary disorders of information processing.

Although there has been extensive research into the nature of attention and information processing since the 1950s, much remains unknown or purely speculative. Indeed, it should be kept in mind that there exists no broadly accepted general theory of attention to be drawn upon in attempting to explain psychopathology.

Attention

Gating and filtering

It has long been known that the brain is capable of controlling its own input.[4] One of the ways in which this is presumed to occur is through the action of certain subcortical neural pathways with substantial basal ganglia and limbic connections. These pathways have been referred to as comprising a sensory regulatory, central gating[5] or "filtering" mechanism.[6] Acting to modulate stimulus levels reaching awareness, this

mechanism is thought to provide a functional barrier against incoming sensory information. This subcortical filter is thus a *neurophysiological* construct used to characterise a proposed mechanism for governing the *quantity* of sensory information entering awareness. It is not to be confused with Broadbent's concept of filtering which is a *psychological* construct, the function of which is to subserve the processes of *selective attention.*[7] This latter form of filter, also referred to as "stimulus set", operates as a *qualitative* information filter that selects sensory features for further perceptual processing on the basis of the *physical* qualities of the sensory inputs (e.g., colour, form, pitch, loudness, spatial orientation). Filtering does not completely eradicate "unselected" sensory features from awareness, it merely attenuates them so that they remain accessible should further processing be required.[7,8] These two processes, although conceptually distinct, are probably not completely independent. In fact, Broadbent describes interactions between the amount of information available for processing and the functioning of the filter.[7] Thus, any changes in the setting of the neurophysiological or sensory "filter" (hereafter referred to as a sensory gating mechanism) would be accompanied by changes in the operation of the attentional filter. Alterations in sensory gating could also be expected to be closely linked to and to influence the level of physiological arousal as well.

Pigeonholing

In addition to filtering, Broadbent also proposed a further type of selective attention.[7] This he referred to as pigeonholing. Pigeonholing can be viewed as the response stage of a finite-capacity information channel which selects on the basis of the *informational* qualities of the input and not the physical or sensory qualities as in the case of filtering. Informational qualities (e.g., semantic class, signs, gestures) are determined by particular combinations of sensory features and generally have meaning or significance

to the individual. To attend to a baby's cry while ignoring the conversation at the dinner table is a filtering task: to seek one's own name in a list of successful examination candidates is a pigeonholing task.

Attentional capacity

Broadbent's filtering/pigeonholing model has several weaknesses, one of which is the problem of the "bottleneck" whereby, theoretically, only one stimulus at a time can be processed. This is at variance with experimental findings. Kahneman's capacity model of attention, which extends and complements that of Broadbent, addresses this problem.[9] He proposes a theory in which attentional capacity can be allocated to more than one of several possible mental activities simultaneously, depending on the prevailing task demands. The various factors which govern the allocation of attentional capacity contribute to what is termed "allocation policy". This model has a number of advantages. For instance, it allows for the influence of arousal on the allocation of available processing capacity. Arousal, in turn, may be determined by several factors among which are included the amount of effort invested in a given task, the actions of certain drugs and the prevailing intensity of sensory stimulation. There is thus provision for the influence of sensory gating, mediated by arousal, on the allocation of attentional capacity. Other factors influencing allocation policy include enduring dispositions (i.e., learned behaviours), momentary intentions and the effects of task demands. The latter provides a means whereby current capacity allocation is evaluated in the light of continuing demands on the system (i.e., the requirements of the immediate environment) and alterations to both level of arousal and allocation policy are made accordingly.

Preattentive grouping

The external world, the principal source of the various inputs to be

processed, is orderly and structured, not chaotic or amorphous. Features occur "in a systematic organization which cannot be altered":[10] there are rankings of probabilities, not randomness, in the environment. For example, we do not hear, in a single human voice, more than one harmonic at a time for a given pitch. Neither do we see shape without colour, nor more than one colour in the same place. Likewise, it is relatively improbable that the outline of our pet cat will fragment before our eyes as it moves or its fur turn green as it crosses a carpet of that colour. Indeed, cats are seldom green in colour: grass is, but it does not normally move of its own accord. Things that move along busy roads are usually vehicles of some sort and we rarely expect to see dolphins in that context. In other words, we can obviously make a large number of assumptions about the environment without ever having to put them deliberately to the test.

Optimal human adaptation to such an ordered, predictable environment would seem to dictate a perceptual information processing apparatus which took this degree of organisation as given. "It is at least a tenable point of view", as Broadbent put it, "that our sensory system takes advantage of this structuring of the world and handles incoming information in a hierarchical way. If this is so, the world around us may fall into natural segmentations or groupings, so that we can attend to a whole segment and must ignore another, rather than pick and choose between parts of one segment and parts of another".[10] The ability to "group" the environment in this way would provide a means by which the large amount of redundant information in the environment could be attenuated in a *structured* way, and so enable the efficient use of available processing capacity.

The phenomenon of perceptual grouping, which occurs *prior* to selective attention was first postulated by Neisser[11] and has since been incorporated into the formulations of other researchers (e.g. [9,10,12]). Treisman demonstrated that the phenomenon of preattentive grouping enabled normal subjects to complete certain visual search tasks by directing their attention to groups of items rather than single items.[12]

Preattentive grouping occurs automatically, without effort and utilises parallel or global processing rather than serial processing. This preattentive organisation of the perceptual field sets the scene for all subsequent stages of perceptual information processing. Independent of preattentive grouping, however, separable features of a stimulus field are also registered preattentively, automatically and in parallel. The degree to which the registration of these separate features is attenuated is a function of filtering.

Percept construction

Subsequent stages of perceptual processing involve assembling whole, coherent percepts out of the component parts of the sensory field. This occurs in a hierarchical fashion, beginning in the preattentive stage with perceptual grouping and individual feature registration. Passage through subsequent stages is a process in which the final percept is constructed through the combined operations of analysis of groupings and active conjunction of individual features.

The rules which govern the conjunction of features in the assembly of percepts comprise the *feature-integration theory* of attention.[13] Feature-integration is a task requiring active, focused attention, and it involves serial processing rather than parallel processing. It is by serially scanning the "spotlight" of attention over the sensory field that features are joined together and percepts thereby assembled. Focused attention is thus said to be the "glue" which holds percepts together.[14] Feature-integration theory provides us with another selective device (compare filtering, pigeonholing, allocation policy), a "spotlight" of attention that selects which features should be conjoined and how.[12]

The "spotlight" metaphor, in fact, provides an accurate representation of focused attention. An attentional spotlight can vary in the speed with which it scans the stimulus field; it can vary in the direction and range in which it scans and the sharpness of

its focus (i.e. a broad versus a narrow beam). A broadly focused spotlight results in attention being spread over a larger number of items, thus increasing the uncertainty with which features are assigned to percepts.[12] A narrowly focused spotlight would have the opposite effect. Obviously, the processes of preattentive grouping and filtering have intrinsic effects on the efficiency of feature-integration.

Perceptual bias

How is it that two individuals may interpret exactly the same event in entirely different ways? The concepts of pigeonholing and allocation policy offer complementary explanations for this phenomenon. As a consequence of prior learning, an individual tends to approach novel situations with certain expectations, or interpretations, "uppermost in the deck". If the novel situation should approximate one of those preferred interpretations, then there is a likelihood that it will be produced, even if it is not entirely appropriate. Broadbent has used the term "preferred pigeonholes"[10] for this phenomenon which can also be referred to as *perceptual bias*. Kahneman's concept of "enduring dispositions" that help to govern allocation policy has a somewhat different explanatory value.[9] It allows for a learned propensity for increased attentional capacity to be turned over to the perceptual processing of inappropriate or irrelevant items to the exclusion of others that may be more immediately relevant to the objective demands of the task at hand. Perceptual bias, then, is a learned pattern of perceptual information processing, accounting for variability in inter-individual interpretations of the same event.

