

BEHAVIOURAL AND PSYCHOPHYSIOLOGICAL ASPECTS OF INFORMATION
PROCESSING IN SCHIZOTYPICS

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ABSTRACT

The aim of the present study was to examine psychophysiological and behavioural aspects of information processing in schizotypics identified on the basis of their scores on the questionnaire measures of schizophrenism and physical anhedonia. The sample used consisted of 15 high scorers on the schizophrenism (SZ) scale, 12 high scorers on the physical anhedonia scale and 15 control subjects who had low scores on the two scales. The purpose of this study was to ascertain whether schizotypics would show a similar disorder of information processing to that found in schizophrenics or children at risk for schizophrenia. The psychophysiological measures employed in this study consisted of skin conductance, heart rate and evoked potentials. The behavioural measures consisted of a variety of reaction time tasks i.e. cross-modal reaction time, choice reaction time and reaction time in the presence of distracting stimuli. The results provided some support for the hypothesis that schizotypics display psychophysiological and behavioural characteristics similar to those found in schizophrenics or individuals vulnerable to schizophrenia. It was thus concluded that the disorder of information processing might be an index of vulnerability to schizophrenia.

INTRODUCTION

Researchers involved in the etiological study of schizophrenia have been faced with the problem of the effects of intervening factors that result from the schizophrenic illness. This problem has led to a method of investigation of individuals at risk for the development of schizophrenia. Most of the risk studies have concentrated on the selection of individuals at genetic risk who have schizophrenic biological parents. However, it has been shown that the majority of schizophrenics do not have a history of schizophrenia among their first degree relatives (Gottesman and Shields, 1972). Therefore, alternative approaches has been developed, one of which is the psychometric selection of schizotypics from the general population. This method of subject selection is believed to be more generalizable. Schizotypy is a hypothesized predisposition for schizophrenia characterized by a particular set of traits similar to those of schizophrenics (Meehl, 1962).

The measures of schizotypy employed in the present study consisted of a scale of physical anhedonia (defect in the experience of pleasure from physical stimuli) and schizophrenism (SZ) scale (mild cognitive and perceptual disorders, distractability and social anxiety). It was hypothesized in the present study that anhedonia and schizophrenism might form two different dimensions of

schizotypy which could be related to two subtypes of schizophrenia. Anhedonia is hypothesized to be associated with negative symptoms of schizophrenia and schizophrenism related to positive symptoms.

Two groups of schizotypics and a control group were selected on the basis of their scores on the scales and were then tested for electrodermal, heart rate, evoked potential and a number of reaction time experiments related to information processing. Previous findings suggest that these measures might be associated with vulnerability to schizophrenia. Electrodermal measures have been shown to be sensitive in distinguishing schizophrenics from normals and have also shown important differences between the responses of children at risk for schizophrenia and those of the control groups. It was hypothesized in the present study that the electrodermal and heart rate orienting abnormalities and disorders in electrocortical activities shown by schizophrenics might be found in schizotypics.

The results of electrodermal studies showed a disorder of habituation in the high scorers on the SZ scale and an orienting deficit in anhedonics. In addition high frequency of responsivity was shown by the high scorers on the SZ scale, while anhedonics showed a significantly lower response frequency. The results of the latency and t/4

recovery data did not differ among groups. This was also the case for the findings concerning the heart rate data.

The evoked potential study using continuous performance test (CPT) showed that anhedonics exhibited a dysfunction of 'pigeon holing' as indexed by a smaller amplitude of the P3 component. Both schizotypic groups showed poor performance in the CPT compared with the control group.

The reaction time data showed that anhedonics and schizotypics have more difficulty switching attention across sensory modalities. For the high scorers on the SZ scale this was found to be the case whether switching of attention was to light or to sound stimuli. In a choice reaction time study no significant differences were found between the groups in the speed and accuracy of their responses. Finally schizotypics were highly distractible and were significantly slower and made more errors when a high number of distracting stimuli were present.

The present results provide further support for the hypothesis that impaired information processing might be an index of vulnerability to schizophrenia. It also provides support for the hypothesis that anhedonia and schizophrenism might form two dimensions of schizotypy..

Chapter 1

SCHIZOPHRENIA

The beginning of the nineteenth century witnessed the start of a move to free the mentally disturbed from neglect and abuse and from being regarded as evil or possessed. It was then that the concept of madness as 'mental illness' became acceptable. This resulted in the classification of various mental disturbances and led to Kraepelin's (1899) categorization of the mental disorders into 'dementia praecox', 'manic depressive' illness, and a group of disorders which he classified as 'paranoia' and 'paraphrenia'.

The term dementia praecox referred to a mental disorder which starts early in life and is followed by gradual deterioration. Kraepelin characterized dementia praecox by symptoms such as; delusions, hallucinations, impairment of affect and disorder of attention and perception. He believed that many of these symptoms are shown by most schizophrenics but none of these symptoms are exhibited by all schizophrenics. Kraepelin suggested that paranoia (prominent delusional beliefs), and catatonia (bizarre postures and motor disturbances), introduced by Kahlbaum (1874), and hebephrenia (inappropriate behaviour), put forward by Hecker (1871), are different subtypes of a single disease dementia praecox. He suggested that the

main cause of dementia praecox is a disease in the cerebral cortex and that different subtypes of dementia praecox could indicate different cerebral localizations in the regions such as the frontal or temporal lobes (Kraepelin, 1899).

Some years later Bleuler (1911), reformulated the Kraepelinian concept of dementia praecox into 'Schizophrenia' or split (schizm) of mental functioning (phrenos). Bleulerian schizophrenia differed from dementia praecox in two important ways. Firstly, he revealed that schizophrenic illness does not necessarily deteriorate and even in some cases, the patients do recover. Secondly, he argued that schizophrenia does not always occur at an early age. He also emphasized that certain symptoms are shown to various extents by all schizophrenics and are not seen in any other mental disorders. These are; loose association, flat or inappropriate affect, autism, ambivalence and disorder of attention. He classified these symptoms as 'fundamental'. Bleuler suggested that autism and ambivalence mainly result from thought disorder and emotional disturbances. Another group of symptoms are those which may or may not be shown by all schizophrenics and might be exhibited by individuals suffering from other mental disturbances. Examples are; hallucinations, delusions and bizarre motor activities. He referred to these symptoms as 'accessory'.

In addition, Bleuler divided the symptoms of schizophrenia into 'Primary' and 'Secondary'. He suggested that primary symptoms are caused by an underlying organic disease, whereas the secondary symptoms result from the interaction between the organic disease and the person's environment. In Bleuler's view, the underlying organic disease might exist, without the presence of the symptoms of the illness.

Since Bleuler's classifications, various types of schizophrenia have been identified such as; simple, catatonia, hebephrenia, paranoia and schizophrenia latent type, which still form the basis of the diagnostic system used in DSM-III (Diagnostic and Statistical Manual of the American Psychiatric Association). A number of subdivisions have also been made e.g. paranoid vs non-paranoid, schizoaffective vs non-affective and electrodermal responders vs non-responders. Also a number of subtypes has emphasized the longitudinal course, such as; acute vs chronic, process vs reactive.

A more recent approach to the classification of symptoms of schizophrenia has been the division of the symptoms into positive (florid) and negative (defect). This classification was originally put forward by a British neurologist, Hughlings-Jackson (1931), and was later developed by other researchers (e.g. Strauss and Carpenter,

1974; Andreasen, 1979; Crow, 1980 and Angrist, Rotrosen and Gershon 1980). Positive symptoms are; delusions, hallucinations, thought disorder and bizarre behaviour. Negative symptoms consist of alogia (a form of aphasia), emotional withdrawal, poverty of the content of speech, lack of social competence, anhedonia, avolition (lack of drive) and impairment of attention:

Negative symptoms therefore, imply a lack of certain abilities and losses of function, whereas, positive symptoms indicate having certain deviant characteristics. Recently there has been a great deal of interest in the empirical study of the positive/negative classification and it has been hypothesized that patients with prominent positive symptoms are likely to differ in many ways from patients who have prominent negative symptoms. For example, patients who show positive symptoms are known to recover with intensive treatment, whereas, patients who exhibit negative symptoms are likely to show less recovery and their illness is more crippling. Furthermore, patients with negative symptoms tend to be more chronic and prove to have had a poor pre-morbid adjustment, do not benefit from drug therapy, show cognitive impairment and a structural brain abnormality e.g. atrophic changes in the brain (Crow, 1980). On the other hand, patients with positive symptoms are believed to exhibit a better pre-morbid adjustment, give a better response to drug therapy, and show an

underlying pathologic disorder that is mainly neurochemical e.g. they show an abnormality in dopaminergic neural transmission.

It is suggested that patients with positive symptoms of schizophrenia resemble 'reactive' type schizophrenics while negative symptoms characterize patients with 'process' schizophrenia. Crow (1980) suggested that the positive/negative symptoms are not related to two different disorders, rather, they are "independent dimensions reflecting different underlying pathological processes".

The proposition that negative and positive subtypes might have separate underlying causes has led to the assumption that different subtypes of schizophrenia might have different vulnerability indicators. In the present thesis it is hypothesized that there might be different subtypes of schizotypy which would correspond to distinct disorders within schizophrenia. Negative schizophrenia is hypothesized to resemble the 'anhedonia' aspect of schizotypy in that high scorers on the anhedonia scale show characteristics similar to negative or process type schizophrenia. Positive schizophrenia might resemble the 'schizophrenism' form of schizotypy. This will be described further in a relevant chapter.

The problem of research in schizophrenia

Even though the classification of schizophrenic disorder has proved to be useful in the study of the structure of schizophrenia, it is important to study schizophrenia before the illness manifests itself, in order to gain a better understanding of the underlying causal factors. For many years investigators involved in research concerning the etiology of schizophrenia have been faced with the problem of ascertaining which of the abnormalities exhibited by schizophrenics are the cause, and which ones are the consequence of their illness. This sort of problem has caused particular difficulties in the evaluation of the differences found between the behaviour of schizophrenics and normals. In recent years researchers have become increasingly aware of this problem and the fact that effects of factors such as years of hospitalization, drug therapy, chronic illness, social isolation and anxiety could produce misleading results. This was stressed by Mednick and McNeil (1968) who pointed out that the behaviour of individuals who are already schizophrenics "is markedly altered in response to correlates of the illness, such as educational, economic, and social failures, prehospital, hospital, and post-hospital drug regimes, bachelorhood, long-term institutionalization, chronic illness, and sheer misery".

The effects of hospitalization

The effects of hospitalization are considered to be a crucial factor in research in schizophrenia. This is evident from the studies of long term hospitalized patients. For example, in a study by Silverman et al. (1966) a group of short and long term prisoners were examined on the Titchener Circles Illusion (TCI) test of visual scanning. The results of this study indicated that the reduced extent of scanning of the long term prisoners was very similar to that of chronic schizophrenics tested by Silverman in 1964. Silverman's interpretation of these results was that, due to a long-term stay in an unpleasant environment, the prisoners are likely to form a narrow perception and intake of unpleasant stimuli in order to minimize their awareness of external threats. They consequently tend to generalize this narrow perception to all classes of stimuli. This type of finding indicates that institutionalization may be responsible for some of the contradictory findings in research in schizophrenia.

Drug treatments

The effect of medications on the behaviour and autonomic functioning of schizophrenics is also a factor of great significance. A number of studies have been carried out in this area. An important one was by Spohn et al. (1971) who showed that medication has an effect on skin conductance and heart rate. In their study Spohn et al.

found that schizophrenic patients who were under phenothiazine medication showed a low skin conductance level (SCL) and the SCL of these patients increased when they were taken off the medication. They also found that the SCL of these patients was negatively related to the (proportional) dosage of the drug they were receiving. This was also the case for spontaneous fluctuations (non-specific skin conductance responses). Furthermore, Spohn et al., found that the patients who were under phenothiazine medication showed a higher tonic level of heart rate and a lower degree of heart rate variability.

A number of studies have shown that medication has an effect on evoked potentials (Heninger and Speck, 1966; Ciganek, 1959; Shagass and Schwartz, 1965).

Heninger and Speck (1966) showed an increase in the latency of visual evoked responses in schizophrenics treated with chlorpromazine. This finding was supported by Saletu et al. (1971), who showed that medication resulted in an increase in the latency and a decrease in the amplitude of evoked potentials.

From the above it appears that it is difficult to carry out research in schizophrenia independently of the intervening factors if one uses the existing schizophrenics as subjects. In particular schizophrenics show changes in symptoms with increased chronicity of their illness

(Mednick, 1958; Broen, 1966; and Venables, 1964). These sorts of problems have led many investigators to employ a new method of research in schizophrenia, known as 'risk studies'. That is, identifying individuals who are considered to have a tendency for the development of schizophrenia. This method has become very popular and many risk studies are going on at present. Most of them are follow up studies in which young children, considered to be at risk, are studied longitudinally from their childhood through to the period of risk to find whether some will have schizophrenic breakdown. The aim of this type of study is to distinguish various behavioural, psychological, biological, and physiological characteristics that are present before the illness occurs, from the ones which appear after, and as a result of the illness.

Chapter 2

HIGH RISK STUDIES OF SCHIZOPHRENIA

Various risk criteria have been used by different investigators some of which are as follows;

Genetic criteria.

Psychogenic criteria.

Sociogenic criteria.

Psychophysiological criteria.

Psychometric methods or selection of subjects on the basis of personality characteristics.

Genetic criteria

A considerable number of investigators involved in the study of individuals at risk for the development of schizophrenia have based the selection of their subjects on genetic criteria. That is, the study of children who are believed to have a genetic predisposition for schizophrenia because one or both of their parents are schizophrenic, or because they have a schizophrenic identical twin.

A longitudinal study of children at risk for the development of schizophrenia is the Copenhagen study by Mednick and Schulsinger (1968), in which they reported that electrodermal variables were the best indices of subsequent schizophrenic breakdown in children at risk for schizophrenia. This longitudinal study was based on the

familial criteria and involved an extensive study of a large group of high risk children who had chronic schizophrenic mothers and a group of low risk control subjects who had normal parents. Among the measures used were a series of experiments testing skin conductance and heart rate using a conditioning, generalization and extinction paradigm.

A follow up study showed that 13 of the high risk children developed schizophrenia and 29 became borderline schizophrenics (Mednick, 1978). The major characteristic which distinguished the children who had psychiatric breakdown from the ones who showed no sign of any psychiatric disturbances was found to be autonomic hyper-responsivity. The high risk children showed skin conductance responses which had greater amplitudes, shorter latencies and most importantly a significantly faster recovery times. Fast recovery of SCR was found to be the best discriminator between high and low risk children. They also showed poor habituation of their SCR. In addition, when they compared the responses of the high risk sample who had schizophrenic breakdown with the high risk group who had not yet demonstrated any pathological behaviour, it was found that a pattern of hyper-responsivity to high intensity stimuli was a characteristic of the whole group of high risk children, but was more intense in those children who had developed schizophrenia.

Mednick (1970) examining the perinatal data of these children, suggested that pregnancy and birth complications (PBCs) such as anoxia, prematurity, prolonged labour in interaction with genetic predisposition could raise the probability of schizophrenic breakdown. He found a higher incidence of PBCs among those subjects who showed abnormal electrodermal behaviour and later on had schizophrenic breakdown.

Another longitudinal study of children at risk for schizophrenia is the New York high-risk project by Erlenmeyer-Kimling et al., which started in 1971. The New York project is based on the theory of interaction between genetic and environmental factors in the etiology of schizophrenia. Erlenmeyer-Kimling et al., influenced by theories such as those of Fish (1957) or Meehl (1962), hypothesized that a genetic predisposition in the form of neurotransmitter disturbances, results in a neurointegrative defect which in interaction with environmental stresses, could lead to schizophrenia. They hypothesized that the neurointegrative defect is indexed by neuromotor disorders, psychophysiological abnormalities and information processing disorders. In the New York project children whose mother or father or both parents were schizophrenics were selected and it was hypothesized that, with age, these children might exhibit more severe neurointegrative dysfunctions. Erlenmeyer-Kimling et al.

designed this longitudinal project to assess a large number of variables in the environment of these high risk children. In addition they studied a number of neuromotor, attentional and several psychophysiological measures believed to be continuous with disorders exhibited by adult schizophrenics. The attentional measures they used consisted of; Continuous Performance Tests (CPT) as tests of sustained visual attention (in the absence and presence of auditory distraction), an attention span short term auditory memory task (with or without distraction), a vigilance task, and a short term memory lag test. Their psychophysiological measures consisted of; electrodermal measures which replicated psychophysiological procedures used in the Copenhagen project i.e. conditioning, generalization and extinction. They also employed measures of cortical evoked potentials in which a CPT paradigm consisting of relevant and irrelevant stimuli. The subjects were required to respond only to relevant tones. The neurological tests consisted of; a variety of tests of neuromotor functioning and motor impairment.