Verification

In the early, relatively passive, preattentive stage, the perceptual groupings formed offer a range of possible interpretations as to the characteristics of the stimulus field. The most promising of these interpretations - and by "most promising" it is meant

the most objectively probable and/or most preferred (on the basis of perceptual bias) - is then verified by active interrogation of the sensory field. In effect, this is a process of checking on the presence and nature of certain informational features that have not previously been the objects of focused attention. The passive flow of information into the perceptual pathways provides "suggestions" of evidence or hypotheses and, by active "enquiry", the perceptual system reciprocates by serially probing the environment for validation of the suggestions, verification of the evidence, confirmation of the hypotheses.[10] This operation, called *verification*, obviously involves serial rather than parallel processing and depicts perception as an active rather than a passive process. It details the interaction between the perceptual apparatus and the environment as implied in feature-integration theory.

Processing "internal" information sources

The emphasis so far has been on the processing of perceptual information, but what of the organism itself which is an integral part of this process? Individuals vary as to their "preferred pigeonholes", "perceptual bias" or "enduring dispositions", and here the role played by long-term memory is important.[7] The organisation and retrieval of information from long-term memory is relevant because selection strategies, instructions for processing or other knowledge which may influence the processing and interpretation of stimuli, require the probing of particular regions of memory storage. Thus, interpretations of, and interactions with, the environment vary according to both the current input and also the results of previous operations.

Broadbent has postulated that memory processes are similar to those of selective attention and perception.[15] Individuals structure memory material according to several possible modes of logical organisation, from hierarchical to a more orthogonal allocation of dimensions.[16] Information may be selected from storage according to a

particular label or property that is relevant, or alternatively it may be selected according to a certain relevant combination of features.

The concept of memory may thus be interpreted broadly to include not only the results of information acquired from the environment, but also the interaction of these with "built in" factors,[7] or other sources of individual difference. It may be, therefore, that thoughts, actions and perhaps even affects, all intrinsic aspects of memory, influence behaviour through a similar system. In other words, it is possible that the model of information processing described above could apply not only to "external" (i.e. perceptual) but to "internal" (i.e. thoughts, actions) information as well.

Primary Abnormalities of Attention in Schizophrenia

Grouping/pigeonholing dysfunction

Preattentive grouping. A series of very interesting experiments has led to the suggestion that schizophrenic patients are impaired in their ability to perceptually organise stimuli. For instance, Cox and Leventhal, in a series of tests of preattentive visual processing, showed that process, non-paranoid schizophrenic patients were deficient in their capacity to organise the stimulus field automatically, compared to reactive, paranoid schizophrenic patients and psychiatric controls.[17] However, when the stimulus field was "enriched" - that is, so that the discriminability of *groupings* was enhanced - the process, non-paranoid schizophrenic patients showed an improved performance, with results no different from those of reactive, paranoid schizophrenic patients and psychiatric controls.

In an innovative series of experiments, Place and Gilmore demonstrated, again in tasks of visual information processing, that although process schizophrenic patients could estimate accurately the number of target elements in a stimulus field, their ability to do so declined relative to psychiatric controls when increasing "noise" elements

(i.e. non-target stimuli) were introduced into the task.[18] The authors concluded that schizophrenic patients were unable to "engage in an initial global analysis of the stimulus array", and thus failed to discriminate target elements from noise elements by grouping. Schizophrenic patients, therefore, relied solely on detailed, local or sequential analysis, and this impaired their performance efficiency. However, in a second series of experiments conducted by the same authors, the stimulus arrays contained no noise elements but, instead, the perceptual organisation of the arrays was manipulated. The psychiatric controls continued to group the stimuli despite the fact that the task did not require this and, consequently, their performance accuracy declined as the complexity of the perceptual organisation of the stimulus array increased. The schizophrenic patients, on the other hand, showed no such decrement in performance. Indeed, their overall accuracy was superior to that of the controls. It was concluded that this was because the schizophrenic patients were unable to group the display and so, in not responding to its organisational qualities, were able to perform the task more efficiently than the controls.

This work has since been replicated by Wells and Leventhal[19] and extended, as reported recently by Kietzman.[20] The conclusions are consistent with another set of experiments using a backward-masking recognition paradigm performed by Knight and his colleagues.[21] In the words of Place and Gilmore, "schizophrenics could view the world differently as early as the initial stage of processing".[18]

Inability to perceptually group stimuli in the preattentive phase of information processing is reflected in the finding of Frith *et al* that schizophrenic patients did not use gestalt grouping principles in a task involving the sorting of human faces.[22] They were able to sort other material that did not require such grouping satisfactorily. This suggests that a holistic appraisal of the material is impossible for schizophrenic patients who are therefore compelled to process separately each component feature. This could also account for the observation that schizophrenic patients seem to be impaired in their ability

to recognise facial expressions of emotion,[23-26] although doubt has been cast on this finding on methodological grounds.[27]

Failure to group adequately in linguistic as well as visual tasks may be interpreted from the results of a study in which chronic and poor premorbid acute schizophrenic patients were found to be impaired in their ability to organise and integrate ideas in long-term memory.[28] Similarly, in a study of memory organisation, others have found schizophrenic subjects unable to generate an internal structure to aid them in recall.[29,30] These authors have interpreted this as a difficulty in "unitising" or "chunking" material. Apart from mnemonic organisation, the ability to organise sensory input into manageable "chunks" of information has also been found impaired by the presence of distractors in certain digit-span tasks.[31] Although not preattentive in nature, the latter studies do reflect deficits in grouping information. Therefore, although Treisman's methodology[12] for measuring preattentive grouping has not been systematically applied in schizophrenic populations, there appears to be fairly compelling, if indirect, evidence that this process is impaired in schizophrenia.

Impaired preattentive perceptual grouping, a function which involves automatic parallel processing, could reflect right cerebral hemisphere dysfunction. Indeed, the suggested impairment in the ability of schizophrenic patients to recognise facial expressions of emotion, referred to above, is consistent with this view in light of a similar abnormality found in persons with right-sided neurological lesions.[32] Evidence of non-dominant parietal lobe dysfunction, among other abnormalities, has also been reported in schizophrenia using an aphasia screening test.[33] Likewise, in a visual discrimination task sensitive to right hemisphere abnormality, the performance of schizophrenic patients resembled that of right brain-injured patients.[34] A right hemisphere-like deficit in spatial identification has also been reported.[35] Further evidence

for right hemisphere dysfunction in schizophrenia has recently been more thoroughly reviewed by Venables.[36] This, however, is not to imply that the underlying disorder in schizophrenia can be localised exclusively to the right hemisphere. Indeed, the caveats of people such as Nuechterlein[37] and Wexler[38] in relation to the interpretation of experimental evidence should be noted, and the possibility of a bilateral disorder or a dysfunction in the interactions between hemispheres is not to be discounted.

Having summarised some experimental evidence supporting a deficit in preattentive perceptual grouping in schizophrenia and the possibility that this may be a product of right cerebral hemisphere dysfunction, we will consider for a moment the inner world of the schizophrenia sufferer. What may be the experience of the schizophrenic individual engaged in routine perceptual information processing outside the laboratory setting?

If there is a failure in preattentive grouping, relatively speaking, there would presumably be apprehended no order, structure, clusters of probabilities or organisation in the external world. All stimulus features would have an equal probability of occurrence in conjunction with one another, rather than being arranged along probability gradients reflective of the structure in the environment. In the absence of a hierarchy of informational features, any informational feature would be just as likely a candidate for selection as the next one. The schizophrenic person, therefore, would have available no "short cuts" in perceptual processing, no "clues" as to which feature to select or the order in which to select them. With substantial loss of access to preattentive parallel processing upon which perceptual grouping is normally based, each percept would have to be assembled by serial processing alone, feature by feature. The schizophrenic individual's ability to organise and maintain an effective strategy for processing perceptual information would thus be gravely compromised.