The follow-up studies showed that the high-risk children performed significantly worse than the control group on the CPT (Erlenmeyer-Kimling and Cornblatt, 1984). That is, they made more errors of omission and commission in both the distraction and no distraction conditions than

the control subjects. They also performed significantly worse on the attention span task. The high-risk children who had shown attentional dysfunctions were mostly hospitalized in later years or sought psychiatric treatment.

Children at risk showed early neuromotor disturbances (Erlenmeyer-Kimling, Marcus, Cornblatt, Friedman, Rainer and Rutschmann, 1984). They also showed evoked response patterns that differed from those of the control subjects. The high risk samples showed a significantly smaller P3 amplitude in response to relevant stimuli compared with the control children (Friedman, Erlenmeyer-Kimling and Vaughan, 1984).

The electrodermal findings of the New York study, however, did not replicate Mednick and Schulsingers' (1968) findings. A significant difference between high risk and control subjects was found for latency of responses, in the opposite direction from that reported by Mednick and Schulsinger. That is to say they found longer response latencies in the children of schizophrenic parents. Recovery time did not differ significantly between groups though high-risk subjects who were later hospitalized were found to have shown longer recovery times than high risk subjects as a whole.

Other investigators have studied children at risk for schizophrenia using measures that have successfully discriminated schizophrenics from normals. In all of these studies children at risk for schizophrenia who had at least one schizophrenic parent were studied. Examples are: The Minnesota Project (Garmazy and Rolf, 1969) in which intellectual, social and academic competence of children at risk were examined, the Stony Brook Project (Oltmanns et al., 1978) which examined the home environment of children of schizophrenic parents as well as their social, cognitive and attentional functioning and the McMaster-Waterloo project (Asarnow et al., 1978) in which attentional and social competence of children of schizophrenic parents were studied.

Genetic criteria have been supported by many researchers (Rosenthal and Kety, 1968; Kety et al., 1968; Gottesman and Shields, 1972). This approach has the advantage of selecting a sample some of which are likely to eventually suffer from schizophrenia. However, despite many advantages of the genetic approach, the selection of subjects on the basis of genetic criteria could result in various drawbacks, one of which is that such selection does not produce a highly representative sample for study. It is believed that only a small percentage (10-12%) of schizophrenics have schizophrenic mothers (Rosenthal, 1970) and in about 14 to 30% of identical twins schizophrenia is

shown only in one twin. Therefore, the problem with this approach is that those individuals who do not have schizophrenic parents but might in future suffer from schizophrenia are not regarded as being at risk and therefore are not selected for study.

Sociogenic criteria

An alternative strategy in the selection of individuals considered to be at risk for schizophrenia is known as the 'sociogenic model'. In this method the risk criteria are factors such as social environmental deprivation and low social class (Kohn, 1968; Dohrenwend and Dohrenwend, 1969). This model assumes that vulnerability to schizophrenia is related to low social status, unfavourable social situations and stresses associated with low social class and deprivation. The major criticism of this approach is from the 'downward drift' theory of mental illness. According to this theory it is likely that mental illness could cause a drift to a lower social class rather than being the result of a low social status.

Psychogenic criteria

Another method used for the identification of individuals at risk for the development of schizophrenia is the 'psychogenic criteria'. In this method severely maladjusted children are considered to be vulnerable to

schizophrenia. A longitudinal study carried out by Rodnick and Goldstein (Goldstein et al., 1968), is an example of the research of this kind. Their study concerned the role of family conflict and its effect on the child's maladjusted and anti-social behaviour. This approach consists of observational studies of adolescents with severe behavioural problems. Rodnick and Goldstein found that most of these disturbed adolescents were showing behaviour such as; withdrawal, excessive dependence on their parents and were passive and isolated in their relationships with others. That is, they were exhibiting methods of coping with stress similar to the coping patterns of schizophrenics e.g. withdrawal and social isolation. The follow-up studies showed a high frequency of schizophrenic disorders among the severely disturbed children when they became adults.

Psychophysiological criteria

In recent years the criteria used for selection of subjects at risk for schizophrenia has extended to strategies such as psychophysiological criteria. The use of this strategy has been greatly influenced by the results obtained from the study of children of schizophrenic mothers, carried out by Mednick and Schulsinger (1968) in Denmark.

Another longitudinal study of children at risk for the development of schizophrenia is the work carried out on the island of Mauritius by Venables et al., started in 1972. This study is unique in the sense that risk is defined by abnormality of electrodermal responsivity. Therefore, the sample is selected on the basis of psychophysiological characteristics of the subjects themselves rather than on the basis of the condition of their parents. The advantage of employing methods such as psychophysiological criteria is that it allows for the selection of a more representative sample of people at risk.

In the Mauritian risk study the selection of the high risk sample has been based on a psychophysiological screening of a population of 1,800, 3 year old children employing a conditioning/generalization paradigm which was a modified version of the method used in the Copenhagen risk studies. A group of children were selected on the basis of showing electrodermal characteristics similar to those exhibited by the Copenhagen breakdown group tested by Mednick and Schulsinger (1968). That is, a hyper-active pattern of electrodermal responsivity characterized by high amplitude and short recovery times. A second group consisted of children who were hypo-responders. That is, they failed to respond to any of the experimental stimuli. This is reported to be characteristic of about 40-50% of adult schizophrenics (e.g. Bernstein et al., 1982). The

control group consisted of children with average skin conductance activity. A total of 200 children were selected from which 100 were placed in nursery schools for observational studies and intervention. The remaining 100 were selected as matched controls and remained in the community. In addition to psychophysiological studies, the children's play behaviour and cognitive developments were examined. Characteristics such as aggression, hyperactivity, withdrawal, schizoid tendencies and social competence were studied.

The follow up study of the Mauritian children at risk has so far shown that children who were differentiated electrodermally revealed significant differences in social and intellectual behaviour. That is, both hyper-responders and hypo-responders exhibited significantly less aggressive behaviour than the control subjects. The hypo-responders showed the lowest level of aggressive behaviour. The low level of aggression in schizophrenic hypo-responders is also reported by Gruzelier (1976) and Straube (1979). In addition, among male non-responders verbal intelligence was shown to be lower.

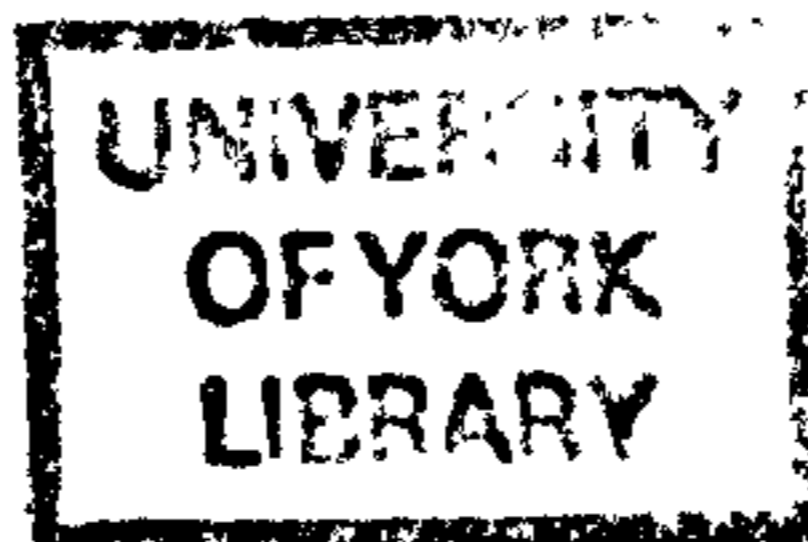
Various other high risk projects have been carried out. For example, Buchsbaum et al. (1976) have investigated the selection of individuals at risk for schizophrenia on the basis of having a biochemical

characteristic found in schizophrenics. A number of other high risk projects has been concerned with the study of remitted schizophrenic patients e.g. Wohlberg and Kornetsky (1973) and Asarnow and MacCrimmon (1978).

Unlike the various approaches to the study of pre-schizophrenics, mentioned above, the one undertaken in the present study is the psychometric detection of individuals with schizotypic personality, selected from the general population on the basis of their scores on the questionnaire. This approach is based on the assumption that schizophrenic tendency might be a point on a continuum and schizophrenia is at an extreme of a dimension (e.g. Claridge, 1972). It is also assumed that underlying characteristics which are not so extreme to have produced schizophrenia could be detected in a mild form in psychiatrically normal schizotypic individuals. This method of the selection of subjects is based on the presence of symptoms and personality characteristics considered to be relevant to the development of schizophrenia. Such selections results in a more representative sample and therefore, the results might become more generalizable.

In the present study the subjects were selected mainly from college students. The advantage of this method is that the subjects are easily obtainable in large numbers.

The questionnaire measurement of schizotypy and the method of selection employed in the present study will be described in a later chapter.



Chapter 3

SCHIZOTYPIC PERSONALITY

The term schizotypy was first put forward by Rado (1956) and was developed by Meehl (1962). This term was used to describe psychiatrically normal individuals who have a predisposition towards schizophrenia. Meehl suggested that the predisposition for schizophrenia is inherited and he termed such predisposition, 'schizotaxia', which is also referred to as 'schizoid-taxon'. He defined schizotaxia as 'an integrative neural defect' and believed that schizotaxics in interaction with factors in their upbringing and in the course of their social learning experiences, develop a type of personality which he called 'schizotypy'. When under severe stress schizotypics are likely to 'decompensate' into schizophrenia.

Thus, according to this theory schizotypy is a non-psychotic state which is characterized by certain features that result from the neurointegrative defect. The neurointegrative defect, Meehl believes, is fundamental for a vulnerability to schizophrenia but by no means is the only responsible factor for the development of schizophrenia. Whether schizotypic individuals become schizophrenics or whether they remain 'compensated', depends on the environmental stress as well as their threshold for stress. A highly vulnerable individual has a

very low threshold for stress and a small amount of stress could have damaging effects, whereas, a non-schizotaxic individual even under severe stress would never develop schizophrenia. This theory, therefore, appears to suggest that the inherited physiological defect of schizotaxics in interaction with their social learning could prevent them from learning to cope with stress. The 'diathesis-stress' or gene-environment interaction theory of Rosenthal (1970) is a theory of the same kind and has been an influential model in the study of the origin of schizophrenia.

Meehl proposed that the neural defect of schizotaxic individuals is mainly related to the functioning of certain nerve cells. This defect he believes, might be in the form of a slight deviation in the synaptic control of the nerve cells and could lead to a disorder of function of 'excitatory' and 'inhibitory' systems i.e. the function which is involved in either excitation or inhibition of the firing of a neighboring neuron. This therefore, causes an abnormality in the amount or patterning of excitatory or inhibitory actions. Thus, according to Meehl theory schizophrenia has an underlying genetic cause which places individuals on the various points on a continuum. The genetic predisposition results in the schizotypal personality which is a point on the continuum prior to decompensation.

Fish (1957) in an attempt to identify the neurointegrative disorders considered to be the index of future schizophrenia, selected a number of newly born infants of schizophrenic mothers and followed them up for their subsequent development. She hypothesized that children who show neurointegrative disorder in infancy, might develop schizophrenia and severe neurointegrative disorder might be the main antecedent of early onset, poor premorbid chronic schizophrenia, of which childhood schizophrenia is the extreme variant (Fish, 1977). She examined factors such as; physical growth, physiological symptoms and neurological maturation as well as irregular development in the infancy which is the criteria used to define severe neurointegrative disorder (Bender 1947).

Follow-up study of these children at 20 to 22 years showed that 6 of the 14 high-risk children showed severe psychiatric disorders (Fish, 1982). One of the disturbed subjects had met the DSM-III criteria for schizotypal personality at age 15 and for schizophrenia at age 19. The other 5 psychiatrically disturbed subjects met criteria for schizophrenia or schizotypal or schizoid personality and possible cyclothymic personality disorders. All of these six subjects were among the ones who in infancy had shown a pattern of abnormal and disorganized maturation in their activities, alertness, and autonomic stability and have had severe to moderate psychiatric disorders at age 10.

Claridge (1972) proposed a theory of schizotypy which emphasized individual differences in the organization of the nervous system and in the activity of neural mechanisms that underly behaviour. He suggested that there is a continuity between normal behaviour and schizophrenic disorder and that schizophrenia forms the extreme position of a personality dimension rather than being a categorically distinct illness. Furthermore, he stated that schizophrenic tendency results from an inherited set of polygenically determined traits which are found to varying degrees in the general population and that individuals inherit different amounts of loading for this underlying personality factor. Extreme loading on such a factor may lead to schizophrenia.

He suggested that the characteristics which form the schizotypy dimension of personality and yet are continuous with normal behaviour and mental illness, might be related to the cognitive and selective attentional aspects of behaviour.

On the basis of the theory of individual differences, Claridge and Broks (1984) examined variations in the organization of the brain's hemisphere in normal individuals who showed schizophrenic-like characteristics as measured by the schizotypy (STA) scale. The STA scale is one of the two scales of a new questionnaire known as

the STQ designed by Claridge et al (19?) to measure schizotypic characteristics in normals. This questionnaire will be described in a later chapter.

In their study Claridge and Broks examined the biological basis of individual differences in schizotypy measured by the performance of schizotypic subjects on a test of hemisphere function. Their study was based on evidence from work with schizophrenic patients which indicated that the disorder of schizophrenia might be related to the function and structure of hemisphere organization. Claridge and Broks (1984) hypothesized that individual differences in vulnerability to schizophrenia-like experiences might be exhibited biologically as differences in brain organization, and especially in patterns of hemisphere function. Support for this view could be cited from studies by Broks (1984) and Rawlings and Claridge (1984) which showed that there was a relationship between performance on several divided visual-field (DVF) tasks and scores on the schizotypal (STA) scale of the STQ questionnaire.

Meehl pointed out that there are four major characteristics which might be regarded as being symptoms of schizotypy. These are;

1. Cognitive slippage
2. Ambivalence

3. Interpersonal aversiveness

4. Anhedonia

He suggested that these four traits are not inherited, but are acquired by the schizotaxic individuals as a result of social learning. Cognitive slippage refers to disturbances such as; a mild form of thought disorder, disorder of association, and illogical thinking. Ambivalence is a term used for contradictory emotion. That is, changing between positive and negative feelings towards the same person, object, or activity in such a way that both the positive and negative feelings are equally strong. Interpersonal aversiveness and ambivalence are considered to derive from the combination of cognitive slippage, and anhedonia. Anhedonia refers to a loss of ability to experience pleasure from various social and physical activities. Anhedonia has long been considered as a symptom of schizophrenia (Kraepelin, 1919; Bleuler, 1950) and is found in certain subtypes of schizophrenics and some schizotypics. Rado (1956) suggested that anhedonia is a genetically transmitted defect found in both schizophrenics and 'compensated schizotypics' and is characterized by an impaired ability to relate to other people, or to experience joy and affection.

The pleasure deficiency of anhedonics is believed to be a long standing disability and relatively unmodifiable rather than a temporary loss of the ability to experience

pleasure which is usually seen in depressed people. Therefore, what would normally be rewarding and pleasurable for non-anhedonic individuals, is much less so for anhedonics. Furthermore, because anhedonics are incapable of experiencing pleasure, this could impair their ability to relate with other people which in turn could lead to social withdrawal.

A biochemical theory by Stein and Wise (1971) suggested that anhedonia is caused by a genetically based lack of dopamine- β -hydroxylase (DBH) which is an enzyme that converts dopamine into noradrenaline. This lack of DBH results in the need to dispose of an excessive amount of dopamine into 6-hydroxydopamine (6-OHDA). This is a neurotoxin which destroys the reward mechanisms and in particular the noradrenergic reward system. This consequently results in anhedonia.

Although Meehl and Rado described anhedonia as a symptom shown by all schizophrenics, evidence suggests that anhedonia is a characteristic of only some schizophrenics. For example, Wise and Stein (1973), in the post mortem examination of the brains of schizophrenics and normal subjects, found that the signs of a DBH deficiency mentioned above, were shown by some and not all the schizophrenics. It has also been shown that although schizophrenics score higher than normal subjects on the

scales measuring anhedonia, not all schizophrenics show this characteristic. It is generally reported that poor pre-morbid schizophrenics more often prove to be anhedonic and good premorbid patients are usually non-anhedonic.

Various methods have so far been employed in the assessment of anhedonia in schizophrenics such as experiments involving the recall of pleasant versus unpleasant words (Keyton and Koh, 1975), examination of learning ability under reinforcement (Watson, 1972), observer rating scales (Harrow et al., 1977) and the application of a questionnaire for the measurement of physical and social anhedonia developed by Chapman, Chapman and Raulin (1976).