We propose that this would have two important consequences: a propensity

to *random* selection/conjunction of features, and a tendency for excessive *personal bias* to affect the selection/conjunction of features. Both, interacting together, would amount to disorder in pigeonholing (and/or allocation policy), while the relative predominance of one over the other would determine the degree of organisation in the assembled percept. The randomised or, at best, biased selections/conjunctions of features would lead to inappropriate or approximate interpretations of inputs, so that the meaning or significance of incoming information would be substantially undermined. A degree of randomness of meaning in the information processing system would have the effect of increasing the entropy of the system. On the other hand, excessive personalisation (i.e. personal bias) would introduce a degree of idiosyncracy of meaning with the effect of compromising the validity of the signal component of the percept.

If the human information processing apparatus not only functioned in the service of sensory input but also governed the selection and subsequent processing of internal information, then one could expect similar disruption in the selection of thoughts and actions. If this proposition is valid, then we have a model for schizophrenia in which a hypothetical central information selector is dysfunctional owing to a failure in preattentive grouping. This kind of abnormality would imply that, at a subjective level, the means by which an individual knows and interprets the external and internal environments are rendered unreliable.

Admittedly, much of the preceding has been speculative. Yet it is basically an empathic attempt to understand the consequences to the individual of a failure in preattentive grouping. We believe that the fore-going account helps to make intelligible certain aspects of the phenomenology of schizophrenia that will be discussed further, when we examine in more detail what the psychopathological consequences may be of this type of information-processing dysfunction. First, it is necessary to examine the evidence for pigeonholing abnormalities in schizophrenia that we propose are largely the result of

disruption in preattentive grouping.

Pigeonholing. The case in favour of a pigeonholing abnormality in schizophrenia has been persuasively argued by Schwartz.[39] However, during the past decade, a number of others have offered similar interpretations based on selective reviews of the literature. Although reviewers have used varying terminologies, such as response set or pigeonholing,[40,41] allocation policy,[42] serial limited-channel-capacity processes[43] or several of the commonly used terms together,[44] each converges on the concept of an impaired, response selection-based serial processor in schizophrenia.

A comprehensive review of this material cannot be undertaken here. The evidence supporting an abnormality in pigeonholing comes, however, from studies employing diverse methodologies, including card-sorting experiments,[45-47] dichotic listening protocols,[48-50] and evoked potential research.[51] In addition, certain other research findings can be interpreted as supporting the abnormal pigeonholing hypothesis,[52-54] including the "span of apprehension" experiments of Asarnow and MacCrimmon.[55,56]

The information processing model for schizophrenia outlined so far is represented in Figure 1. Venables has recently argued that a dysfunction in preattentive parallel processing, normally a right hemisphere activity, necessitates the utilisation of consciously controlled sequential processing, which is normally a left hemisphere activity.[36] Consequent overloading of the latter limited channel-capacity processing system may provide the basis for the abnormalities in pigeonholing described in the literature. The relationship between this pattern of information processing abnormality and cerebral localisation has been addressed in several studies. For instance, in the course of reporting a study of schizophrenia using neuropsychological techniques, Gur wrote, "schizophrenia can be considered an expression of a shift from right to left hemisphericity,

a result of the failure of right hemisphere strategies to cope with reality stresses".[57] Similarly, using visual half-field presentations of verbal and spatial material, Schweitzer concluded that the left hemisphere advantage for spatial detection that he found in schizophrenia "may be a compensatory reaction to a fundamental deficit in the processing of spatial material by the right hemisphere".[35] At a physiological level, a study of regional cerebral-blood flow demonstrated in schizophrenics an anomalous increase in left hemisphere cerebral blood flow during a spatial task.[58] This task was one which normally requires automatic parallel processing for its efficient completion and, in contrast to the above, had been associated with increased right hemisphere blood flow in normal subjects.[58]

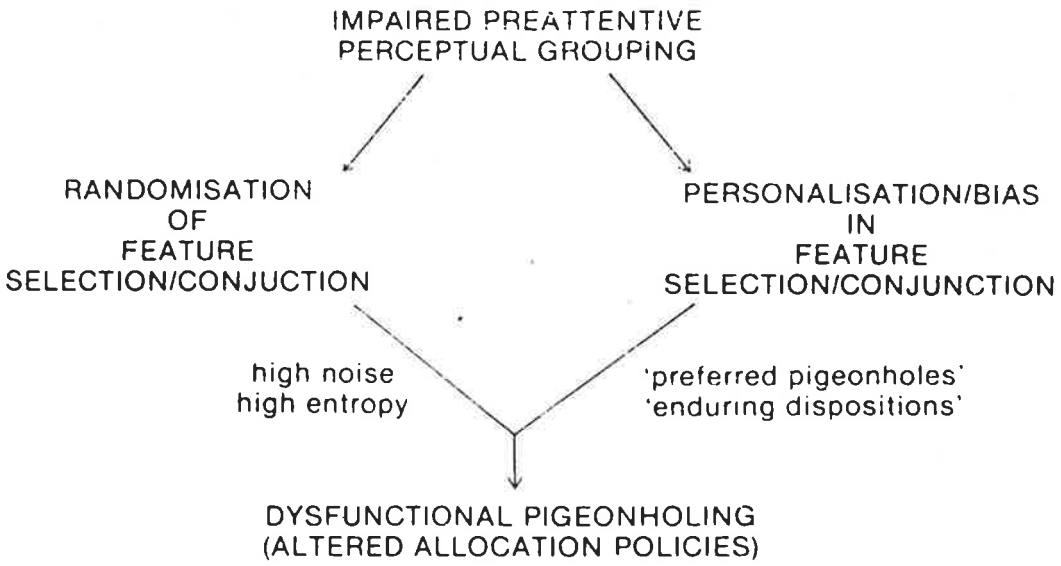

Figure 1. Relationship between dysfunctional preattentive grouping and pigeonholing abnormality.

In summary, so far we have proposed a primary defect in pre-attentive perceptual grouping, a function which utilises automatic parallel processing and which may be the result of a dysfunctional right cerebral hemisphere. The immediate consequence of this abnormality would be a combination of tendencies towards both randomisation and personalisation of feature selection/conjunction. This would result in compensatory overactivity of sequential limited channel-capacity processing, a left hemisphere function, and would manifest as a disorder of pigeonholing.

Psychopathological features. The quotations listed in Table 1 have been taken from the well-known reports of McGhie and Chapman.[59,60] Listed under the headings of perception, thinking and speech, and action, they seem to reflect very closely the grouping and pigeonholing abnormalities described above.

Particularly notable among these phenomena is a loss of perceptual stability, with fragmentation of percepts and failure to interpret "wholes" as meaningful gestalts. The consequent need for conscious, deliberate effort in the assembly of percepts is apparent. Other perceptual disturbances, documented in this and similar literature, that are compatible with the proposed pattern of information processing disorder include altered spatial perspective, faulty perception of movement, impaired capacity for recognition, and bizarre, disagreeable body sensations.[61] Distorted body image and, eventually, fragmentation of identity are also well described. Cognitive interferences include loss of control over thinking, with thoughts coming and going unpredictably, and the inability to select a required thought, thus leading to words which were not intended being spoken. Comprehension of language suffers as a result of fragmentation or loss of inner connectedness normally perceived in relation to particular language samples. Motor disturbances include the sense of loss of control over movements or loss of the automatic qualities of natural movement, so that motor sequences feel uncoordinated or unintegrated and limbs seem to be moving of their own accord. Schizophrenic individuals' own facial

Table 1

Psychopathological features of grouping/pigeonholing dysfunction

Perception:

Everything is in bits. You put the picture up bit by bit into your head. It's like a photograph that's torn in bits and put together again.[59]

I have to put things together in my head. If I look at my watch I see the watch, watchstrap, face, hands and so on, then I have got to put them together to get it into one piece.[60]

I see things flat. Whenever there is a sudden change I see it flat . . . It's as if there were a wall there and I would walk into it. There's no depth, but if I take time to look at things I can pick out the pieces like a jigsaw puzzle, then I know what the wall is made of.[60]

If there are three or four people talking at one time I can't take it in. I would not be able to hear what they were saying properly and I would get the one mixed up with the other.[59]

It's the same with listening. You only hear snatches of conversation and you can't fit them together.[59]

Thinking and speech

My thoughts get all jumbled up. I start thinking or talking about something but I never get there. Instead I wander off in the wrong direction and get caught up with all sorts of different things that may be connected with the things I wanted to say but in a way I can't explain.[59]

Often I have to go through two or three things in my head before I find the thought I want - words I don't want come out - not the correct words - not the words I wanted for the meaning I wanted to give. I have to pick out thoughts and put them together.[60]

The words wouldn't come out right. I know how to explain myself but the way it comes out of my mouth isn't right.[60]

I can't control my thoughts. I can't keep thoughts out. It comes automatically.[60]

Actions

I am not sure of my own movements any more . . . I am not sure about even simple actions like sitting down. It's not so much thinking out what to do, it's the doing of it that sticks me . . .[59]

If you move fast without thinking, coordination becomes difficult and everything becomes mechanical.[59]

I have to do everything step by step, nothing is automatic now. Everything has to be considered.[59]

None of my movements come automatically to me now. I've been thinking too much about them, even walking properly, talking properly and smoking - doing anything.[60]

If I do something like going for a drink of water, I've got to go over each detail - find cup, walk over, turn tap, fill cup, turn tap off, drink it. I keep building up a picture. I have to change the picture each time. I've got to make the old picture move.[60]

expressions may not conform to the mood they wished to express or the subjective emotional state experienced at the time, and they may feel as if they are not applying their emotions correctly or in context.[61] With further regard to affective phenomena, schizophrenic individuals may experience their emotions as not genuine, not natural or inappropriate.[61]

In the interests of devising an objective means of measuring symptoms that closely correspond with abnormal grouping/pigeonholing, we adopted a particular cluster of symptoms called psychotic disorganisation[62] which seemed to reflect the phenomenon quite faithfully. The term "psychotic disorganisation" highlights the loss of organisation, lack of structure and high levels of noise or entropy in the information processing system that appear to be the most immediate consequences of grouping/pigeonholing dysfunction. This symptom dimension has been further described in the course of a literature review dealing with the symptomatology of recovery from schizophrenia.[63] It includes phenomena such as bizarre, idiosyncratic behaviour (e.g. mannerisms, posturing, grimacing), incongruity of affect and positive formal thought disorder. Certain first-rank symptoms such as thought withdrawal and thought insertion are also seen as belonging to this symptom group. A number of items of the Present State Examination (PSE)[64] have been identified that, together, can provide an estimate of the severity of psychotic disorganisation in a given case. The PSE items which comprise this scale are listed in Appendix B.

Questions. The model outlined so far raises a number of hypotheses that could be tested using currently available research methods. Among them are the following questions.

1. Is there a defect in peattentive grouping in all cases of schizophrenia and only in schizophrenia?
2. If so, is it a vulnerability marker or an episode marker?[65,66]

3. Does it vary in degree between individuals and/or within the same individual over time and, if so, what are the determinants/correlates of that variability?
4. In particular, does the severity of pigeonholing dysfunction co-vary with changes in the preattentive grouping deficit?
5. Is there a positive correlation between degree of preattentive grouping defect or pigeonholing dysfunction (or both) and severity of psychotic disorganisation symptoms?

Gating/filtering dysfunction

Sensory gating. The fore-going account still leaves much to be explained about schizophrenia, particularly the episodic nature of psychotic episodes within the disorder.[66,67] What is the mechanism whereby a particular individual is carried over the illness threshold? The intervening variable that may account for this is the sensory gating mechanism. An alteration, that is, an "opening", in the sensory gating mechanism would produce an increase in the rate at which sensory stimuli entered the perceptual processing apparatus from the environment. Although less accessible to measurement, this alteration in gating may also apply to *internally* generated stimuli, namely, thoughts and actions.

Alteration in sensory gating is a process which may precede, but is not to be confused with, "input dysfunction", a psychological concept first articulated by Venables.[68] He wrote that "the acute (and possibly the reactive and paranoid) patient is characterized by an inability to restrict the range of his attention so that he is flooded by sensory impressions from all quarters.[68] Twenty years later, he stated, "More recent empirical studies show little need to modify that early statement . . .".[36] Thus, "input dysfunction" refers to a dysfunction of attention and not to a dysfunction of the neurophysiological regulator of sensory input.

A number of reviews, some of which tend to blur this distinction, support the

concept of the faulty neurophysiological "filter" or sensory gating defect in schizophrenia.[6,69-71] Empirical support has come from several sources[6,72] and, more recently, from a Colorado group using the methodology of auditory evoked potentials in a conditioning-testing paradigm.[73-75] The Colorado group proposes that the neurophysiological basis for the failure of the sensory gating mechanism may be a lowering of the activity of subcortical inhibitory pathways which normally control sensory inputs. Freedman *et al* reviewed the evidence for the role of dopamine and noradrenaline in facilitating sensory responsiveness.[75] This evidence suggests that the subcortical neural pathways, whereby dysfunctional sensory gating occurs in schizophrenia, may be catecholamine-mediated. The importance of dopamine pathways in schizophrenia, together with a recently renewed emphasis on the evidence for noradrenergic hyperfunction in this disorder,[76-79] fits well with this position. Indeed, the basal ganglia system, which is functionally integrated with the limbic system,[80] receives noradrenergic as well as dopaminergic projections. The basal ganglia and its connections have recently been described as "an active sensory information gating station [which maintains] the normal flow of afferent information to both ascending and descending structures".[80] Recent evidence for a basal ganglia abnormality in schizophrenia comes from both a morphological study[81] and a PET scan study.[82] The latter revealed metabolic hyperactivity in the basal ganglia of schizophrenic persons prior to, but not after, treatment with antipsychotic drugs.

The findings of Franks *et al* were that the proposed gating failure is not specific to schizophrenia but is present also in manic patients.[74] In the latter group it appeared to be closely tied to clinical state and was completely reversed in association with clinical improvement. However, no such reversal occurred in association with drug-induced clinical improvement in schizophrenic subjects, although certain components

of the evoked potential did change under the influence of medication in this group.[74] Evidence for this gating failure has also been found among the clinically well first-degree relatives of schizophrenic persons.[83]

The finding of sensory gating dysfunction in affective disorder as well as in schizophrenia may indicate a neurophysiological link between these two conditions compatible with Crow's proposal that bipolar disorder and schizophrenia may share a common aetiology, presumably genetically based.[84] The principal differences between schizophrenia and bipolar disorder within this framework would be, first, that a compromised or vulnerable sensory gating mechanism remains an enduring trait in schizophrenia, whereas in mania there is a state-dependent abnormality in sensory gating. Second, a primary dysfunction in preattentive grouping underlies the pigeonholing dysfunction that occurs in schizophrenia, whereas in mania pigeonholing could become dysfunctional secondary only to the overloading of sequential processing capacity induced by sensory gating failure.

Filtering. With the increased amount of information available for processing attendant upon sensory gating failure, significant effects on the functioning of the attentional filter could be expected.[7] It could be predicted that such conditions of stimulus overload would be associated with high levels of arousal and correspondingly altered attention. Increasing levels of arousal result in a narrowing of the "spotlight" of attention.[9] A narrowly focused "spotlight" of attention, rapidly and widely scanning the stimulus field, would result in the selection of inputs with poor discrimination between relevant and non-relevant features. In other words, the attentional filter would be "wide open" or "leaky". This is the "input dysfunction" of Venables.[36,68]

Evidence in relation to this form of filter dysfunction in schizophrenia is contradictory. In some cases, this may be due to a failure to distinguish paranoid from non-paranoid subtypes or, more importantly, acute from chronic schizophrenia.

Nevertheless, the subject has been reviewed by a number of authors[70,71,85-87] and considerable support for the above form of filtering dysfunction in acute schizophrenia can be found in their reviews as well as in those of Venables.[36,68]

Further empirical support for this type of dysfunction in acute schizophrenia can be found in studies of the functional visual field,[88,89] auditory signal detection,[90] and auditory verbal recall.[91,92] Many of these authors do not use filter terminology, but their findings are consistent with such a model. The filter abnormalities were also shared by depressive[91] and manic[92] patients, supporting the non-specific nature of this abnormality.