Chapman et al. (1978) suggested that individuals with schizotypic personality characteristics might be at risk for the development of schizophrenia. In support of this theory they referred to the findings of Hoch and Cattell (1959) and Hoch et al. (1962) on 'pseudoneurotic schizophrenia', the symptoms of which are very similar to Meehl's description of schizotypy. In 1949 Hoch and Polatin used the term pseudoneurotic schizophrenia to characterize a group of out-patients suffering from anxiety disorders. These patients were showing prominent neurotic symptoms, which were referred to by Hoch and Polatin as; pan-anxiety, pan-neurosis and pan-sexuality. They were

also exhibiting various temporary psychotic symptoms which are not normally shown by neurotics. This led Hoch and Polatin to infer that these patients should not be classed as neurotics. They suggested that the symptoms shown by these patients might indicate a pre-disposition for the development of schizophrenia. These studies showed that 20% of subjects who had the diagnosis of pseudoneurotic schizophrenia, in a 5 to 20 year follow-up, were found to have developed schizophrenia.

Most of the psychotic symptoms of pseudoneurotic schizophrenia are similar to those described by Meehl as the symptoms of schizotypy. Examples are;

impaired thinking and association, disturbance of awareness, disorder of attention and concentration and disorder of emotions and feelings.

The work of Hoch and Cattell (1959) has led to a substantial development in the study of the so-called 'borderline conditions'. The term borderline has long been applied to certain abnormalities of personality which are similar to psychosis but are not sufficiently severe to be classified as psychotic disorder. In recent years there have been much developments in the use of the concept of borderline conditions and have led to specific criteria and a precise definition of borderline conditions. an important development has been the work by Spitzer,

Endicott and Gibbon (1979) who suggested that individuals identified as borderline are likely to show two groups of traits which are different from each other. One group of traits consists of relatively long-term personality characteristics identified by instability of interpersonal behaviour and is referred to as 'borderline personality' in work by e.g. Gunderson and Singer (1975); Kernberg (1967). The other are schizoid symptoms or schizophrenia-like traits in the absence of clear schizophrenia. This is referred to as 'borderline schizophrenia' and is believed by Kety et al. (1968) to have a genetic relationship with schizophrenia.

Spitzer, Endicott and Gibbon (1979) examined widely the relationship between the two borderline conditions and differentiated two types of borderline characteristics and produced new criteria for the diagnosis of the two concepts. They used the term 'schizotypal personality disorder' (SPD) instead of borderline schizophrenia and borderline personality was named 'unstable personality'. The schizotypal personality disorder was characterized by symptoms such as; odd communication (vagueness of speech), ideas of reference, suspiciousness, paranoid attitudes, illusion, magical thinking (e.g. superstition, telepathy), disorder of affect, excessive social anxiety and social isolation.

Unstable personality was characterized by; instability in self-concept, unstable interpersonal relations, anti-social behaviour and anger dyscontrol.

Spitzer, Endicott and Gibbon (1979) developed two scales; one for identifying schizotypics and the other for borderline personality. A factor analytical study of the items of the two scales confirmed that these two scales measured two separate types of borderline disorder.

These two personality characteristics were later included in the new DSM-III (1980) under the term schizotypal and borderline personality disorders.

From the brief review of the theories and findings of schizotypy described above it might be concluded that there might exist a population who inherit a particular type of personality which makes them vulnerable to the development of schizophrenia and they could be identified from among the members of the general population through psychometric measures.

QUESTIONNAIRE MEASURES FOR IDENTIFYING SCHIZOTYPICS

Various researchers have examined the predisposition to schizophrenia using questionnaires. Examples of questionnaires used for the measurement of schizophrenic tendencies are; physical and social anhedonia, perceptual aberration, sub-scales of MMPI, schizophrenism scale, psychoticism (P) scale, magical ideation scale and the STA and STB scales of the STQ questionnaire.

Anhedonia scale

Anhedonia was described by Meehl as a major schizotypic characteristic and has in recent years received most attention. The measurement of anhedonia has been advanced by the work of Chapman and his group. In 1976 Chapman, Chapman and Raulin constructed a scale for the measurement of anhedonia. This scale contains items which are related to the type of behaviour and attitudes that indicate a lack of ability to experience pleasure.

In the construction of anhedonia scale, Chapman et al. categorized pleasure into physical and social pleasures and constructed the scales of physical and social anhedonia. Physical anhedonia scale consisted of items related to physical pleasure. Examples of items from this scale are;

"I have never cared much about the texture of food".

"Sunbathing isn't much more fun than lying down indoors".

Their social anhedonia scale contained items associated with the non-physical social pleasure of being with people and doing things with others e.g. "I attach very little importance to having close friends". "Writing letters to friends is more trouble than it's worth".

The reliability of the anhedonia scale was tested by Chapman et al. (1976). The test-retest reliability of the physical anhedonia scale with 6 weeks between first and second testing showed this scale to have high test-retest reliability. Similar results were found by Chapman, Edell and Chapman (1980) in which the estimate of reliability was found to be high when the scale was applied to college students.

The relationship between the anhedonia scale and several other scales has been examined in a number of studies. For example, Chapman, Chapman and Raulin (1976) examined the relationship between both social and physical anhedonia scales and depression as measured by Harris's (1975) depression scale. The results showed that no strong correlation was found between anhedonia and depression scales. They suggested that this lack of a relationship could indicate that the anhedonia scale was not measuring the anhedonia related to depression. Chapman et al. (1976)

also examined the relationship between both the social and physical anhedonia scales with the pre-morbid adjustment measure (Harris, 1975). The results showed that anhedonics were more often poor in their pre-morbid adjustment compared with non-anhedonics.

Physical anhedonia scale has been found to have a significantly low correlation with perceptual aberration and magical ideation scales (Chapman, Chapman and Miller 1982). This could indicate that anhedonia is measuring a schizotypic tendency which is different from perceptual aberration or magical ideation.

Anhedonia scale has shown high validity in discriminating schizophrenics (Chapman et al., 1976). Evidence that this scale taps schizophrenic proneness and not simply psychosis proneness comes from examining high scores for correlates of schizophrenia. Haberman, Chapman, Numbers and McFall (1979) studied social competence in subjects with high scores on the physical anhedonia and perceptual aberration scales. Each subject role played responses to 24 problematic social situations as a test of interpersonal competence and the responses were rated on a 3-point scale. The physically anhedonic group did significantly worse than the control group in this test. Furthermore, Edell and Chapman (1979) studied the relationship between physical anhedonia and scores from the

Rorschach Inkblot Test and found that anhedonics exhibited schizophrenic-like thought disorder in this test. They found twice as many high scorers on Rorschach indices among anhedonics as compared with the control group.

In a study by Chapman, Edell and Chapman (1980) it was found that anhedonic subjects scored highly on schizotypal characteristics but their scores did not differ from control subjects on psychotic-like experiences (attenuated form of psychotic experiences), tested by the scale of rating for psychotic-like experiences (Chapman and Chapman, 1980). Their anhedonic subjects did not report psychotic-like symptoms, but reported more schizotypal symptoms examined by Spitzer's et al. (1979) scale. They were also found to be more socially isolated and withdrawn and were less interested in the opposite sex.

Chapman et al. (1976) suggest that the physical anhedonia scale might provide a more accurate measure of anhedonia than the social anhedonia scale. They believe that physical anhedonia is more likely to reflect the kind of neurological deficit hypothesized to be the underlying cause of anhedonia (Meehl 1962; Rado 1956). Furthermore, the physical anhedonia scale was shown to have a very low correlation with the desirability scale whereas, the social anhedonia scale showed a higher correlation with desirability scale. Chapman et al. (1976) also suggested

that the responses of subjects to the social anhedonia scale could be distorted by their desire to appear more socially acceptable.

Evidence for the efficiency of the anhedonia scale for the measurement of schizotypy could be cited from a number of psychophysiological studies of schizotypy carried out in recent years. These will be referred to in a relevant chapter.

Perceptual aberration scale

Another scale constructed for the measurement of schizophrenia and schizotypy is the 'perceptual aberration' scale. Perceptual aberration is considered to be a symptom exhibited by most schizophrenics and individuals vulnerable to schizophrenia. It is characterized by perceptual distortion, especially in relation to one's own body. This includes symptoms such as, having delusions to do with rotting of parts of one's body, changes in the size or shape of the body, or feelings that parts of one's body are unreal. This scale contains 35 items and was constructed by Chapman, Chapman and Raulin (1978).

Chapman, Edell and Chapman (1980) examined the reliability of the perceptual aberration scale and found that a test-retest revealed high reliability for this scale.

The perceptual aberration scale was applied to a group of schizophrenics by Chapman et al. (1978) and it was found that only some of the schizophrenics scored highly on this scale. They suggested that perceptual aberration might be a characteristic of only some schizophrenics. In a study by Chapman, Edell, and Chapman (1980) a group of college students who scored highly on the perceptual aberration scale were found to show much more evidence of psychotic-like experiences than anhedonics and the control subjects, when examined by Chapman et al.'s structured interview scales. Seventeen per cent of the perceptually aberrant subjects showed psychotic-like symptoms versus 2% of the controls and 2% of the physically anhedonic subjects. The examples of psychotic-like experiences were firstly, depersonalization i.e. some part of the body sometimes seems not to be one's own, or seems not to be connected to the rest of the body, or seems not to be there or takes on an unusual appearance. Secondly, derealization i.e. one's surroundings sometimes seem unreal or dream-like or very different from usual, or like a specific other environment. The perceptually aberrant and anhedonic subjects also scored highly for schizotypal characteristics tested by the Spitzer et al. (1979) schizotypal scale compared with control subjects. They have also had histories of having seen a psychologist or psychiatrist. Chapman et al. concluded that the perceptual aberration scale identifies

subjects who are schizotypic and it is capable of isolating a group of subjects at risk for schizophrenia.

The relationship between the perceptual aberration scale and a number of other scales for the measurement of schizophrenia was tested by Chapman et al. (1978) who found that perceptual aberration had no correlation with physical anhedonia. It was therefore, suggested by Chapman et al. that the perceptual aberration scale might measure a form of schizophrenic tendency which is different from anhedonia.

It ought to be mentioned that although the perceptual aberration scale is constructed to be used with the general population some of its items give the impression that it is testing for very abnormal behaviour which may not be present at the pre-schizophrenic stage. Chapman et al. (1978) have therefore, recommended that this scale should be used mixed with items of other scales.

MMPI (Minnesota Multiphasic Personality Inventory scale)

The MMPI scale has been extensively used in research in schizophrenia and a sub-scale of MMPI has been widely employed in the identification of individuals with schizotypal personality. This sub-scale consists of scale 2 (D, or depression), scale 7 (Pt, or psychasthenia), and scale 8 (Sc, or schizophrenia). This triad which is known

as 2-7-8 was first used for the identification of schizotypic individuals by Peterson (1954). He employed the 2-7-8, to compare three groups of patients; group (a) consisted of a number of out-patients originally known as non schizophrenics who were later diagnosed as schizophrenics. Group (b) were patients who were never diagnosed as schizophrenics. Group (c) were known as latent remitted schizophrenics who were later hospitalized for schizophrenia. The results of this study demonstrated that the shape of the 2-7-8 profile of group (a) was similar, but more pronounced than that of group (c) and was different from that of group (b).

Another study is that by Gilberstadt and Duker (1965) who reported on the basis of a study of psychiatric hospital records, that patients who have a 2-7-8 profile on the MMPI, are most often either pseudoneurotic schizophrenics or chronic schizophrenics.

Further support for the efficiency of the 2-7-8 scale for use in the identification of pre-schizophrenics could be cited from the work by Koh, Kayton and Berry (1973) and Koh and Peterson (1974) who have shown that individuals from the general population who scored highly on the 2-7-8 scales exhibited a deficit of short-term memory similar to that shown by schizophrenics. Furthermore, Sterenko and

Woods (1978) and Schulman (1976) found various cognitive abnormalities in college students with 2-7-8 profiles.

Golden and Meehl (1979) employed the MMPI scale in order to identify schizotaxics or what they called 'schizoid taxon' membership. They used 7 items based on responses of 211 psychiatric outpatients, none of whom had had a formal diagnosis of schizophrenia. They then classified cases into schizotypal and nonschizotypal groups. The mean MMPI profile of schizotypy corresponded closely to Peterson's (1954) pre-schizophrenic samples profile which indicated that the seven-item scale might be capable of identifying schizotypy. Golden and Meehl (1979) called these seven items the schizoid scale. However, a study by Miller et al. (1982) did not replicate Golden and Meehl's findings. They therefore, suggested that the efficiency of such short scale drawn from the MMPI for use in the identification of schizotypic individuals, is in some doubt.

Schizophrenism scale

Another questionnaire used for the measurement of schizotypy is known as the 'schizophrenism' scale developed by Nielsen and Petersen (1976). This is a 14-item questionnaire constructed on the basis of the symptoms described by J. Chapman (1966) to be the characteristics of individuals at the early stage of schizophrenia. Some of

the items are also related to the type of behaviour which is thought to result from disturbances in the functioning of limbic system which is suggested by e.g. Venables (1973) to be the characteristic of schizophrenics. This scale contains items such as; "I often have difficulty controlling my thoughts", which relates to cognitive slippage, or "I do not like to mix with many people", which represents social anxiety.

Nielsen and Petersen (1976) applied the schizophrenism scale to a group of undergraduates who also took part in skin conductance and heart rate experiments. The subjects who scored highly on this questionnaire were found to be electrodermal hyper-responders. They gave high amplitude responses with short latencies and fast recovery which were similar to those obtained in Danish studies of children at risk for schizophrenia conducted by Mednick and Schulsinger (1968) mentioned previously.

The schizophrenism scale has been examined in relation to other scales such as Extroversion (E), Neuroticism (N) and Anxiety scales (A) from the EPI questionnaire developed by Eysenck and Eysenck (1967). The inter correlation between these scales have shown that the schizophrenism scale significantly correlated with N and A scales but had a low correlation with the E scale.

Psychoticism (P) scale

Psychoticism as a dimension of personality was first put forward by Eysenck (1955). He carried out a number of studies using normal subjects and mentally disturbed patients. These studies resulted in a new personality dimension known as psychoticism (P), orthogonal to the two other dimensions of personality known as 'extroversion' (E) and 'neuroticism' (N) of the EPQ questionnaire developed by Eysenck and Eysenck (1972).

The P scale was constructed to measure psychotic characteristics in clinically normal individuals and has been found efficient in discriminating between psychotics and normals but is also scored highly by criminals. The construction of the P scale was based on the theory of continuity between normal and psychotic behaviour. The P scale consists of items related to nonconformity, carelessness, antisocial attitudes and paranoia.

Bishop (1977) has argued that the P scale is not a reliable measure of psychosis proneness, pointing out that many other groups score higher on the scale than do schizophrenics. Bishop also pointed out that people with high scores on the P scale do not show the type of characteristics found in subjects truly prone to psychosis. For example, high psychoticism subjects are faster than control subjects on a reaction time task, rather than being

slower, like schizophrenics. However, according to Eysenck and Eysenck (1976) schizophrenics score highly on the P scale and the P scale could be considered as being applicable in the search for individuals predisposed to schizophrenia. This is confirmed by a study undertaken by Claridge and Chappa (1973) in which normal subjects who showed a profile of psychophysiological responses similar to those shown by schizophrenics, were high scorers on the P scale. Additionally in a recent study Claridge, Robinson and Birchall (1983) using Eysenck's P scale, tested a group of subjects who were genetically related to diagnosed schizophrenics and a control group who were the first degree relatives of neurotics. The results of their study showed that the relatives of schizophrenics scored significantly higher on the P scale than the relatives of neurotics.

Magical ideation scale

Magical ideation is considered by Meehl (1964) and Hoch and Cattell (1959) to be a symptom of schizotypy. From the review of the case notes of subjects diagnosed as borderline schizophrenics in the Danish adoption study (Kety, Rosenthal, Wender and Schulsinger, 1968), Spitzer Endicott and Gibbon (1979) suggested that magical ideation is an important symptom of borderline schizophrenia (which was later on named schizotypal personality disorder).

These subjects consisted mainly of the biological relatives of adopted schizophrenics.

Magical ideation has appeared in the DSM III as one of the diagnostic criteria of schizotypic personality disorder. It refers to a belief in a causal relationship between events which can not have a relation with each other. For example, belief in the presence of secret messages in the behaviour of other people or in the arrangement of objects, thought transmission, reincarnation, superstition, telepathy and 6th sense.

The magical ideation scale is a 30-item scale which was constructed by Eckblad and Chapman (1983). They found that subjects who scored highly on this scale also showed more schizotypal characteristics such as affective symptoms and difficulty with concentration. Analogous to the perceptual aberration scale, magical ideation has a negative correlation with the anhedonia scale which indicates that magical ideation and perceptual aberration scales measure those symptoms of schizotypy which are different from that of anhedonia. In a study by Eckblad & Chapman (1983) it was found that magical ideation subjects showed much more evidence of magical thoughts than the control subjects and reported more psychotic or psychotic-like experiences (e.g. other people can read one's thoughts), showed more schizotypal experiences (e.g. the

experience of some force or entity being present when there is no one around) and showed difficulties in concentration. It was suggested by Chapman et al. (1983) that subjects with high scores on the magical ideation scale show symptoms suggestive of predisposition to psychosis.

The STA and STB scales of the STQ questionnaire

Claridge and Broks (1984) constructed a questionnaire, the items of which were expected to tap various aspects of thinking, attention, perception and thought disorders found in the self-reports of schizophrenic patients. The questionnaire originally consisted of 97 items and was referred to as the 'S' scale (Reichenstein, 1976). Revision of the items resulted in a shorter version of the S scale known as ST1 (Rawling, 1983).

Claridge and Broks (1984) revised the ST1 scale on the basis of the new criteria of the DSM-III classification of borderline conditions (Spitzer et al., 1979), mentioned previously. They therefore, constructed a new version of the scale which covered each of the areas of dysfunction related to SPD and BPD. This resulted in a questionnaire, currently known as the STQ which consists of two scales, labelled STA and STB. The STA corresponds to schizotypal personality and STB to borderline personality. The items of the STA scale are related to schizophrenic-like characteristics whereas, the items of the STB scale reflect

an unstable interpersonal relationship, such as ambivalence and lack of control of emotional expressions.

The STQ contains elements of the earlier questionnaire work but is the first to link in with the DSM-III definitions. Rawling (1983) in a detailed examination of the STQ scale administered this scale together with Eysenck's EPQ P scale and the PEN P scale to normal subjects. The results of the correlational studies of these scales showed that both of the STQ scales correlated with the PEN P scale but did not correlate significantly with the EPQ P scale. A very similar result was reported from a study by Claridge, Robinson and Birchall (1983) in which the STQ scale was administered to the first degree relatives of schizophrenic and neurotic patients together with the two versions of the P scale and it was found that the PEN P scale correlated significantly with both STA and STB, whereas the EPQ P scale showed a highly significant correlation only with the STB. The correlation between STA and P was found to be very low.

Claridge and Broks (1984) suggested that the two scales of the STQ seem to be related to two different aspects of psychoticism and appear to correspond to the two versions of the Eysenck P scale. The STA scale concerns schizophrenic-like features, which are found in the PEN P

scale and the STB scale relates to anti-social personality which to some extent parallels the EPQ P.

From the work stated above it appears that several criteria could be employed in the identification of individuals with schizotypic personality which appear to be capable of detecting schizotypic individuals. It therefore, can be concluded that several dimensions of schizotypy might exist and it might be possible to identify several subtypes of schizotypy each showing different sets of abnormalities of personality which could be associated with different schizophrenia subtypes.

Chapter 5

FACTOR ANALYSIS OF SCHIZOTYPIC SCALES.

This section concerns the factor analysis of a questionnaire which was employed in the present study for the identification of individuals with schizotypic personality characteristics from the general population. The questionnaire employed for this purpose was one developed by Venables (unpublished). In its original form this questionnaire contained 250 items which have been constantly revised and have been validated against the psychophysiological measures known to reliably distinguish between schizophrenics and normals (e.g. skin conductance and heart rate orienting). Venables constructed most of the items of this questionnaire on the basis of the theories of the etiology of schizophrenia. For example, the involvement of disturbance of the limbic system (e.g. the hippocampus and the amygdala). The rest of the items were selected from the MMPI, and some were from Eysenck's P scale. Revision of these items resulted in 120 items in which the 14 item scale of Nielsen and Petersen (1976), was also included. Venables then presented this version of the questionnaire to 65 subjects who subsequently took part in an experiment in which skin conductance and heart rate orienting were measured in order to validate the questionnaire items against autonomic activities known to be related to schizophrenia i.e. autonomic hyper- or hypo-activity. Therefore, he examined each item of the

questionnaire to find out which items distinguished autonomic responders from non-responders and excluded the items which did not do so.

The items which were retained were subjected to factor analysis. This resulted in two main factors one of which seemed to be related to the Nielsen and Petersen's schizophreniaism factor. This factor contained many of the items which had differentiated the responders from non-responders in the skin conductance and heart rate experiments. The second factor appeared to be related to Eysenck & Eysencks' P scale. On the basis of the results of this analysis Venables constructed a new version of the questionnaire in which he included some of the items from the scales for anhedonia and perceptual aberration constructed by Chapman et al. (1976 and 1978). He included only a few items from the perceptual aberration scale, as most of the items of this scale give the impression that it is testing for very abnormal behaviour and not appropriate to be used for the general population. Finally, further analyses resulted in an 86 item questionnaire which was employed for the selection of subjects in the present study. A copy of the 86-item questionnaire is presented in Appendix A.

Subjects and Method

A large number of males and females from the general population were contacted and were asked to complete the 86-item questionnaire. The questionnaire was completed by a total of 470 subjects. About 20% of the subjects did not specify their sex or personal details. The subjects were mainly undergraduate and postgraduate students at York University in the age range of 20-35 and formed two independent samples containing 221 and 249 subjects. The questionnaires were filled out either by groups or by sending copies to individuals together with a letter explaining the purpose of the test. The subjects were told that the questionnaire was a survey of attitudes, experiences and beliefs. Subjects were instructed to answer all the questions which were in the form of 'true/false' statements. Each response received a score of 1 for the absence of the characteristic measured and a score of 2 for the presence of it.

Results

Analysis of response frequencies revealed that the subjects responded to four of the items with frequency exceeding 20-80% balance. Therefore, these items were not used in the subsequent analyses. Principal factor analyses with varimax rotation were carried out separately for the two samples in order to examine the factor structure of the questionnaire. In these analyses the Scree test (Cattell,

(Cattell, 1966) indicated that there were four factors present. An oblique solution was carried out in order to test the relationship between the factors. The results showed no correlation between the factors which indicates that the four factors are orthogonal. Separate factor analyses were also carried out for male and female subjects extracted from the total of the two samples. The items with loadings greater than .3 were selected.

The results are presented in Tables 1 to 5, in which four tables show the loadings of the items of the four factors and the fifth table shows the items which had loadings of less than .3 in any analysis. S1 and S2 refer to samples 1 and 2. The column with the label 'H.S.O.L.' stands for "Highest Significant Other Loadings" and includes; the loading, the factor involved and the sex of the sample used in the factor analysis. Only the data from the factor analyses by sex were examined for entry in this column.

The column labelled 'source' shows the origin of these items.

(SZ) factor; Sample 1 factor 1. Sample 2 factor 2.

The loading of the items of the factor labelled 'Schizophrenism' (SZ) are presented in Table 1. The items of this factor are mainly from the schizophrenia scale of Neilsen & Petersen (1976) which loaded significantly mainly

on the SZ factor. As shown these loadings indicate that this factor is orthogonal to items related to anhedonia. The items from the perceptual aberration also loaded highly on this factor. Other item loadings on this factor are either from those constructed by Venables or are derived from the MMPI, 'Sc' scale or from Browne and Howarth (1977) which were included in the original questionnaire.

(PA) factor: Sample 1 factor 4. Sample 2 factor 1.

Table 2 presents the item loadings on the factor labelled 'Physical Anhedonia' (PA). The items of (PA) factor as can be seen, are distinctively related to a deficiency in the experience of physical pleasure. With only one exception of a Psychoticism item, all items which loaded highly on this factor were derived from the Physical Anhedonia scale.

(SA) factor: Sample 1 factor 3. Sample 2 factor 4.

The factor presented in Table 3 is labelled as 'Social Anhedonia' (SA). The majority of the items of this factor loaded highly on items from Chapman's social anhedonia scale with the exception of two which loaded on physical anhedonia items. These two items, however, give the impression of measuring social anhedonia as they seem to be associated with the types of activities performed in social situations. These two items are;

I have had very little fun from physical activities

like walking, swimming and sports.

Sunbathing isn't much more fun than lying down indoors.

(C) factor: Sample 1 factor 2. Sample 2 factor 3.

Item loadings of this factor are shown in Table 4. This factor was labelled 'Cautiousness' (C) the items of which relate to Eysenck's psychoticism (P) scale. As can be seen the items with high loadings on the C factor mainly appear to be related to the acceptance or rejection of the values of society and to cautiousness or lack of it.

Results of data for males and females

The data for male and female samples were subjected to a further analysis using an oblique rotation. For the male sample the highest inter-factor correlation was .06 which supports the existence of four independent factors. For the female sample the inter-factor correlation was slightly higher, even though the highest was only .12 between physical and social anhedonia which still supports the existence of four orthogonal factors.

The shortened version of the questionnaire

A short version of the questionnaire which contained 28 items was subsequently constructed on the basis of the results of the factor analysis on the questionnaire scores

of sample 1. This version of the questionnaire contained all the items with loading higher than .3 from the Schizophrenism (SZ) scale (items; 6, 18, 21, 24, 27, 36, 41, 46, 52, 59, 62, 63, 69, 82, and 83), Physical Anhedonia (PA) scale (items; 3, 9, 28, 39, 57, 73, 78), and from the Social Anhedonia (SA) scale (items, 7, 12, 29, 35, 75 and 79). A copy of the shortened version of the questionnaire is presented in Appendix A. This version of the questionnaire was employed for selection of subjects who took part in the experiments examining psychophysiological and behavioural studies of attention and information processing in schizotypics. This will be reported in the following chapters of the thesis.

TABLE 1

"Schizophrenism" (SZ) factor. Sample 1 Factor 1, Sample 2 Factor 2. Males Factor 3, Females Factor 2

Item No.	S1	S2	M	F	HSOL	Source
59	.47	.55	.50	.47	-	NP
	I often have grave difficulties controlling my thoughts when I am thinking.					
52	.47	.41	.34	.48	-	NP
	I find it difficult to concentrate, irrelevant things seem to distract me.					
83	.45	.28	.50	.37	-	PAb
	Sometimes people who I know quite well begin to look like strangers.					
82	.43	.41	.32	.35	-	NP
	I prefer others to make decisions for me.					
46	-.42	-.38	-.54	-.35	-.39/C/F	BH
	I am not usually self conscious.					
63	.42	.33	.39	.25	-	PAb
	Now and then when I look in the mirror my face seems quite different from usual.					
41	.38	.27	.41	.36	-.40/C/F	BH
	I suddenly feel shy when I want to talk to a stranger.					
24	.37	.39	.41	.40	-	Sc
	I often get a restless feeling that I want something but do not know what.					
18	.37	.33	.25	.41	-	NP
	I often change between positive and negative feelings toward the same person.					
36	-.37	-.23	-.36	-.35	-	NP
	I am not much worried by humiliating experiences.					
69	.36	.41	.28	.42	-	BH
	People can pretty well influence me even though I thought my mind was made up on a subject.					
6	-.36	-.25	-.26	-.42	-	NP
	I am not easily confused if a number of things happen at the same time.					
27	-.32	-.32	-.38	-.23	-	NP
	I am never so nervous that my mind goes blank.					
62	-.32	-.28	-.30	-.36	-	
	I do not find it difficult to switch my attention quickly from one task to another.					
21	.31	.43	.31	.39	-	PAb
	My body or part of it occasionally seems dead or unreal.					

TABLE 2

"Physical Anhedonia" (PA) Sample 1 Factor 4, Sample 2 Factor 1. Males Factor 1, Females Factor 1.

Item No.	S1	S2	M	F	HSOL	Source
73	-.56	-.63	-.52	-.47	-.37/SA/M	PA
78	-.46	-.58	-.43	-.58	-	PA
28	.42	.42	.48	.40	.39/C/M	PA
9	-.41	-.50	-.23	-.40	-	PA
39	-.41	-.57	-.44	-.43	-	PA
3	.31	.44	.32	.48	-	PA
57	.31	.46	.45	.43	-	PA
17	-.30	-.38	-.44	-.43	-	PA
31	.30	.41	.57	.32	.40/C/F	P
16	-.27	-.55	-.48	-.37	-.35/SA/M	PA
49	.25	.57	.49	.53	-	PA
14	.25	.35	.24	.28	-	PA
81	.23	.31	.52	.09	-	-
22	-.20	-.58	-.46	-.28	-.38/SA/M	PA
86	.20	.39	.23	.15	-	PA
61	-.16	-.48	-.11	-.49	-.44/SA/M	PA
20	.12	.51	.44	.48	-	SA
34	-.10	-.36	-.07	-.34	-	PA

TABLE 3

"Social Anhedonia" (SA) Sample 1, Factor 3; Sample 2, Factor 4. Males Factor 2, Females Factor 4.

Item No.		S1	S2	M	F	HSOL	Source
75	When anticipating a visit from a friend I have often felt happy and excited.	-.48	-.21	-.42	-.22	-	SA
79	The idea of going out and mixing with people has always pleased me.	-.45	-.47	-.35	-.33	-.36/PA/M	SA
12	I attach very little importance to having close friends.	.37	.37	.52	.25	-	SA
35	Getting together with old friends has been one of my greatest pleasures.	-.37	-.24	-.44	-.35	-	SA
29	When I'm extremely happy I have sometimes felt like hugging someone.	-.36	-.30	-.39	-.27	-	SA
7	I have thoroughly enjoyed laughing at jokes with other people.	-.32	-.45	-.30	-.14	-	SA
54	Sunbathing isn't much more fun than lying down indoors.	.30	.37	.40	-.21	-	PA
55	Although there are things that I enjoy doing by myself I usually seem to have more fun when I've done things with other people.	-.14	-.47	-.46	-.36	-	SA
39	In the course of my life I've tried to avoid romantic involvement.	.14	.36	.23	.46	-	SA
5	I have had very little fun from physical activities like walking, swimming and sports.	.08	.34	.39	.18	-	PA

TABLE 4

"Cautiousness" (C) Factor Sample 1, Factor 2; Sample 2, Factor 3. Males Factor 4, Females Factor 3.

Item No.		S1	S2	M	F	HSOL	Source
56	I think people spend too much time safeguarding their future with savings and insurance.	-.52	-.29	-.27	-.37	-	
48	I like to arrive at appointments in plenty of time.	.51	.43	.35	.38	-	
33	Good manners and cleanliness matter much to me.	.47	.29	.23	.28	-	P
64	When I catch a train I often arrive at the last minute.	-.43	-.49	-.27	-.31	-	
37	I think marriage is old fashioned and should be done away with.	-.41	-.40	-.38	-.47	-	P
4	Being in debt would worry me.	.40	.17	.42	.11	-	
19	I would take drugs which may have strange and dangerous effects.	-.39	-.35	-.26	-.43	-	P
8	I lock up my house carefully at night.	.36	.39	.38	.32	-	
15	I believe insurance schemes are a good idea.	.36	.26	.22	.24	-	
67	Sometimes when I look at tables and chairs they seem strange.	-.34	-.27	-.29	-.39	-	PAb
40	People who drive carefully annoy me.	-.09	-.39	-.08	-.30	-	
1	I stop to think things over before doing anything.	.24	.18	.44	.29	-	
13	I do not like to be interrupted when I am concentrating.	.25	.19	.47	.06	-	

TABLE 5

Items not significantly loaded on any factor.

Item No.		Source
2	I have gone out of my way to watch children play.	SA
23	I enjoy hurting people I love.	P
30	I do not find it difficult to telephone in a noisy place.	
32	I do not find it difficult to tolerate waiting for the outcome of something.	P
42	Most things taste the same to me.	
43	I'd just as soon go to the cinema alone as with a companion.	SA
44	It worries me if I know there are mistakes in my work.	
45	I have had very little desire to try new kinds of food.	PA
50	My mother is (or was) a good woman.	P
51	In the course of my life it has generally been very unusual for me to feel longing for someone.	SA
53	There are several people who keep trying to avoid me.	BU
60	I try not to be rude to people.	P
65	I have usually found lovemaking intensely pleasurable	PA
66	Making new friends is so difficult it hardly seems worth the effort.	SA
68	I have never especially cared for women/men to flirt with me.	SA
70	My friendships break up easily without it being my fault.	P
71	People often expect me to spend more time talking to them than I would like.	SA
72	I sometimes like teasing animals.	
74	My hearing is never so sensitive that ordinary sounds become unbearable.	
76	I would like other people to be afraid of me.	P
77	I do not often daydream.	NP
85	Often I have a day when indoor lights seem so bright that they bother my eyes.	

Item No.		S1	S2	M	F	HSOL	Source
80	I often hesitate when I am going to say something in a group of people I don't know well.	.31	.45	.41	.37	-	NP
10	My plans frequently seem so full of difficulties that I have to give them up.	.24	.42	.22	.39	-	BH
26	I have enemies who want to harm me.	.22	.44	.24	.31	.50/PA/M	BH

¹Source codes NP = Neilsen, Petersen
 (and for Tables PAb = Perceptual Aberration. Chapman et al.
 2-5) BH = Browne, Howarth
 Sc = MMPI Sc Scale
 P = Psychoticism. Eysenck & Eysenck
 PA = Physical Anhedonia. Chapman et al.
 SA = Social Anhedonia. Chapman et al.

DISCUSSION

Factor analyses of the 86-item questionnaire produced promising results. The results suggested that there might be three or possibly four independent dimensions of schizotypy. The first factor referred to as schizophrenism (SZ factor) appears to be measuring an aspect of schizotypy which is related to cognitive and perceptual disturbances. The physical anhedonia factor (PA) is associated with lack of ability to experience physical pleasure, and the social anhedonia (SA) factor which is related to social withdrawal and lack of interest in social pleasure. The fourth factor, labelled as cautiousness (C) which is orthogonal to SZ, PA and SA could be associated with Eysenck's psychoticism P scale.