We would suggest that failure in sensory gating may be the means by which already vulnerable preattentive grouping and, hence, pigeonholing functions are disrupted to a sufficient degree to trigger an acutely symptomatic episode of schizophrenia. We also propose that the intervening variable that mediates this effect may be physiological arousal. That is, sensory gating failure increases the level of arousal and this, in turn, leads to the kind of changes in filtering described above. The "opening" of the filter augments the effects of preattentive grouping dysfunction on pigeonholing. If, as a result, pigeonholing processes are sufficiently compromised by this means, then this will be expressed in terms of pigeonholing disorder.

This is, in effect, a dual process model for the pathogenesis of schizophrenia, a combination of preattentive grouping dysfunction and sensory gating failure. Others have also proposed a dual process model at a similar level of information processing dysfunction in schizophrenia, although not quite in these terms.[40,93,94] Recently Spohn *et al* also considered "the possibility that there are at least two kinds of disorders of central processing, one modifiable by neuroleptic treatment, the other not".[95] We would expect the former to be some, but not all, aspects of sensory gating failure, and the latter preattentive grouping dysfunction. In bipolar disorder, preattentive grouping is probably

less vulnerable or less tenuously maintained than in schizophrenia, so that in schizophrenia, a given alteration in sensory gating, in magnifying the effects of preattentive grouping failure, produces a more severe degree of pigeonholing disturbance than occurs in mania.

The role of stimulant drugs and psychosocial stressors such as high "expressed emotion"[96] in triggering acute episodes of schizophrenia may operate at the level of gating/filtering dysfunction. In particular, stimulant drugs would be likely to exert their effect on the catecholaminergic neural substrate for sensory gating or, perhaps, directly on the centres which control physiological arousal. Psychosocial stressors, on the other hand, may have their impact at the level of the attentional filter or on the arousal control mechanisms. Both sets of triggering agents, by these means, could further compromise vulnerable grouping/pigeonholing functions sufficiently to carry individuals beyond their illness thresholds.

Psychopathological features. The patient self-report descriptions of McGhie and Chapman,[59,60] which illustrate the sensory and cognitive bombardment thought to be attributable to sensory gating failure or the "leaky" attentional filter, are already very well known. A selected few have nevertheless been listed in Table 2 for purposes of illustration.

Table 2

Psychopathological features of gating/filtering dysfunction

Perception

It has to do with what is going on around me - taking in too much of my surroundings - vital not to miss anything. I can't shut things out of my mind and everything closes in on me.[60]

It's as if I am too wide awake - very, very alert. I can't relax at all. Everything seems to go through me. I just can't shut things out.[59]

Things are coming in too fast. I lose my grip of it and get lost. I am attending to everything at once and as a result I do not really attend to anything.[59]

Colours seem to be brighter now, almost as if they are luminous.[59]

I see things more than what they really are. Everything's brighter and louder and noisier.[59]

Thinking

My trouble is that I've got too many thoughts. You might think about something, let's say that ashtray and just think, oh! yes, that's for putting my cigarette in, but I would think of it and then I would think of a dozen different things connected with it at the same time.[59]

My mind's away. I have lost control. There are too many things coming into my head at once and I can't sort them out.[59]

My mind is going too quick for me. It's all bamboozled. All the things are going too quick for me. Everything's too fast and too big for me.[59]

Half the time I am talking about one thing and thinking about half a dozen other things at the same time . . . You see I might be talking about something quite serious to you and other things come into my head at the same time that are funny and this makes me laugh.[59]

This range of phenomenology points to heightened perception with colours appearing brighter or more vivid, sounds seeming to be clearer or louder, and a generally increased intensity of sensory experience. Cognition is overloaded and is marked by distractibility and racing thoughts. Likely objective concomitants of these phenomena would probably include accelerated speech and overinclusiveness.[97,98] Affective experiences would be likely to include elation, hostility or lability of mood, each marked by increased intensity of experience and expression. Motor behaviour under these conditions would probably be increased and/or accelerated.

Similar overstimulation occurring in the context of schizophrenia has been described by Docherty *et al* and its resemblance to the disinhibition of mania noted.[62] A review of the symptomatology of recovery from schizophrenia also identified and described a similar cohesive symptom dimension giving it the term "activation".[63] In an attempt to devise a method for measuring the severity of symptoms on this activation dimension, certain items from the PSE[64] were selected and put together to form a rating scale which roughly corresponds to the suggested psychopathology of gating/filtering dysfunction (see Appendix B).

Questions. The dual process model for the pathogenesis of schizophrenia described in this section offers a large number of testable hypotheses. Some of the more important questions to be addressed would probably include the following:

1. What is the nature of the link between sensory gating and physiological arousal?
2. (a) Is there a disorder of sensory gating mechanisms in schizophrenia?
   (b) If so, does this occur in all cases of schizophrenia?
   (c) In what way is gating failure modified by antipsychotic drug treatment in schizophrenia?

3. If sensory gating failure is not specific to schizophrenia, in what other conditions does it occur?
4. Is gating failure genetically based and, if so, how does its pattern of inheritance in schizophrenia compare with that in bipolar disorder?
5. What is the relationship between sensory gating failure and measures of attentional functioning such as filtering?
6. Does gating failure and/or corresponding filter dysfunction correlate positively with severity of the "activation" symptom dimension?
7. Is the site of the therapeutic action of neuroleptic drugs principally in the sensory gating mechanism?
8. Is there a positive feedback from grouping/pigeonholing dysfunction to the filtering processes such that a vicious cycle is created with each exacerbating dysfunction in the other?

Secondary Abnormalities in Schizophrenia

Although we have described and discussed in detail what we propose may be the primary abnormalities in schizophrenia, many clinical and experimental phenomena remain unexplained. We propose that these can be understood as compensatory or self-correcting mechanisms adopted in the service of restoring homeostatic equilibrium.

Filtering

Filter "closure". The first of the compensatory processes to be discussed is that of "closure" of the attentional filter or restricted attention. The combined effects of grouping/pigeonholing dysfunction and sensory gating/filter failure tend towards

producing a disorganised, overstimulated, hyperscanning condition[70] which cannot be sustained for long without further adjustments being made.[85,89]

These adjustments, which seem to be made in the transition from the acute to the chronic or residual schizophrenic state, have been interpreted by some[70,85,99] as protection against the disorganisation and overstimulation characteristic of the acute schizophrenic episode. Broen, in particular, describes the chronic schizophrenic state as one of restricted monitoring of the environment with narrowed attention and attenuation of signal strength.[99] This may be understood in terms of the filtering model but, in this case, unlike acute schizophrenia, there is reduced scanning or closure of the filter so that attention focuses on a very limited aspect of the stimulus field and excludes most others. Again, this is a restatement of the model proposed previously by Venables.[68]

Several early studies suggested that chronic schizophrenic patients reduce information input to avoid or lower their sensitivity to stimulation.[100-103] This appears to apply to both internal and external sources of stimulation. More recent research has shown, using forward/backward masking techniques, that information processing is slowed in these patients[104] while, in the use of various language tasks, restricted processing has also been demonstrated.[105,106] More direct evidence at the level of the filter, for a narrow spotlight of attention with less extensive scanning of the environment, comes from studies on auditory signal detection[107] and the functional visual field.[88,89]

Psychpathological features. From the phenomenological point of view, the effects of this form of processing disorder - filter "closure" - can readily be identified in the patient quotations listed in Table 3. As far as more objective psychopathology is concerned, this form of attentional disorder could well be reflected in such items as dulled perception, the experience of blunting of sensory impressions. Slowed or inefficient thinking, poverty of thought and slow, sparse speech would also be compatible.