Most of the items with high loading on the SZ factor came from the schizophrenism scale (Neilsen and Petersen, 1976) and some from the perceptual aberration scale (Chapman et al., 1978). Some of these items appear to be related to what is described by Meehl (1962) as cognitive slippage and others seem to be related to some of the symptoms of pseudoneurotic schizophrenia (Hoch and Cattell, 1959) such as disorder of attention and concentration. Examples are as follows:

I often have grave difficulties controlling my thoughts when I am doing something.

I find it difficult to concentrate, irrelevant things seem to distract me.

The rest of the items of the SZ factor relate to symptoms such as odd perceptual experiences, social anxiety and ambivalence. These items resemble the type of symptoms and behaviours which are reported to be associated with schizotypal personality characteristics (SPD) in the study by Spitzer et al. (1979). Spitzer et al., from the results of a factor analytical study of schizotypal personality disorder, suggested that this is a unidimensional concept and is characterized by odd communication, ideas of reference and suspiciousness, recurrent illusions and magical ideation and to a lesser extent social anxiety and social isolation. This appears to be conceptually close to the schizophrenism factor in the present study.

The loading of items from the perceptual aberration scale on the SZ factor could be an indication that this scale, in addition to perceptual disorder might be measuring a broader range of behaviour and also gives the impression that the symptoms such as cognitive disorder and perceptual aberration might share the same underlying cause. This is also in line with the previous findings by Chapman et al. (1978) who found that the perceptual aberration scale had a negative correlation with the physical anhedonia scale. Additional support for the independence of anhedonia from perceptual aberration might

be cited from recent psychophysiological studies of schizotypy in which anhedonics and perceptual aberration subjects were differentiated by skin conductance and heart rate orienting behaviour (Simons, 1981) and by somatosensory evoked potentials (Josiassen et al., 1985). In addition it may be noted that in a study by Asarnow, Nuechterlein and Marder (1983) in which subjects were divided into two groups on the basis of their performance on a span of apprehension test, the two groups differed on the perceptual aberration and on the Nielsen-Petersen schizophreniaism scale but not on the physical anhedonia scale.

The independence of the physical anhedonia factor from the SZ factor indicates that physical anhedonia might identify a different types of psychological dysfunction than does the SZ scale. Both types appear to be consistent with high risk for the development of schizophrenia but might correspond to different subtypes of schizophrenia.

The finding in the present study that physical and social anhedonia proved to be independent factors with interfactor correlation of .04 for males and .12 for females is in contrast with the correlation of .60 for males and .51 for females reported by Chapman, Chapman and Raulin (1976) in their original standardization study.

The position of factor C (cautiousness) is at the moment ambiguous and without further work it would be difficult to say whether it should be considered as a dimension of schizotypy or whether it could be related to the Eysenck's P scale.

These analyses resulted in a new shortened scale (containing 28 items) for the identification of individuals with schizotypal personality characteristics. The shortened version of the questionnaire was applied by Calev, Venables and Monk (1983) to a group of normal subjects to be selected for a verbal memory test. They found that high scorers on the combined PA and SA (physical and social anhedonia) scales showed a memory deficit similar to that shown by schizophrenic subjects. It has also been reported by Calev (unpublished data), that the SZ scale as well as the three scales combined, are capable of distinguishing subjects with mentally ill relatives from those with normal relatives.

In a recent study by Raine (1987) the external validity of the shortened version questionnaire was assessed against the scales of schizotypal personality disorder (SPD) and borderline personality disorder (BPD) as defined in DSM-III. In this study the scores of a group of prisoners, for the SPD and BPD were intercorrelated with 10 scales of schizoid personality. The SZ scale was one of

the scales which correlated highly with SPD as was the perceptual aberration scale. No significant correlations were found between anhedonia scales and SPD and BPD which implies that the anhedonia scale measures a different type of schizophrenic tendency.

In conclusion the results of the factor analyses of the questionnaire measure of schizotypy are consistent with the hypothesis that there might be different subtypes of schizotypy which correspond with distinct disorders within schizophrenia.

Chapter 6

METHODS AND PROCEDURES

Three groups of subjects were selected on the basis of their scores on the new version of the questionnaire. The selection of subjects was based on the scores that they obtained on the schizotypy and physical anhedonia scales. Therefore, the first group of subjects consisted of those who had high scores on the SZ scale. The second group of subjects were those who scored highly on the PA and the third group, who served as the control subjects, consisted of those with the lowest overall scores. Only 3 subjects scored highly on the social anhedonia scale, therefore it was decided not to include the social anhedonic subjects in the study and consequently the 3 social anhedonia subjects were dropped. The total sample used in this study consisted of 42 subjects in three groups, comprising of 15 subjects who were high scorers on the SZ scale, 12 subjects who scored highly on the physical anhedonia scale and 15 control subjects. The groups were selected from the screening of 470 subjects who completed the questionnaire. The 42 selected subjects were mainly undergraduate and postgraduate students at York University. Subjects ranged in age from 21 to 30 and comprised of a total of 19 females and 23 males.

Throughout this study the high scorers on the SZ scale are referred to as schizotypics, the high scorers on the

physical anhedonia scales are called anhedonics and the low scores on these scales are referred to as control subjects. The anhedonic group composed of 6 females and 6 males, the schizotypics were made up of 6 females and 9 males and the control subjects consisted of 7 females and 8 males. No anhedonics or schizotypics scored highly on both of the scales. As far as possible the control subjects were matched with the high scoring groups for age and sex. All subjects had either normal or corrected-to-normal vision. Table 6 presents the subjects characteristics

Table 6
SUBJECTS CHARACTERISTICS

Subjects	No. of subjects	Age (in years)	
		Mean	SD
Anhedonics			
Females	6	24.33	3.01
Males	6	23.83	2.91
Schizotypics			
Females	6	25.43	1.72
Males	9	24.66	1.58
Controls			
Females	7	26.12	2.10
Males	8	25.42	2.69

HYPOTHESES

This section presents a summary statements of the hypotheses that will be considered in detail in relevant sections where the literature on which they are based will be reviewed.

In the present study it was hypothesized that individuals who score highly on the questionnaire measures of schizotypy might show psychophysiological and behavioural characteristics similar to those of schizophrenics. Two aspects of schizotypy were examined in this study; physical anhedonia (described as a lack of ability to experience physical pleasure) and schizophrenism (characterized by e.g. cognitive and perceptual disorders). On the basis of the results of the orthogonality of the SZ and physical anhedonia scales of the questionnaire employed in the present study, it was hypothesized that physical anhedonia and schizophrenism might form two independent dimensions of schizotypy and therefore, it was hypothesized that the high scorers on the physical anhedonia scale might exhibit characteristics which are different from the high scorers on the schizophrenism scale.

On the basis of previous findings of psychophysiological studies of schizophrenics and individuals at risk for schizophrenia, it was hypothesized that high scorers on the physical anhedonia scale might

show a low degree of responsivity to simple non-signal stimuli and a lack of heart rate orienting behaviour, whereas the high scorers on the SZ scale would be over responsive and might produce responses of larger amplitude with short latencies and short recovery times as well as a disorder of habituation of SC responses similar to that shown by schizophrenics and children at risk who have had schizophrenic breakdown. It was also hypothesized that schizotypics might show a tendency to produce responses of larger amplitude to high intensity stimuli than the control subjects.

Using evoked potential indices of the early (N1) and the late (P3) stages of information processing (stimulus set and response set), it was hypothesized that individuals with schizotypic personality characteristics might show a disorder of filtering or stimulus set indexed by the amplitude of the N1 component and a deficit of pigeon-holing or response set indexed by the amplitude of the P3 component. On the basis of previous CPT findings of schizophrenics and individuals vulnerable to schizophrenia it was assumed that the schizotypics and anhedonics might show a deficit of performance on the target detection of the continuous performance test.

On the basis of previous behavioural studies of schizophrenia it was hypothesized that the reaction time of

the individuals with schizotypic tendencies might be slower than that of the control subjects.

It was hypothesized that individuals with schizotypic tendencies would have significantly more difficulty in switching their attention across sensory modalities. It was also hypothesized that increases in the task complexity might affect the reaction time performance of schizotypics and anhedonics and finally that individuals with schizotypic personality might be more distractable in the presence of irrelevant distracting stimuli than the control subjects as is the case for schizophrenics.

Chapter 7

PSYCHOPHYSIOLOGY

Psychophysiology is extensively used in research in schizophrenia and is regarded as having the advantage of being free from the effects of factors such as schizophrenics' lack of motivation.

Most psychophysiological recordings are analyzed in terms of three types of activities; 'tonic' activity which is often referred to as background level of activity and is always present, 'phasic' activity or evoked responses which are discrete responses to specific stimuli, and 'spontaneous fluctuations' which refers to the non-specific changes that occur in the absence of any identifiable stimulus.

The psychophysiological measures employed in the present study are; skin conductance response (SCR), heart rate (HR) and event related potentials (ERPs).

SKIN CONDUCTANCE

In recent years skin conductance studies have been a major area of research in schizophrenia and have resulted in a considerable amount of well established findings. Skin conductance involves methods and techniques for recording the electrical activity of the skin by applying a small constant voltage across a pair of electrodes placed

on the fingers. The electrical activity of the skin reflects the activity of the eccrine sweat glands, densely distributed at the surface of the palm of the hands and fingers. These activities, according to Venables and Christie (1973), are controlled by the sympathetic branch of the autonomic nervous system and provide a measure of behavioural and cognitive activation and the general state of the organism in interaction with the environment.

In the present study skin conductance is examined in relation to information processing in schizotypics and the phasic aspect of the skin conductance is the major area of concern.

The components of skin conductance which are related to the phasic aspect of responsivity are known as amplitude, latency, rise time and recovery time. Phasic increase in the SCR to low intensity stimuli is referred to as an orienting response (OR) and has motor, autonomic and central nervous system components. An OR reaction is particularly evoked in response to a novel or unexpected stimulus. OR is believed to play an important role in the facilitation of information processing and is regarded as a fundamental mechanism in attention. It has therefore, been widely examined in the study of attention in schizophrenia.

An important characteristic of skin conductance orienting is habituation which is indexed by a decrease in amplitude as a result of stimulus repetition. Moreover, an orienting response can be reevoked by any discriminable changes in a repeated series of stimuli. An explanation for the phenomenon of habituation was proposed by Sokolov (1960), and is known as the 'neural model' theory. He suggested that when a stimulus is presented for the first time, it produces an OR because of it's novelty. A neural model of the particular features of the stimulus is then formed in the central nervous system and is retained in the long term store. On subsequent presentations the stimulus is compared with it's neural model, and if it matches the stored information, repeated presentation of that stimulus fails to evoke an OR and habituation occurs.

While OR is elicited by stimuli of low intensity, the high intensity stimuli are known to generally produce a DR or defensive reflex. One characteristic of DR is that it does not habituate with the repeated presentation of stimuli.

The application of electrodermal measures in the study of schizophrenia has provided valuable data concerning the differences between schizophrenics and non-psychotics in their autonomic nervous system functioning. The concepts such as 'arousal' and 'attention' have overwhelmingly

influenced these studies. The tonic level of autonomic nervous system activity is considered to be related to arousal and the phasic responses are thought to provide a measure of attention. Changes in arousal and attention are believed to be associated with changes in the activity of the sympathetic nervous system which controls the changes in tonic and phasic electrodermal activities.

Studies of electrodermal activity in schizophrenics have produced conflicting results. A number of researchers have found that schizophrenics are electrodermal hypo-responders and exhibit no or very little responsivity to simple, non-signal stimuli of moderate intensity (e.g. Bernstein, 1970). A number of other studies have shown that schizophrenics are hyper-responders and produce high amplitude responses which show little sign of habituation (e.g. Zahn, Rosenthal and Lawlor, 1968). Subsequent to these studies Gruzelier and Venables (1972 and 1974) provided data which to some extent resolved these contradictory findings. They found that a heterogeneous group of schizophrenics demonstrated a bimodality of skin conductance responses in such a way that about half of them produced no orienting responses, and the other half exhibited responses which did not habituate. This finding was replicated by Rubens and Lapidus (1978), Gruzelier and Connolly (1979) and Gruzelier et al. (1981) and has become a matter of considerable interest.

An influential theory concerning the bimodality of responses in schizophrenics is the arousal theory. According to this theory schizophrenics, in their autonomic nervous system functioning, are either hypo- or hyper-aroused. An abnormally low level of arousal leads to hypo-responsivity. On the other hand, a very high level of arousal results in hyper-responsivity and a lack of habituation. The hypo- and hyper-responder are believed to differ in a number of important characteristics. The responders are usually acute, good premorbid and paranoid. The non-responders are chronic, poor premorbid, non-paranoid and are hypothesized to be hypo-aroused (Venables, 1964). A hyper-active pattern of SC responsivity has also been found to be the characteristic of children at risk for the development of schizophrenia.

Hypo-responsivity to low intensity, non-signal stimuli has not been found in children considered to be at genetic risk for the development of schizophrenia, but it appears to be present in the schizotypics who score highly on the physical anhedonia scale (Simons, 1981). Bearing in mind that it has been shown that only some schizophrenics are anhedonic and anhedonia is not seen in all schizophrenics (Chapman, Chapman and Raulin, 1976), it is likely that the anhedonic group are also the ones who are skin conductance non-responders.

Recently Ohman (1981) in an extensive review of skin conductance studies of over 30 independent samples involving nearly 1000 schizophrenic patients found that on average about 40 percent of schizophrenics can be classified as skin conductance non-responders. In a further review by Bernstein et al. (1982) skin conductance data from six independent studies collected in four countries were examined. In these studies the statistical procedures used for data analysis were all the same. A common finding of nearly all of these studies was that about 50 percent of the schizophrenics were skin conductance non-responders compared with 5 to 10 percent of normals. However, the finding of Gruzelier and Venables (1972) that schizophrenic patients who were not non-responders may be thought of as non-habitulators has not had the same degree of unanimity.

Since the skin conductance orienting is believed to be associated with the allocation of information processing capacity to external stimuli (Ohman, 1979), the abnormal skin conductance orienting behaviour of schizophrenics could be a reflection of a disorder of information processing and an abnormality of their arousal mechanism. As stated by Venables (1964) a high level of arousal is believed to be associated with an abnormally narrow range of attention and a low level of arousal associated with an excessively wide range of attention.

The limbic system and orienting behaviour

It is suggested that electrodermal activity is partly controlled by the limbic system (e.g. Venables and Christie, 1973). The term limbic system refers to the brain tissues which lie in the rhinencephalon and create a ring in the inner surface of each cerebral hemisphere. The limbic system consists of a group of cerebral structures comprising of amygdala, hippocampus, septal area and the cingulate gyrus. Stimulation or ablation of parts of the limbic system are known to affect many types of behaviour such as attention and avoidance behaviour. Evidence from animal studies suggest that monkeys with lesions of the amygdala demonstrate a hypo-responsivity of skin conductance responses (Bagshaw, Kimble and Pribram, 1965). Animals with lesions of the hippocampus, on the other hand, are known to exhibit hyper-responsivity of skin conductance responses. Gruzelier and Venables (1972) on the basis of the evidence from the work with animals suggested that the bimodality of electrodermal responsivity could be attributed to disturbance of the limbic system in schizophrenics. They stated that non-responsivity could be due to the dysfunction of the amygdala and hyper-responsivity may result from disturbance of the hippocampus.

Skin conductance recovery time

Another parameter of skin conductance which is relevant to the study of schizophrenia is the length of the skin conductance recovery time. In a review of studies of skin conductance recovery time in schizophrenics, Venables (1974) reported that schizophrenics produced responses of both short and long recovery times. Long recovery of SC appears to be the characteristic of those schizophrenics who are electrodermal minimal responders (fast habituators), as reported in a study by Patterson (1976b). Moreover, in a study by Maricq and Edelberg (1975) a group of schizophrenics were classified as 'process' schizophrenics on the basis of their scores on 'Plexus Visualization' (a test believed to distinguish between different subtypes of schizophrenics on the basis of their rating of blood capillary patterns of the nailfold, Maricq, 1970). These subjects produced a long recovery of skin conductance responses.

In addition schizophrenics are found to exhibit a short recovery of skin conductance responses (Ax and Bamford, 1970; Gruzelier and Venables, 1972; Zahn, Carpenter and McGlashan, 1976). The high risk children who later had schizophrenic breakdown as reported in a study by Mednick and Schulsinger (1968) as well as the subjects classified as schizotypics by Nielsen and Petersen (1976)

were found to show short recovery of skin conductance responses.

In an animal study by Bagshaw, Kimble and Pribram (1965) mentioned earlier, it was found that animals with lesions of the hippocampus who were electrodermal hyper-responders also produced shorter skin conductance recovery times than control animals.