Table 3

Psychopathological features of restricted attention (filter "closure")

Perception

I just turn off all my senses and I don't see anything and I don't hear anything. Things going on around me don't affect me.[60]

You tend to linger in these trances and your mind goes dead to the world around you. You can very easily go into a trance - it goes on as soon as the mind stops and then you realize you are not actually seeing anything or hearing anything.[60]

My mind goes blank when I lisen to somebody speaking to me - telling me a story, and my eyes just stare and I'm not aware of anything. It happens when I'm watching television as well and my concentration drifts away and focuses on any point in the room and I can't pick up anything that's going on.[60]

Thinking

My brain is slowed up and when I'm talking to someone I don't know what to say back to them to keep it going.[60]

I try to empty my head of thoughts to enable me to stand still.[60]

I'm slow in everything and everything is too quick . . . It's not that they talk too fast it's me that's slow.[59]

I just go into myself. I just stop moving. I may be looking at something in a window for example, and then I find myself thinking deeper and getting caught up in it. My mind can't move past it.[59]

What happens is that I suddenly stick on a word or an idea in my head and I just can't move past it.[59]

Affectively, this would probably be a state of lowered motivtion with anergia and loss of interest; anhedonia, emotional dulling or flat affect would likely be characteristic. Behaviour marked by inactivity and social withdrawal with self-neglect and apathy could reasonably be expected as the outward manifestations of a state dominated by this kind of attentional dysfunction. Perhaps, on neuropsychological testing, there would be evidence of cognitive impairment.

This constellation of clinical signs is clearly recognisable as the negative symptom complex[108] or type II syndrome,[109] and we propose that this symptom pattern constitutes the outward manifestations of one of the most widely used compensatory mechanisms in schizophrenia, namely, protective filter "closure" or restricted attention. A group of very similar symptoms was identified in the literature review mentioned earlier and labelled "inhibition".[63] As with the other symptom groups already mentioned, we have selected a number of PSE[64] items which together comprise a scale for estimating the severity of symptoms on the "inhibition" dimension (see Appendix B).

No direct relationship between sensory gating and the attentional filter is suggested by the available evidence, apart from alteration of the amount of information available for processing and the level of arousal. Indeed, not only are these two processes probably quite independent of each other, but it is important not to confound the two concepts, as one belongs to the realm of neurophysiology and the other to psychology. It must be kept in mind that "closure" of the attentional filter in the proposed compensatory process manifest as "inhibition" is not the same as, nor is it necessarily accompanied by, sensory gating changes.

This distinction allows for such phenomena as the simultaneous occurrence of an "opened" sensory gating mechanism and "closure" of the attentional filter in the same individual. This could help to explain the otherwise somewhat paradoxical finding of high arousal combined with restricted attention or symptoms of withdrawal-retardation

in chronic schizophrenic patients.[110] It could also help to account for the simultaneous occurrence of "activation" and "inhibition" symptoms, not only in some cases of schizophrenia but also in schizo-affective disorder, mixed manic and depressive states - see Jampala *et al* for an account of mania with emotional blunting[111] - and agitated endogenous depression.

Questions. The pattern of change in attentional function outlined in this section suggests the following:

1. Does "closure" of the attentional filter (reduced scanning) occur in schizophrenia?
2. If so, is it detected in the premorbid, post-acute or residual stages and not during an acute episode?
3. Is there a positive relationship between "closure" of the attentional filter and the severity of "inhibition" (i.e. negative or type II) symptoms?
4. What is the effect of antipsychotic drugs or other therapeutic interventions on the attentional filter?

Organising phenomena

So far the supposed hallmarks of schizophrenia, namely delusions and hallucinations, have not been discussed. Although often the most obvious and compelling aspects of schizophrenia's clinical presentation, they are neither specific to that disorder nor do we view them as central to the underlying biopsychopathology. In a way that is not inconsistent with psychoanalytic theory[e.g 112,113], we take the view that these symptoms serve an organising or restitutive function. That is, the formation of delusions and hallucinations represents the individual's attempts to restore psychological equilibrium and achieve adaptive mastery over the experience of psychotic disorganisation through the establishment of ideational and perceptual schemata, respectively. This view is one in which delusions and hallucinations are conceptualised as secondary phenomena growing

out of the individuals' attempts to organise their experience by imposing order and meaning on percepts or other subjective phenomena that would otherwise be experienced as orderless or meaningless.

Perceptual organisation. With regard to hallucinations, this position has been articulated by Frith who cited evidence in support of the view that auditory hallucinations are based on actual sounds and "involve the same processing channels as speech and other auditory stimuli".[114] Thus, misinterpretations or improbable interpretations of real sounds form the basis of auditory hallucinations.[114] In a similar vein, Hartman related hallucinations to the "ability to pattern sensory input".[115]

One of the few to undertake experimental investigations of hallucinations in the clinical setting was Slade who found that hallucinations became less intense when schizophrenic patients performed complex auditory tasks which required particular responses.[116] In a later, more comprehensive discussion of the topic, Slade reiterated that external stimulation that was of high information content and required a response acted to inhibit hallucinations.[117] He explained this phenomenon in terms of a limited channel-capacity processing model in which an increasing information load reduced the amount of spare capacity for an hallucinatory experience.[117] Further support for this conceptualisation comes from a subsequent study that found that the extent of hallucinatory experience varied according to the form or structure of the auditory input.[118]

The mechanism whereby perceptual input is erroneously patterned to form the basis of hallucinations is not known. However, the work of Treisman and Schmidt on what they call *illusory conjunctions*[119] may help to answer this question. According to feature-integration theory, percepts are assembled by the conjunction of particular stimulus features held together by the "glue" of focused attention.[14] Under conditions in which attention is diverted or information processing capacity overloaded (as in schizophrenic

psychosis), erroneous conjunctions of features may occur so that a particular percept, which has no real basis in the actual stimulus input, may be registered. Instead, it is made up of unrelated, unconnected stimulus features that the perceptual processing apparatus has put together by mistake. Using this framework, hallucinations in schizophrenia could be understood as forms of *perceptual organisation* or restitution, creations of higher cortical processes whereby disorganised, unpatterned or, more precisely, ungrouped features of stimulus inputs are falsely conjoined and idiosyncratically interpreted. The role of perceptual bias may be crucial in this process in determining which features are erroneously conjoined and how and, thence, the content of or interpretation given to the percept thereby generated.

Ideational organisation. Delusions appear to serve a similar organising function. According to Silverman, the "development of a delusional system is an adaptive solution" to an overstimulated or "hyperscanning" state.[70] Heilbrun stated that delusions serve to organise an overextended and disorganised information processing system.[120] This author went further in stating that delusional beliefs were reinforced by the reduction in anxiety which followed from the decline in disorganisation brought about by the delusions.[120] Similar conclusions have been reached by others.[121]

Frith emphasised the role of abnormal perception as the primary cause of delusions.[114] He proposed that, as a result of dysfunctional filtering, schizophrenic persons became aware of stimuli that would normally be rejected from consciousness, and that it is the attempt to determine what is important or significant about those stimuli that gives rise to delusion formation. This is not incompatible with the view of McReynolds that delusions arise from the individual's attempts to assimilate what are otherwise "unassimilable percepts".[122,123] In some experimental work in this field, it was found that delusional schizophrenic persons had a "stronger tendency to organize ambiguous stimuli in a meaningful way" than non-delusional schizophrenic persons.[124] The ubiquity

of the need to organise stimuli is implied in a recent comment by Steinhauer that normal controls, under laboratory conditions, often attribute meaning to what is going on, regardless of instructions.[125]

Of relevance to the proposed importance of perceptual bias on selective processing dysfunction in schizophrenia, is the finding that delusional schizophrenic persons showed unusual allocation policies on dichotic listening tasks.[48] Similarly, Frith reported a stronger tendency for chronic schizophrenic persons with positive symptoms to select unusual features compared to those with negative symptoms.[47]

Within the information processing framework described here, the schizophrenic individual appears to have to contend with increases in randomly and/or idiosyncratically selected information that cannot be adequately assimilated. This becomes, then, a psychobiological state characterised by relatively lowered levels of organisation or increased entropy. In this context, delusions and hallucinations appear to be the products of self-correcting strategies brought to bear in the face of a lack of structured input. As the information of hallucinations provided perceptual organisation to relatively unpatterned inputs, so delusions can also be viewed as instances of *ideational organisation*, creations of higher cortical processes by which disorganised inputs are ordered or structured to form ideational schemata. It is likely that personal bias, based on what have been referred to as "preferred pigeonholes" or "enduring dispositions" may help to explain the particular idiosyncratic content of the delusions in each case.

The way in which delusions, at times, can be held with such utter conviction that the sufferer will brook no alternative explanation despite clear evidence to the contrary can be quite striking. Can this be explained solely by the reduction in anxiety which is said to follow the construction of organisation or meaning where before there was neither? A further explanation for this phenomenon could, perhaps, be located in the reciprocal processes referred to earlier as "suggestion" and "enquiry" in what was described as

verification. It may be that, in delusional forms of schizophrenia, this phenomenon of verification is curtailed: the "enquiry" component is suspended, owing to such an overload of existing sequential processing capacity that no further processing capacity can be spared for verification. Conceptually, the similarity between verification and the clinical term "reality-testing" seems obvious enough not to require further comment. Heilbrun and Blum have demonstrated something similar in relation to hallucinations in which they found hallucinating subjects unable to delay the assignment of meaning to ambiguous stimuli.[126] Their subjects also showed a reduced availability of alternative meanings for these stimuli.

Once delusions have been established, they seem prone to being perpetuated by environmental reinforcements, including nosocomial and iatrogenic influences. This may help to explain the very high frequency with which delusions tend to continue past the acute schizophrenic episode.[127,128]

Psychopathological features. As with the previous symptom dimension (psychotic disorganisation, activation, inhibition) linked with the patterns of information processing disorder described earlier, we have attempted to devise a means by which the severity of organising phenomena, delusions and hallucinations can be measured. Again, we have selected particular items of the PSE[64] to comprise rating scales for these phenomena. We have also identified certain items which are also ideational organising phenomena but are neurotic in nature rather than delusional. These include such symptoms as obsessions, compulsions, phobias, hypochondriasis and so forth, all of which have been identified as playing an important, if often overlooked, role in schizophrenia at certain stages of the illness.[62,63] The individual PSE items comprising each of these three symptom rating scales are listed in Appendix B.

Questions. Based on the material in this section, it is difficult to formulate specific questions that can be addressed using currently available research methods.

Nevertheless, the following may be useful in beginning to explore this field.

1. In what ways can the experience of hallucinations in schizophrenia be manipulated experimentally?
2. In what ways can the formation of delusions in schizophrenia be manipulated experimentally?
3. Is there an inverse relationship between the severity of hallucinations or delusions and the degree of psychotic disorganisation both between individuals and within individuals over time?

Dysphoric symptoms

The dysphoric affects of anxiety and depressiosn are almost invariant experiences in schizophrenia at some stage during the illness. They do not appear to be fundamental to the biopsychopathology of schizophrenia. Neither can they be viewed as compensatory phenomena. Instead, they can be regarded simply as expressions of distress. Scales for measuring them using selected PSE[64] items have been derived and are included with the other symptom dimensions in Appendix B.

Coping techniques

Finally, there is a limited literature that describes a range of techniques that schizophrenic patients use in coping with the effects of their illness.[129-131] These techniques are all conscious and under voluntary control. They can be divided into four broad categories (Carr, unpublished manuscript):

1. alterations in behaviour patterns
2. cognitive control mechanisms
3. socialisation
4. symptomatic behaviours

Further description of these phenomena would go beyond the scope of this paper and the matter is simply mentioned for the sake of completeness.

Summary

A schematic representation of the information processing model of schizophrenia proposed here is shown in Figure 2. The postulated primary abnormalities involve failure in preattentive perceptual grouping, a function which utilises parallel processing and which may be a right cerebral hemisphere function. The consequent tendency towards randomised feature selection/conjunction, modulated by a counterbalancing tendency towards personalised feature selection/conjunction (i.e. perceptual bias), results in disordered pigeonholing. The latter, which utilises serial processing, may be a left hemisphere function that becomes overactive and/or overloaded in compensating for the breakdown in preattentive grouping.

An acute episode of schizophrenia could be mediated by dysfunction in a subcortical sensory gating mechanism. Such sensory gating failure would have the effect of increasing the rate of input of information requiring processing. This mechanism which, perhaps, bipolar disorder shares with schizophrenia, puts further strain on the premorbidly vulnerable grouping/pigeonholing processes. Sensory gating failure, by producing an arousal-mediated "opening" of the attentional filter, presumably results in an augmentation of the effects of grouping dysfunction on pigeonholing so that a degree of pigeonholing disorder is effected sufficient to carry the individual over the illness threshold. Stimulant drugs may trigger an acute schizophrenic episode by acting on the neural substrate of either sensory gating or physiological arousal. Psychosocial stressors (e.g. high "expressed-emotion") may exert their illness-triggering effect at the level of the attentional filter or arousal mechanisms. It may also be possible that the state of increased entropy, brought about by pigeonholing dysfunction, exerts a positive feedback effect on

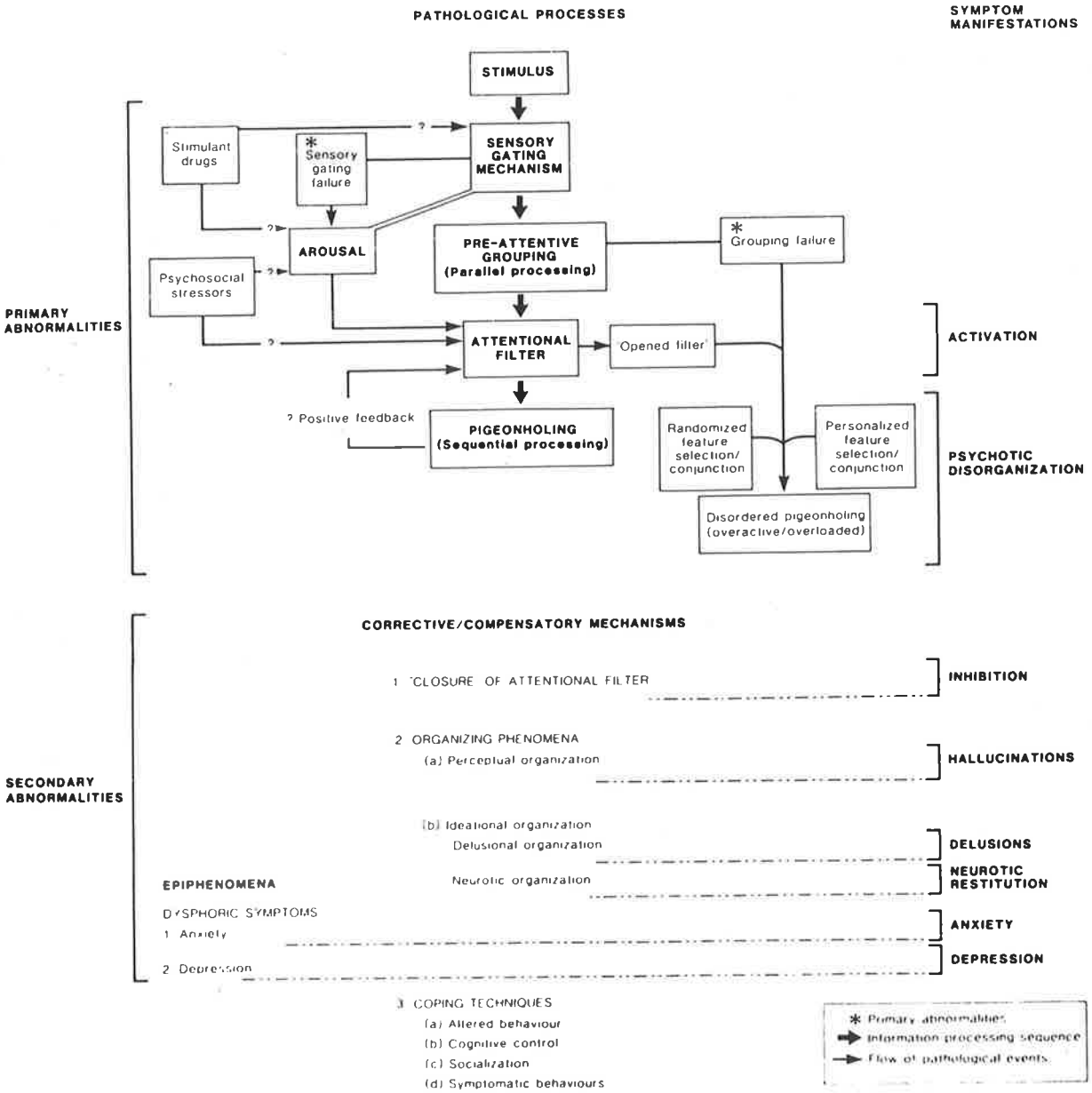

Figure 2. Schematic representation of the proposed pattern of information processing abnormalities in schizophrenia.

the attentional filter, thus setting up a "vicious cycle".