Venables (1974) suggested that the different lengths of recovery time could be associated with 'openness or closedness' to the environment. Short recovery of SC responses could indicate an exceptional openness to environmental stimulation and long recovery is an index of closedness to the environment. Short skin conductance recovery, he suggested, reflects a too wide range of attention and an inability to filter environmental stimulation, whereas long recovery is an indication of too narrow a range of attention.

Skin conductance in children at risk for schizophrenia

As mentioned previously the psychophysiological data from the Copenhagen project (Mednick and Schulsinger, 1968) reported that children of chronic schizophrenic mothers produced SC responses of high amplitude, short latency and short recovery times to high intensity unconditioned stimuli (UCS). They also had higher skin conductance levels and showed greater SC conditioning which showed resistance to extinction. Van Dyke et al. (1974) also reported higher response amplitudes and higher response frequency in children of process schizophrenic mothers or fathers who were brought up by nonschizophrenic foster parents compared with control children. Studies by Janes and Stern (1976) and Erlenmeyer-Kimling (1975), however, did not replicate Mednick's findings. It is of interest to note that in the data reported by Erlenmeyer-Kimling et al. (1979) children of schizophrenic mothers showed a slightly faster recovery rate than the low risk children whereas, children of schizophrenic fathers showed a rather slower recovery rate.

In an attempt to replicate the findings of the Copenhagen study, Klein and Salzman (1977) employed a series of experiments which closely resembled those of the Copenhagen study. They examined autonomic habituation, conditioning and generalization in children of

schizophrenic and schizoaffective mothers. Their data were collected from a subsample of 42, ten year old children, twelve of whom had at least one parent with the DSM-II diagnosis of schizophrenia. The comparison group consisted of 30 children who had parents with non-schizophrenic illnesses (affective neurosis and personality disorder). The results partially replicated Mednick's findings. They found a higher skin conductance responsivity to unconditioned stimuli UCS and a greater conditioning in the children of schizophrenic mothers. There was, however, no evidence of any differences between the groups in SCR habituation or recovery times for the sample of high risk children used. Prentky, Salzman and Klein (1981), using the SC paradigm as above examined skin conductance in a group of 7 years old children of schizophrenic parents who had a DSM-III diagnosis of schizophrenia or schizoaffective disorder and a group of control subjects who consisted of children of parents with nonpsychotic disorders. The results showed that children of schizophrenic parents demonstrated significantly larger SC responses to the high intensity UCS compared with the control groups. Once again the SC recovery time did not differ among groups. It ought to be mentioned that although the results of the Prentky et al. (1981) study failed to replicate some of Mednick and Schulsinger's findings, it confirmed that larger SCR in response to UCS and better SCR conditioning were characteristics of children at risk for schizophrenia.

Although most of the electrodermal studies of children at risk, mentioned above, indicate a hyper-responsivity of autonomic activity in high-risk children, there is a lack of consistency in the results concerning other parameters of electrodermal responses. Methodological differences among the various studies such as subjects' age, chronicity of illness in the parents and diagnostic criteria employed for schizophrenia might account for the variability in the results.

Skin conductance in schizotypics

Schizotypics have also been found to exhibit abnormalities of autonomic responsivity. In a study of individuals identified as schizotypics conducted by Nielsen and Peterson (1976), a group of female subjects were selected on the basis of their scores on the schizophrenism (S) scale. The schizophrenism scale was constructed on the basis of the types of behaviour described by Chapman (1966) as being the characteristics of schizophrenics who are at pre-morbid or at an early stage of schizophrenia.

Nielsen and Petersen (1976) administered the schizophrenism scale together with the extroversion (E) scale, the neuroticism (N) scale and the anxiety (A) scales from the EPI questionnaire by Eysenck and Eysenck (1967) to a group of female subjects. The subjects then took part in an experiment in which electrodermal orienting and

conditioning in response to auditory stimuli of moderate and high intensities were tested. The high schizophrenism subjects showed a pattern of electrodermal responsivity similar to that shown by high risk sample in Mednick and Schulsinger's (1968) study. They exhibited responses of large amplitude with fast recovery times to high intensity stimuli and also showed a disorder of habituation. The correlation studies of the scores on the questionnaires and the electrodermal data revealed that high scores on the S scale correlated significantly with the high amplitude of SC responses. The anxiety and neuroticism scales on the other hand, did not have a significant correlation with the amplitude of SCR. Additionally the neuroticism scale correlated significantly with the skin conductance level, whereas no significant correlation was found between the S scale and the skin conductance level. On the basis of these findings Nielsen and Petersen concluded that the hyper-responsivity of SCR, and high schizophrenism might be associated with attentional features such as high sensory receptivity. Another important finding of this study was a highly significant correlation between the schizophrenism scale and the fast recovery of skin conductance responses. As mentioned before, the children of schizophrenic mothers who later had schizophrenic breakdown, tested by Mednick and Schulzinger (1968) were most distinctively distinguished from the low risk subjects on the basis of their fast SC recovery time. This finding provided support

for the schizophrenism scale as a measure of predisposition to schizophrenia.

Another psychophysiological study of individuals with schizotypic personality is one carried out by Simons (1981). He selected three groups of subjects consisting of young adults; one group scored high on Chapman's scales of physical anhedonia, a second group had high scores on the perceptual aberration scale and a third group were control subjects. In this study Simons examined the electrodermal and heart rate orienting and habituation responses of these three groups in response to auditory stimuli. He hypothesized that anhedonic and perceptual aberration subjects would show psychophysiological characteristics similar to those shown by schizophrenics. That is, a bimodality of skin conductance responses which was reported by Gruzelier and Venables (1972) to be a characteristic of schizophrenics.

In this study Simons (1981) hypothesized that anhedonics would be expected to demonstrate a hypo-responsivity of skin conductance and heart rate, whereas the perceptual aberration subjects would be hyper-responders. This study was therefore designed on the assumption that anhedonia and perceptual aberration are two independent aspects of schizotypic personality characteristics.

The results of this study supported parts of Simons' hypotheses. The data provided evidence for an orienting deficit in the anhedonic subjects similar to that observed in the hypo-responsive schizophrenics. There was a significantly greater incidence of non-responsivity and a faster habituation of skin conductance among anhedonics compared with control subjects. This finding was also in line with heart rate orienting data, in which anhedonic subjects showed less primary and secondary deceleration compared with control subjects.

Simons' results however, did not support the hypothesis that perceptual aberration subjects are electrodermal hyper-responders. Perceptual aberration subjects demonstrated normal skin conductance and heart rate orienting responses in this study.

From the findings of the psychophysiological studies of individuals identified as schizotypics, mentioned above, it may be suggested that it is possible to categorize schizotypics into autonomic responders and non-responders, with anhedonics being hypo-responders and subjects with high scores on the schizophrenism scale being hyper-responders. As mentioned previously, it was suggested by Crow (1980) that negative and positive symptoms might be related to separate underlying causes of schizophrenia. The electrodermal findings of schizotypics mentioned above

therefore, makes it possible to hypothesize that these two presumably different types of schizotypy might be related to two different subtypes of schizophrenia. In support of this hypothesis it could be pointed out that apart from their autonomic functioning, anhedonics and high schizophrenism schizotypics are known to differ in the types of symptoms that they exhibit. For example, it is reported that anhedonics display the type of symptoms shown by 'process' schizophrenics and mainly exhibit negative symptoms. This is in line with the findings by e.g. Gruzelier (1976) and Straube (1979) who reported that schizophrenic non-responders commonly show negative symptoms such as; emotional withdrawal, conceptual disorganization and disorder of affect, whereas responders are characterized by manic state, anxiety and attention-demanding behaviour. Therefore, the findings of skin conductance hyperactivity in children of schizophrenic parents might be related to a different form of vulnerability to schizophrenia.

From the above, it may be concluded that it can be hypothesized that anhedonia and schizophrenism might form two dimensions within the schizotypic personality characteristics and form two distinct subtypes of schizotypy, each group being different from the other in their behavioural and psychophysiological characteristics.

Method and procedure

This section concerns the recording of skin conductance and heart rate from 42 subjects selected as schizotypics, anhedonics and control subjects.

Skin conductance was recorded using the bipolar method of electrode placements i.e. both electrodes were placed on active sites. Beckman miniature silver/silver chloride disc electrodes of 1 cm in diameter were used. This type of electrode shows a minimal bias potential between pairs of electrodes at the interface between electrode and electrolyte. The electrolyte consisted of 0.5% Potassium Chloride (KCl) in 2% agar-agar. The electrodes were attached to the second phalanges of the first and second fingers of the right and left hands. These areas are the best recording sites because of the high concentration of eccrine sweat glands and because their use involves few movement artifacts.

The electrode sites were cleaned with warm water and the electrodes were attached using double sided adhesive masks, exposing an area of skin of .45 cm diameter. This was done to control the size of the skin area which comes into contact with the electrode. The electrodes were then filled with electrolyte and were fastened in place using adhesive tape. Skin temperature was recorded from

thermistors attached to the proximal phalanges of the forefingers of both hands in order to examine the skin conductance responsivity in relation to skin temperature. Skin conductance was measured directly using a constant voltage system (Lykken and Venables 1971).

Skin conductance was recorded using a Grass Model 79D Polygraph in conjunction with a 7P1 preamplifier. The recording of skin conductance was carried out using a system referred to as ASCBOS (Active Skin Conductance Back Off System). The ASCBOS consisted of an active skin conductance measurement coupler, which worked with an automatic 'backing-off' device. The active skin conductance coupler received the input from the subject electrodes. Following necessary attenuation, the subject input from the coupler was fed into the polygraph input. One side of the subject input was fed into the auto backing-off or suppression device, the output of which was fed into one side of the polygraph input. This provided a polygraph record in which the skin conductance level was automatically suppressed.

The gain settings of each channel of this system were adjustable. The normal setting used is 1 μ mhos/volt. In cases when an increase in sensitivity was necessary during the experiment, adjustment was made after response recovery and prior to the occurrence of the next trigger pulse. In

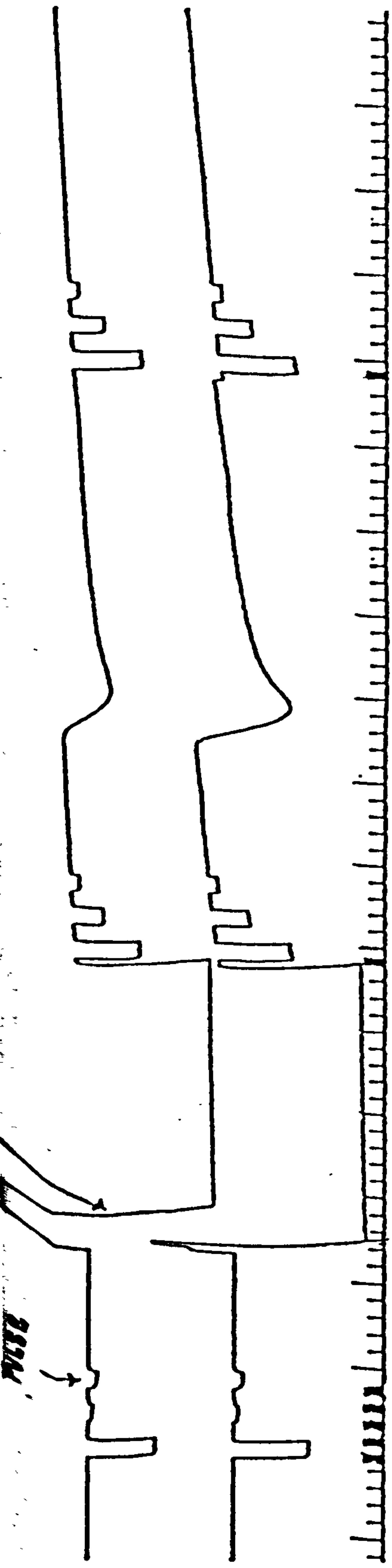
order that the gain of the system could be identified by the computer a standard calibration pulse was fed into the input channel of the polygraph. Skin conductance was recorded in response to auditory stimuli using an auditory tape played from one channel of a Tandberg tape recorder and were presented binaurally through headphones. Trigger pulses which were related to stimulus onset were recorded on another channel of the Tandberg tape recorder.

At the onset of the recording and prior to the occurrence of the first stimulus, five identifying trigger pulses of 1 second duration at 1.5 second intervals were introduced. These trigger pulses were recorded on one channel of the Tanberg tape recorder and were employed to identify the onset of the skin conductance data. Immediately following the appearance of the five identifying trigger pulses the input switch of the skin conductance channel was turned to the 'subject' position. This connected the subject directly to the input from the amplifier. Subsequent triggers delivered a set of three pulses which were related to the subjects' skin temperature, skin conductance level and skin conductance response gain. These trigger pulses occurred prior to the onset of each trial.

Figure 1 presents a skin conductance response waveform constructed from the skin conductance level and the skin temperature.

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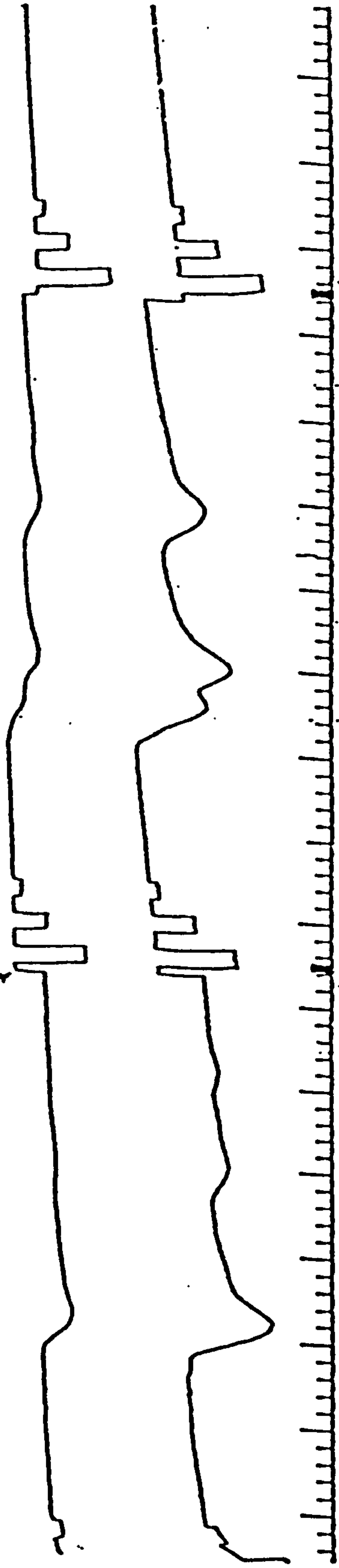


Figure 1. An example of a skin conductance response waveform
(constructed from the skin conductance level and the skin
temperature).

Two channels of skin conductance and skin temperature were simultaneously recorded without the need to employ a further channel for the recording of skin temperature. An additional polygraph channel was also used to record the trigger pulses related to the onset of each stimulus.

The two channels of skin conductance data and the trigger channel were connected to a Racal magnetic tape recorder to store the skin conductance data and signals related to the stimulus onset prior to the computer analysis of data. The Racal speed was set at 3.75 ins/sec.

The subjects sat in a sound and light attenuated, temperature controlled room separated from the recording equipment and were then given information about the experiment. They were instructed that following a short period of silence they would hear a number of tones and would be expected to sit and listen to them. They were requested to relax and to remain as still as possible throughout the experiment. Identical instructions were given to all the subjects.

STIMULUS PRESENTATION

The stimuli used for the measurement of skin conductance and heart rate consisted of an auditory tape containing 39 tones. This stimulus tape was designed by Venables et al (unpublished) to be used in the Mauritian longitudinal risk study of 1800 three year old children. Venables based the selection of these stimuli on the procedures used in the electrodermal studies in which a similar paradigm had been successfully used in the studies of adult schizophrenics and children at risk for schizophrenia such as the Copenhagen risk study by Mednick and Schulsinger (1968).

A list of the 39 auditory stimuli and details of their characteristics are presented in Table III which is folded in Appendix B.

Of the 39 stimuli used those that are relevant to the purposes of the present study were as follows.

Stimuli 1 to 3 which consisted of tones of 1000 Hz and 75 dB intensity. The inter-stimulus intervals for these three trials ranged from 35 to 42 msec. These trials were used to test orienting and habituation of skin conductance responses.

Stimuli 4 to 12 which were a set of 9 identical trials with a frequency of 1311 Hz and intensity of 75 dB. The inter-stimulus intervals for this set of trials ranged from 36 to 50 msec.

Stimuli 13 to 15 were tones of 500 Hz and 75 dB intensity with inter-stimulus intervals ranging from 35 to 50 msec. For all of the above trials the rise time was 25 msec and the stimulus duration was 1 sec. These trials aimed at examining re-orientation and re-habituation of responses.

Trials 16, 18, 20, 23, 24, 25 which were consonant vowels (CVs) of 75 dB intensity with 360 msec duration. These stimuli were interspaced with 3 other tones and were used in order to test OR and habituation to 'speech like' stimuli as well as to maintain responsivity. All of the above tone sequences had the characteristics to elicit orienting rather than defensive responses.