The individual attempts to compensate for the state of psychotic disorganisation and activation, which is the consequence of the above, by "closure" of the attentional filter. Restricted attention may thus be the earliest and most fundamental self-corrective mechanism employed in schizophrenia. The proposed symptom manifestations of this phenomenon are those termed "inhibition" and they overlap substantially with what is referred to as the negative or type II syndrome. Other important compensatory operations include organising phenomena (i.e. hallucinations, delusions, neurotic symptoms) that represent the individual's attempts to pattern or make sense of inputs that the primary disorder in information processing has rendered relatively patternless. The dysphoric affects of anxiety and depression are regarded as secondary, unpredictable epiphenomena, signs of distress rather than compensatory processes. Finally, a range of conscious, voluntarily controlled coping techniques are used by individuals in their attempts to deal with the totality of the schizophrenic experience.

With the exception of anxiety and depression, the symptom dimensions listed on the right of Figure 2 are presumed to be the external manifestations of particular patterns of information processing dysfunction and the individual's attempts to compensate for or correct these dysfunctions. All can usefully be regarded as *vectors*, the measurement of which in a given case would enable the psychopathological state of that individual to be characterised[132] and, if the model is valid, certain conclusions to be drawn about the underlying pattern of information processing dysfunction. The model does not purport to represent a necessary or invariant temporal sequence of events beginning with the primary abnormalities and proceeding stepwise through a series of secondary abnormalities. On the contrary, the model allows for any combination of symptoms to be present at a given time or for any group(s) of symptoms to be absent altogether.

The proposed model of schizophrenia is presented as a hypothesis to be tested. It can be broken down into a number of component questions that can be addressed using scientific methods. Whether any of these constitute the "right" question referred to at the outset depends on the answers. In any event, the model is one which attempts to organise and examine variability in schizophrenia rather than to minimise or ignore it. The model is an attempt to exploit this variability in order to further our understanding of schizophrenia, rather than simply to get to know more about it.

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APPENDIX F

DISCUSSION OF STATISTICAL ANALYSES

Sample Size.

An important limitation of this study was the relatively small sample size. The original design provided for a group of 30 schizophrenic subjects. The expectation was that subgrouping for purposes of within-group comparison in relation to symptom heterogeneity would be statistically sound (i.e. of sufficient power) if there were two subgroups of at least 15 subjects each. On the other hand, it was anticipated that the group of depressed subjects would be clinically much more homogeneous than the schizophrenic group. Therefore, a smaller sample size was determined for those with depression (N=20), the main purpose of which was to provide a clinical group to compare with schizophrenia.

At the end of the data collection period 33 subjects had been given an initial diagnosis of schizophrenia. On subsequent review and analysis of the clinical data, involving personal follow-up of cases over several months, the original diagnosis of schizophrenia could not be substantiated in 9 cases. Diagnoses were reassigned in these instances to schizoaffective disorder, mania or other psychoses on the basis of this follow-up period. This reduced the schizophrenic sample size to 24. From the statistical point of view it was estimated that this sample size would be adequate for group comparisons but not for within-diagnosis, subgroup comparisons in relation to symptom variablility. Therefore, in order to test the hypotheses regarding symptom variability, it became necessary to rely on correlation analyses alone rather than on a combination of correlation statistics and subgroup comparisons. This was not seen as a significant disadvantage because, given the dimensional view of symptomatology adopted here, correlational analysis was considered to be the preferred method of examining the relationships between symptom severity and skin conductance variables. Had a categorical understanding of symptom variability been used at the outset, subgroup comparisons would have been the more appropriate method of data analysis.

In the literature regarding skin conductance variability in schizophrenia, comparable sample sizes have often been used and so the numbers of schizophrenic subjects in the present study, although smaller than originally planned, were not out of keeping with the work of other researchers in this field. Neither was the likely degree of variance in the skin conductance measurements expected to exceed the limits beyond which the probability of failing to reject the null hypothesis would be excessively high in a sample of 24 subjects. Since the major problem of small sample size is the relatively greater probability of failing to reject the null hypothesis (i.e. type II error), this issue was given due consideration in determining the adequacy of the sample size of 24 subjects. A minimum of 20, as for the depressed group, was thought to be an adequate lower limit for the purposes of this study. A sample size of 30 for the schizophrenic group would have been ideal and the actual sample size is thus a compromise between the minimum and the ideal.

Thus, though the sample size in this study was deemed to be adequate, it must be acknowledged that a larger N would, of course, have increased the power of the study and possibly resulted in the confirmation of hypotheses which have been rejected. It would not be expected that the hypotheses supported by the results of the present study would fail to be confirmed in a larger sample. If, however, the findings of the present research are sufficiently important, then a replication study using a larger sample would be required.

Choice of Statistical Tests

Both parametric and non-parametric tests were used depending on the nature of the data being analysed. Tonic skin conductance levels (SCL), mean frequency of spontaneous responses (mean NSSCR), amplitude of responses (Amp) and the temporal

variables of the orienting response were each continuous scale variables. As expected, their distributions were skewed and, therefore, $\log_{10}$ or square root transformations were used, as appropriate, to normalize their distributions. Analyses with these transformed variables were performed using parametric statistics (t-tests) which are appropriate for continuous scale variables of normal distribution. On certain occasions in which laterality was the subject of statistical analysis, laterality indices (ratio scales) were computed and, since the distributions of these indices also approximated normal, the use of parametric statistics was justified. When analyses were performed using untransformed or raw data which was skewed in distribution and/or measured on ordinal or nominal scales (e.g. number of orienting responses, trials to habituation; symptoms rating and other clinical data), the appropriate non-parametric statistics were used (e.g. Mann-Whitney U-test, Wilcoxon matched-pairs, Chi square, Spearman rho).

As mentioned above, the central hypotheses of the study were tested by means of correlation analyses between skin conductance variables and symptom ratings. Given that the symptom ratings were measured on ordinal scales, the appropriate statistic to be used was rank order correlation (Spearman rho). The ability of this statistic to handle skewed data and/or outlying values was especially important given the fact that some of the symptom rating scale data tended not to be normally distributed (e.g. hallucinations). The latter problem was also substantially counteracted by means of symptom quotient (ratio) scales in which, for example, the ratio of hallucinations to psychotic disorganization was computed. These ratio scales each approximated a normal distribution.

The magnitude of the statistically significant correlation coefficients ranged from .38 ($p<.05$) to .75 ($p<.005$) thus accounting for between 14% and 56% of the variance. In other words, and not surprisingly, differing proportions of the variance were left unaccounted for. Although this point needs to be acknowledged, it can legitimately be

stated that the symptom dimensions in question do contribute significantly, in the *directions predicted by the proposed model* of schizophrenia, to the magnitude of the skin conductance parameters under investigation. In other words, the mechanisms which are proposed to underly symptom formation in schizophrenia appear to contribute quantitatively, with other unidentified variables, to the electrodermal activity of schizophrenic patients.

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8. Conclusions.

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