Finally stimuli 28-39 consisted of some intense 90 dB stimuli of fast rise time, presented with the aim of evoking defensive responses. These were interspaced with 75 dB stimuli for comparison purposes. The frequencies of the tones were 4000 and 550 Hz and 4 of the stimuli were of 'white noise'.

The duration of the experiment was approximately 30 minutes. The experiment started with an adaptation period of 5 minutes of silence.

SCR DATA REDUCTION

Analogue skin conductance data stored on the magnetic tape were fed into a PDP11/40 computer via an analogue-to-digital converter (A/D), to be sampled. A sampling program was used in conjunction with a sequence file which provided information concerning the inter-trial intervals and other relevant details of the auditory stimuli.

Sampling started at 5 seconds pre- and 20 seconds post-stimulus following the appearance of the triggers related to temperature, level, and gain of the recorded data. Sampling was done at the rate of 20 Hz, giving 500 samples. The output for the 39 stimuli was stored in a file on a disk. The program offered the possibility of sampling both data channels at the same time.

The sampling of skin conductance data resulted in 39 responses from each hand and for each subject. These responses were used as input to a program which scored the SCR level, latency, amplitude, rise time, half recovery time ($t/2$) and quarter recovery time ($t/4$ recovery) for each skin conductance response. The measure of quarter recovery time (recommended by Fletcher, Venables and Mitchell, 1982)

has been useful when the half recovery time is interfered with by additional responses prior to a full recovery of SCR amplitude to the baseline.

The next stage consisted of the display of the skin conductance response curves on the GT40 graphics system of the PDP11/40 computer in order to be scored. The scoring program allowed for the scoring of both channels of the skin conductance data at the same time. The data were displayed trial by trial from the stimulus onset to 20 seconds post-stimulus and a hand held box was used for scoring the skin conductance data by moving a cursor and by pressing an appropriate button. The data were displayed directly in μmhos for the levels and amplitude of the responses and in seconds for the temporal variables.

The output of the scoring process was a file containing values of skin conductance level, skin conductance response latency, amplitude, rise time, and quarter and half recovery times for each response and for each hand. The skin conductance response level (SCL) was defined as changes in the levels that are not immediately related to discrete stimulus events and were sampled at 5 seconds pre-stimulus. The SCR amplitude was defined as an increase in conductance greater than $.03 \mu\text{mhos}$ occurring within a latency window of 1-3 seconds post-stimulus. These criteria were used in order to distinguish the skin

conductance responses from the 'spontaneous' responses. The recovery times were recorded as half and quarter of the time during which the responses recovered to the pre-stimulus level. The data were then transferred on to the University's Dec 10 computer for further analysis.

DATA ANALYSIS

Skin conductance

The skin conductance variables which are the concern of the present study are; skin conductance level, latency, amplitude and recovery time. In this study the analysis of SC responses were concentrated on trials considered to represent orienting, re-orienting and habituation of the SCR amplitude, latency and recovery time. Skin conductance responsivity to a group of loud (90 dB) tones expected to elicit defensive responses were also examined in this study. It was discovered at this stage that due to a design fault in the apparatus used there was an interaction between the two channels recording the skin conductance data such that constant voltage was not fed to each channel independently. Therefore, only the skin conductance data from the right hand were included in the data analysis. The technical fault might also have affected the accuracy of the data obtained for the skin conductance level.

A plot of the means of the skin conductance response amplitudes in μmhos for the 39 trials, for the control subjects, are presented in Figure 2 in order to give an overall picture of the responses. The X axis represents the 39 stimuli and the Y axis shows the means of the amplitude of the responses in μmhos .

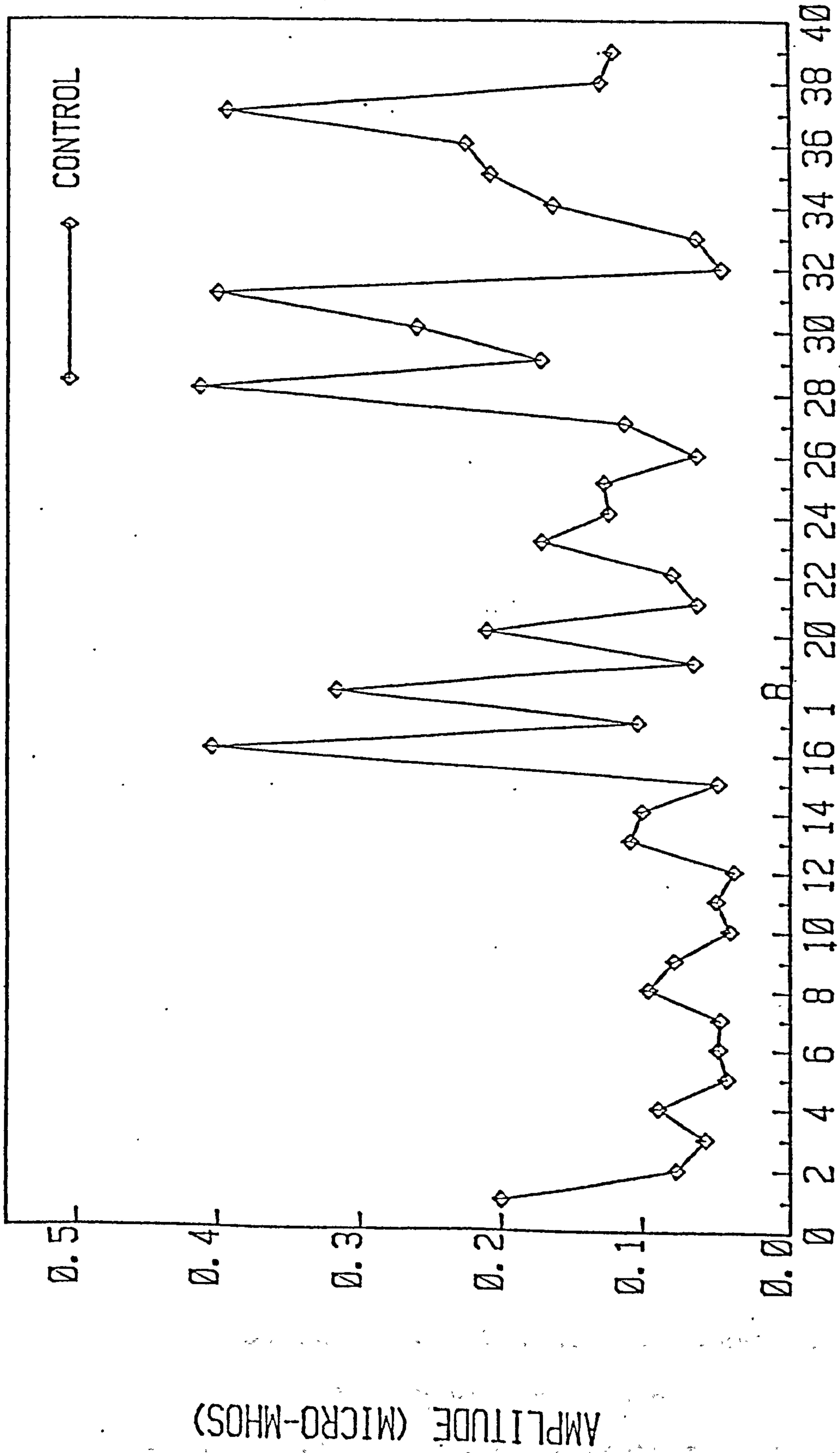


Figure 2. The amplitude of skin conductance responses obtained for control subjects in response to 39 stimuli.

Correlation studies of SC parameters

In order to correlate the skin conductance variables with each other, correlation coefficients were computed between the SC variables using the first tone of each stimulus sequence i.e. trials 1, 4, 13, 16, 28 and 30 representing; orienting and re-orienting trials, a CV trial, a high intensity tone and a white noise stimulus.

Results

Correlation between SC Level and Latency

Correlations were computed between SC level and latency responses for each group of subjects. The results showed that for the control group the correlations for 3 out of the 6 stimuli were significant (trials 1, 13 and 16) from which 2 were negatively and 1 was positively correlated. For the anhedonic group only trial 1 ($r = -.54$) and for the schizotypics trial 13 ($r = .52$) showed a significant correlation between these two measures. The results for the 6 trials and for the 3 groups of subjects are presented in Table 7. SCL refers to skin conductance level, Lat refers to latency, Mag refers to magnitude and t/4 Rec refers to quarter recovery time.

Correlation between SCL and SCR magnitudes

Correlations between SCL and SC response magnitudes showed significant coefficients for all of the trials with the exception of trial 13 for the control group and trial

30 for anhedonics. Overall the results showed that skin conductance level and skin conductance response magnitude were positively and significantly correlated which indicates that there is a regular relationship between these measures. These correlations are presented in Table 7.

Correlation between SCL and t/4 recovery

As shown in Table 7 there were significant correlations between SCL and t/4 recovery for the control group for trials 16 and 28. There were also significant correlations between these two variables for anhedonics (trial 28) and for schizotypics (trial 13).

Correlation between Latency and SCR magnitude

There were only two significant correlations between latency and magnitude i.e. for trial 13 for the schizotypic group and for trial 28 for the anhedonic group. In general, while the direction of the majority of these correlations was negative (Table 7), there were no significant correlations between these two measures for most of the trials.

Correlation between Latency and t/4 recovery

Correlation between latency and t/4 recovery showed that there was in no case any significant correlation between these two variables for any of the trials, which

Table 8

Correlation of SCR variables for the anhedonic group

	SCL/Lat	SCL/Mag	SCL/Rec	Lat/Mag	Lat/Rec	Mag/Rec
S1	-0.52*	0.55*	0.05	0.39	0.36	0.38
S4	0.16	0.66**	-0.15	-0.09	0.22	0.05
S13	-0.09	0.78***	-0.32	0.05	-0.14	0.04
S16	-0.29	0.53*	0.20	-0.16	-0.06	0.30
S28	0.40	-0.61*	0.63*	-0.70**	0.12	-0.45
S30	-0.13	0.27	0.04	-0.32	-0.29	-0.17

Correlation of SCR variables for the schizotypic group

	SCL/Lat	SCL/Mag	SCL/Rec	Lat/Mag	Lat/Rec	Mag/Rec
S1	-0.25	0.58*	-0.26	-0.28	0.32	-0.04
S4	-0.19	0.59*	0.04	0.20	0.16	0.19
S13	0.54*	0.79***	0.58*	0.55*	-0.03	0.39
S16	-0.16	0.53*	0.14	-0.08	-0.29	0.18
S28	-0.33	0.69**	-0.27	-0.16	-0.10	-0.12
S30	-0.07	0.55*	-0.10	-0.07	0.17	-0.05

Correlation of SCR variables for the control group

	SCL/Lat	SCL/Mag	SCL/Rec	Lat/Mag	Lat/Rec	Mag/Rec
S1	-0.61*	0.69**	0.40	-0.29	-0.22	0.37
S4	0.30	0.54*	0.29	0.14	-0.05	0.22
S13	0.56*	0.60*	0.31	-0.06	-0.31	0.06
S16	-0.58*	0.70**	0.56*	-0.27	-0.16	0.40
S28	-0.13	0.65**	0.69**	0.32	0.03	0.32
S30	-0.10	0.52*	-0.11	-0.12	0.24	-0.33

* P<.05, ** P<.01, *** P<.001

indicated that latency and recovery time are independent of each other.

Correlation between SCR magnitude and t/4 recovery

No significant correlations were found between the SCR magnitude and t/4 recovery for any of the groups and for any of the trials. The results are presented in Table 7 and indicate that SCR and recovery time are independent measures.

In summary the results of correlations between different SC variables showed that the correlation between SCL and SCR was significant with consistency across almost all of the trials. The results of the correlation between SCL and t/4 recovery showed a relationship between these two variables only for some of the trials. Correlation between SCL and latency also showed some indication of a relationship between these two variables though, these results showed no consistency across all the trials.

Skin conductance level

Previous studies have shown that the difference in skin conductance responses between groups could be attributed to the law of initial values (LIV). That is, the SC responses depends on the pre-stimulus level from which they are measured. Therefore, the differences in the SC level between groups were examined using analysis of variance with trials as a within subject variable. The trials selected for the analysis consisted of the first tone of each stimulus sequence i.e. trials 1, 4, 13, 16, 28 and 30. The skin conductance level values were first subjected to a log transformation as they were highly skewed. Analysis of variance was then carried out on the skin conductance levels of the groups with trials a within subject variable. A significant difference was found between the skin conductance level of the groups ($F = 2.29$, $P < .01$). The means in μmhos , standard deviations, F ratios and P values of the skin conductance levels for the selected trials and for the 3 groups of subjects are presented in Table 8. The means are graphically presented in Figure 3. As a significant difference between the skin conductance level data for the 3 groups was found, it was decided to examine the SC responses using analysis of covariance with the SC level as the covariate. However, it should be pointed out that due to a technical fault in the apparatus used for recording skin conductance responses,

Fig 3 Skin conductance level
(micro-mhos)

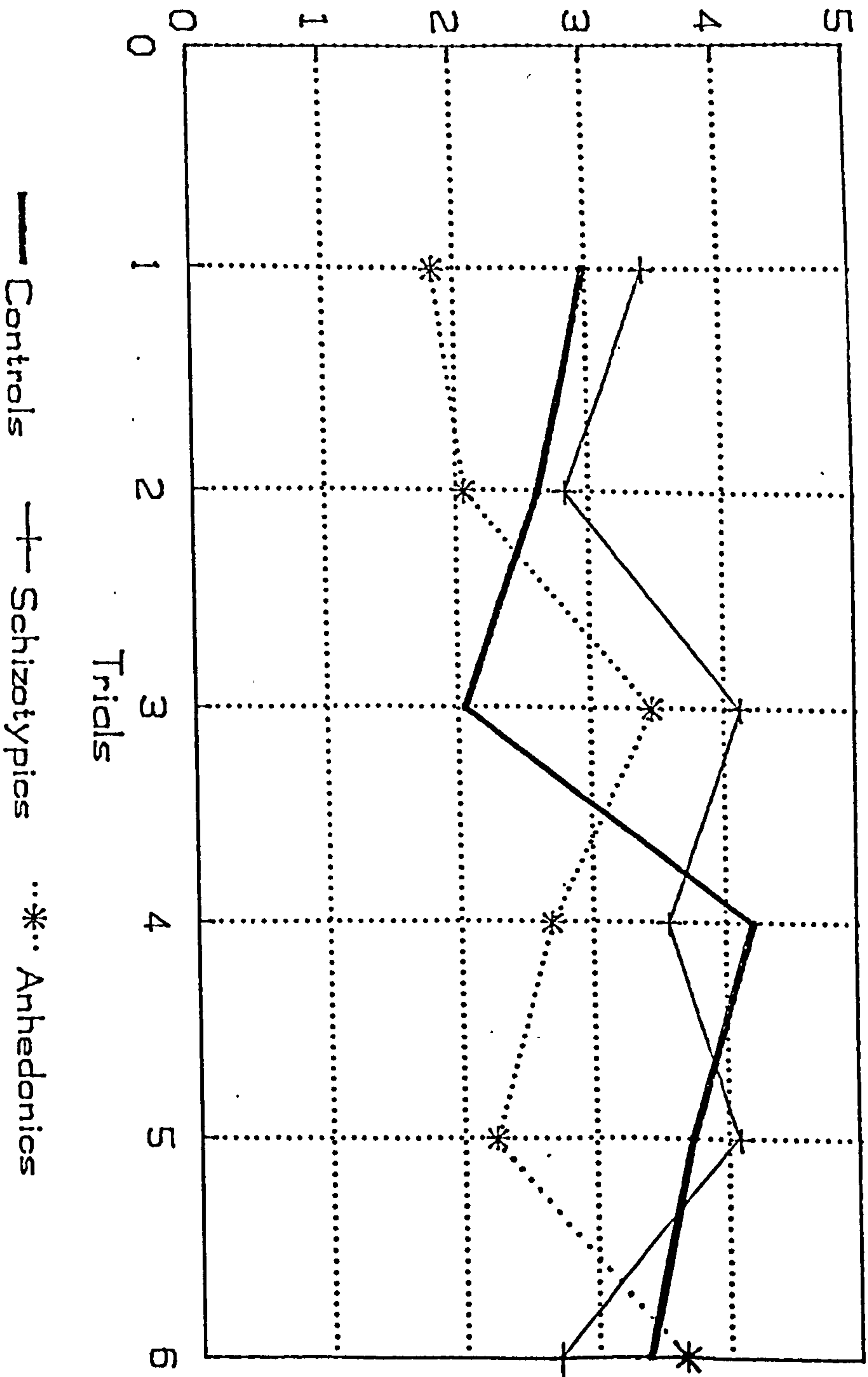


Table 8

The SCL for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls	
	M	(SD)	M	(SD)	M	(SD)
S1	1.83	(1.46)	3.42	(2.27)	2.98	(1.45)
S4	2.06	(1.50)	2.85	(1.98)	2.62	(1.47)
S13	3.48	(2.21)	4.15	(3.11)	2.05	(1.21)
S16	2.69	(1.50)	3.56	(2.35)	4.20	(1.73)
S28	2.25	(1.42)	4.08	(3.28)	3.72	(1.34)
S30	2.72	(1.17)	3.67	(3.22)	3.38	(1.77)

Main effects

n. s.

Group x trials interaction

F = 2.29

P < .01

mentioned previously, there is some doubt as to the accuracy of the skin conductance level values.

Habituation of SCR trials

Trials representing habituation were identified as follows;

- a) Trials 1 - 3 consisting of a set of 3 identical trials of 75 dB, 1000Hz.
- b) Trials 4 - 12 consisting of a set of 9 successive trials of 75 dB, 1311 Hz.
- c) Trials 13 - 15 consisting of 3 successive trials of 75 dB, 500 Hz.
- d) Consonant vowel (CV) trials consisting of 6 non-successive trials. These were stimuli 16, 18, 20, 23, 24 and 25.

The above trials were chosen as they were thought to best represent habituation. A list of these trials is presented in Table III of Appendix B.

Habituation was defined as a gradual decrease in the magnitude of the SC responses from the early trials to late trials in the repeated series of tones.

The SCR magnitudes

Data analyses for the amplitude of responses were carried out on the magnitude of responses. That is, the zero responses which represented either failure to respond

or responses which were below the criterion, were included with the non-zero responses in the data analysis. This gave a measure of SCR magnitude.

The groups were compared using analyses of covariance, with the level as covariate and the trials as a within subject variable using the responses which had been converted to log values. The log transformation was performed for the magnitude of SCR as well as for the SC level in order to reduce the skewness of the distribution of the responses. To avoid the log of zero, the log transformation involved adding 1 to all the scores obtained for the magnitude of responses (a method recommended by Venables and Christie, 1980).

RESULTS

TRIALS 1 to 3

The response magnitudes of anhedonics, schizotypics and control subjects for the first 3 trials were examined using analysis of covariance with trials as a within subject variable. A significant group x trial interaction effect ($F = 4.37$, $P < .003$) was found. Group means, standard deviations together with F ratios and levels of significance for the 3 groups in response to trials 1 to 3 are given in Table 9. The means are graphically presented in Figure 4.

Fig 4 Skin conductance magnitudes
 trials 1 - 3

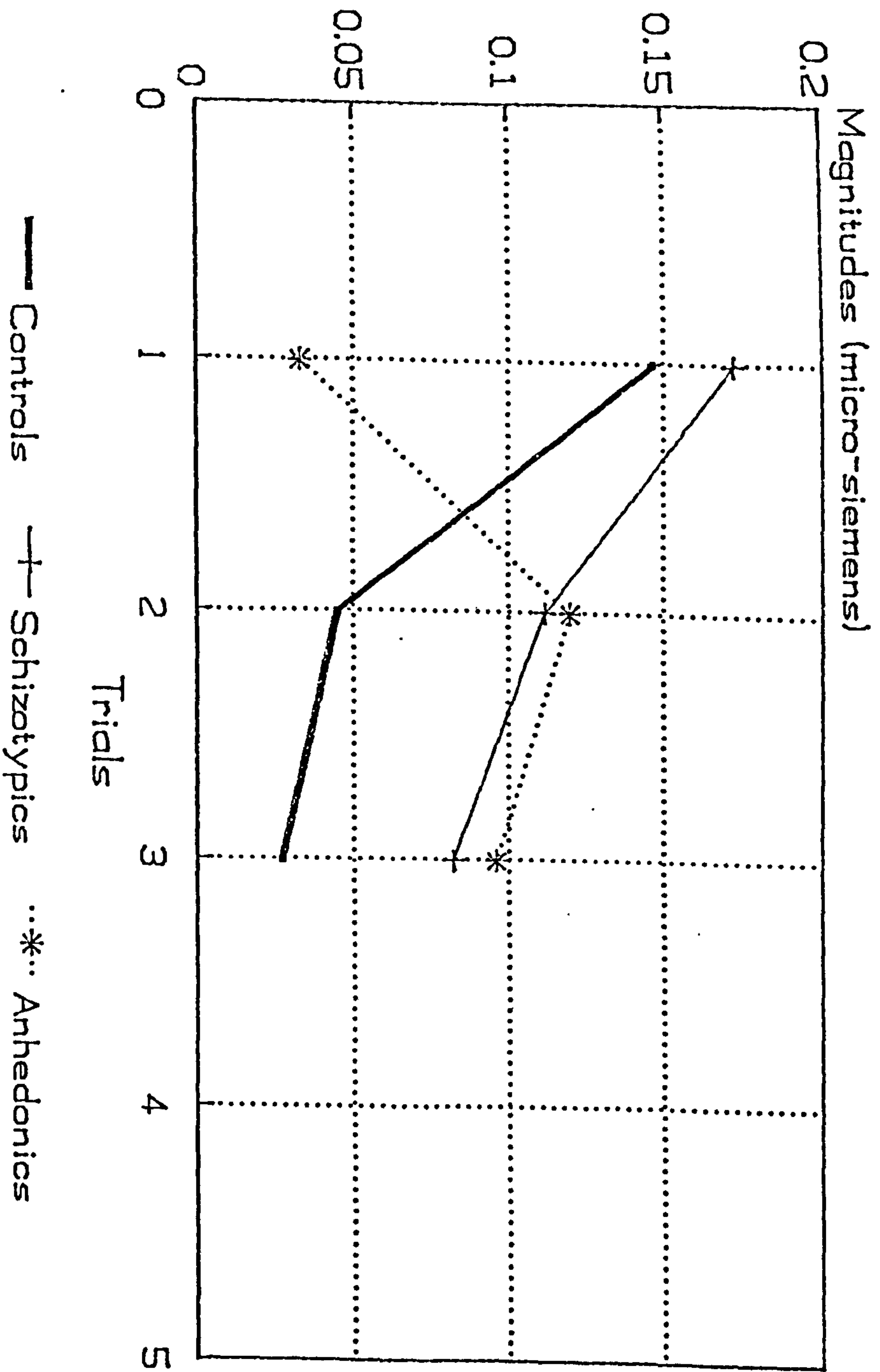


Table 9

TRIALS 1 to 3

The SC magnitudes for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S1	0.03	(0.05)	0.17	(0.22)	0.15	(0.18)	2.98	<.06
S2	0.12	(0.11)	0.11	(0.11)	0.04	(0.05)	2.80	<.01
S3	0.10	(0.10)	0.08	(0.11)	0.03	(0.05)		n.s.
Main effects								n.s.
Group x trials interaction							F = 4.37	P <.003

Visual inspection of the plots of the magnitudes of trials 1 to 3 gives the impression that the magnitudes of the responses of schizotypics and anhedonics were larger for trial 1 than those of the control group. The responses of the three groups for trial 1 were therefore subjected to analysis of covariance with the levels as covariate. The results showed only a marginally acceptable level of statistical significance between the groups for trial 1 ($F = 2.98, P < .06$).

The difference between the means of the responses of each group were then examined by a post hoc analysis, using Tukey's HSD procedure. There was no significant difference between the means of the responses of schizotypics compared with the control group. A significant difference was found between the means of the responses of anhedonics and the control group ($F = .034, P < .05$), indicating that anhedonics produced a significantly smaller magnitude of responses to trial 1. Schizotypics were found to have produced significantly larger responses to trial 1 than the anhedonics ($F = .042, P < .01$).

It is apparent from Figure 4 that anhedonics tended to give larger responses to the second rather than the first trial of this stimulus sequence. Analysis of covariance was carried out on the magnitude of responses of the 3 groups for trial 2. The result showed that the

difference between the groups approached only a marginally acceptable level of statistical significance ($F = 2.80$, $P < .07$). Post hoc analysis indicated that anhedonics produced responses of larger magnitudes compared with the control group ($F = .023$, $P < .05$). The comparison between the responses of schizotypics and control subjects showed that schizotypics produced significantly larger responses than the control group ($F = .031$, $P < .01$). No significant difference was found for the comparison between anhedonics and schizotypics for trial 2.

Analysis of covariance compared the magnitude of responses of the groups for trial 3. No significant difference was found between the groups. The results are presented in Table 9.

TRIALS 4 to 12

In the analysis of trials 4 to 12 a highly significant main effect of groups ($F = 14.02$, $P < .0001$) and a highly significant group x trials interaction effect were found ($F = 2.90$, $P < .0002$). Means and standard deviations, together with F ratios, and the levels of significance for the 3 groups in response to trials 4 to 12 are presented in Table 10. The means for the 3 groups are plotted and are presented in Figure 5. Inspection of the plots of the mean SCR magnitude data for trials 4 to 12 gives the impression that in general the magnitude of responses of schizotypics were larger than those of the control subjects. It also

Fig 5 Skin conductance magnitudes
 trials 4 - 12

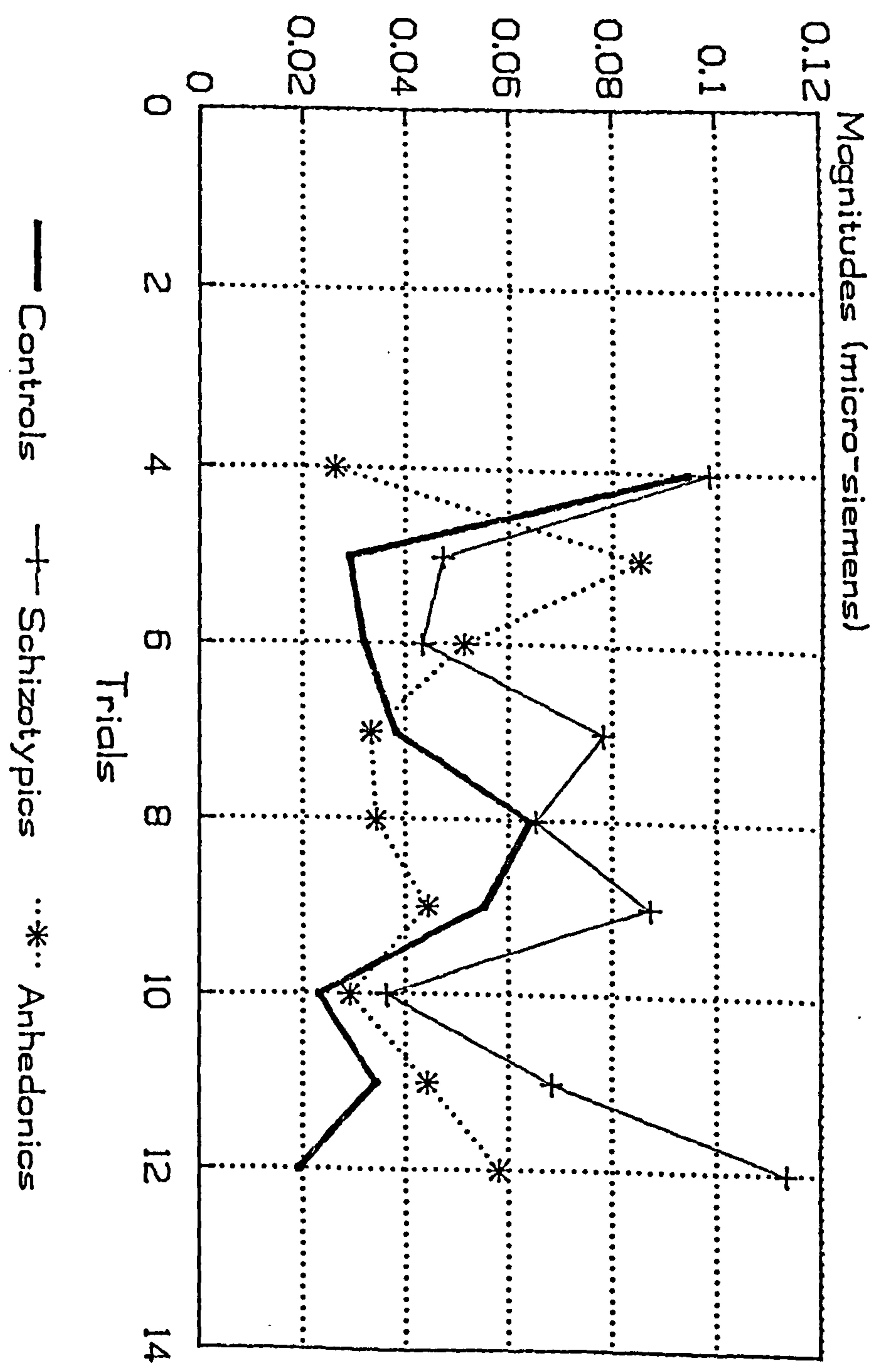


Table 10

TRIALS 4 to 12

The SC magnitudes for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	0.02	(0.02)	0.08	(0.10)	0.07	(0.09)		n.s.
S5	0.07	(0.08)	0.05	(0.05)	0.03	(0.03)		n.s.
S6	0.04	(0.05)	0.04	(0.04)	0.02	(0.03)		n.s.
S7	0.02	(0.03)	0.14	(0.08)	0.03	(0.04)	19.83	<.0001
S8	0.02	(0.03)	0.08	(0.06)	0.04	(0.06)	3.38	<.04
S9	0.03	(0.04)	0.10	(0.09)	0.02	(0.05)	6.85	<.003
S10	0.02	(0.03)	0.03	(0.04)	0.01	(0.02)		n.s.
S11	0.04	(0.04)	0.05	(0.07)	0.03	(0.03)		n.s.
S12	0.05	(0.06)	0.12	(0.11)	0.01	(0.02)	6.77	<.01
Main effects							F = 14.02	P <.0001
Group x trials interaction							F = 2.90	P <.0002

appears that schizotypics tended to give responses with a more irregular pattern in such way that their responses did not decline consistently over trials but varied randomly and a pattern of repeated orienting and re-orienting occurred. The plots of trials 4 to 12 also gave the impression that anhedonics gave larger responses to the second rather than the first trial.

Analyses of covariance were performed for the three groups and for each of these trials separately. Contrary to the impression given by the plots of trials 4 to 12, no significant difference was found between the groups in response to trial 5. The results of the findings which were significant are summarized below;

S7; $F = 19.83, P < .0001$

S8; $F = 3.38, P < .04$

S9; $F = 6.85, P < .003$

S12; $F = 6.77, P < .01$

Tukey's HSD test was performed to compare the means of the responses of each group for trials 7, 8, 9 and 12. The results were as follows;

S7; schizotypics vs controls $F = .018, P < .01$

S7; anhedonics vs controls n.s.

S7; schizotypics vs anhedonics $F = .019, P < .01$

S8; schizotypics vs controls $F = .015, P < .05$

S8; anhedonics vs controls n.s.

S8; schizotypics vs anhedonics $F = .020, P < .01$

S9; schizotypics vs controls F = .022, P <.01
S9; anhedonics vs controls n.s.
S9; schizotypics vs anhedonics F = .023, P <.01
S12; schizotypics vs controls F = .022, P <.01
S12; anhedonics vs controls n.s.
S12; schizotypics vs anhedonics F = .023, P <.01

As shown for all the above trials no significant differences were found between the responses of anhedonics and the control group. The comparison between the responses of schizotypics with those of the control subjects revealed that schizotypics produced significantly larger responses than the control subjects for all the above trials. This was the case for the comparison between anhedonics and schizotypics indicating that schizotypics produced significantly larger responses than the other groups.

TRIALS 13 to 15

Analysis of covariance was carried out on the magnitude of responses of the 3 groups for trials 13 to 15. The results showed neither a significant main effect of groups nor a significant group x trials interaction effect, indicating that there were no difference between the responses of the groups for this sequence of trials. The results of trials 13 to 15 are presented in Table 11.

Table 11

TRIALS 13 to 15

The SC magnitudes for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S13	0.10	(0.06)	0.12	(0.12)	0.09	(0.11)		
S14	0.04	(0.05)	0.02	(0.03)	0.03	(0.06)		
S15	0.05	(0.06)	0.04	(0.08)	0.03	(0.03)		

Main effects							n.s.	
Group x trials interaction							n.s.	

CV TRIALS

ANCOVA was used to compare the responses of the 3 groups to the 6 CV stimuli with trials as a within subject variable. No significant main effect of groups was found and the group x trials interaction effect did not quite reach the acceptable level of significance ($F = 1.63$, $P < .09$). The means, standard deviations, F ratios and P values are presented in Table 12. The means are graphically presented in Figure 6.

HIGH INTENSITY TRIALS

Trials expected to elicit defensive responses (DR) consisted of 4 high intensity, 90 dB tones. These were trials 28, 31, 34 and 37. Analysis of covariance was carried out for the 3 groups with trials as a within subject variable. Neither a significant main effect of groups nor a significant group x trials interaction effect were found. The results are shown in Table 13.

Fig 6 Skin conductance magnitudes
CV trials

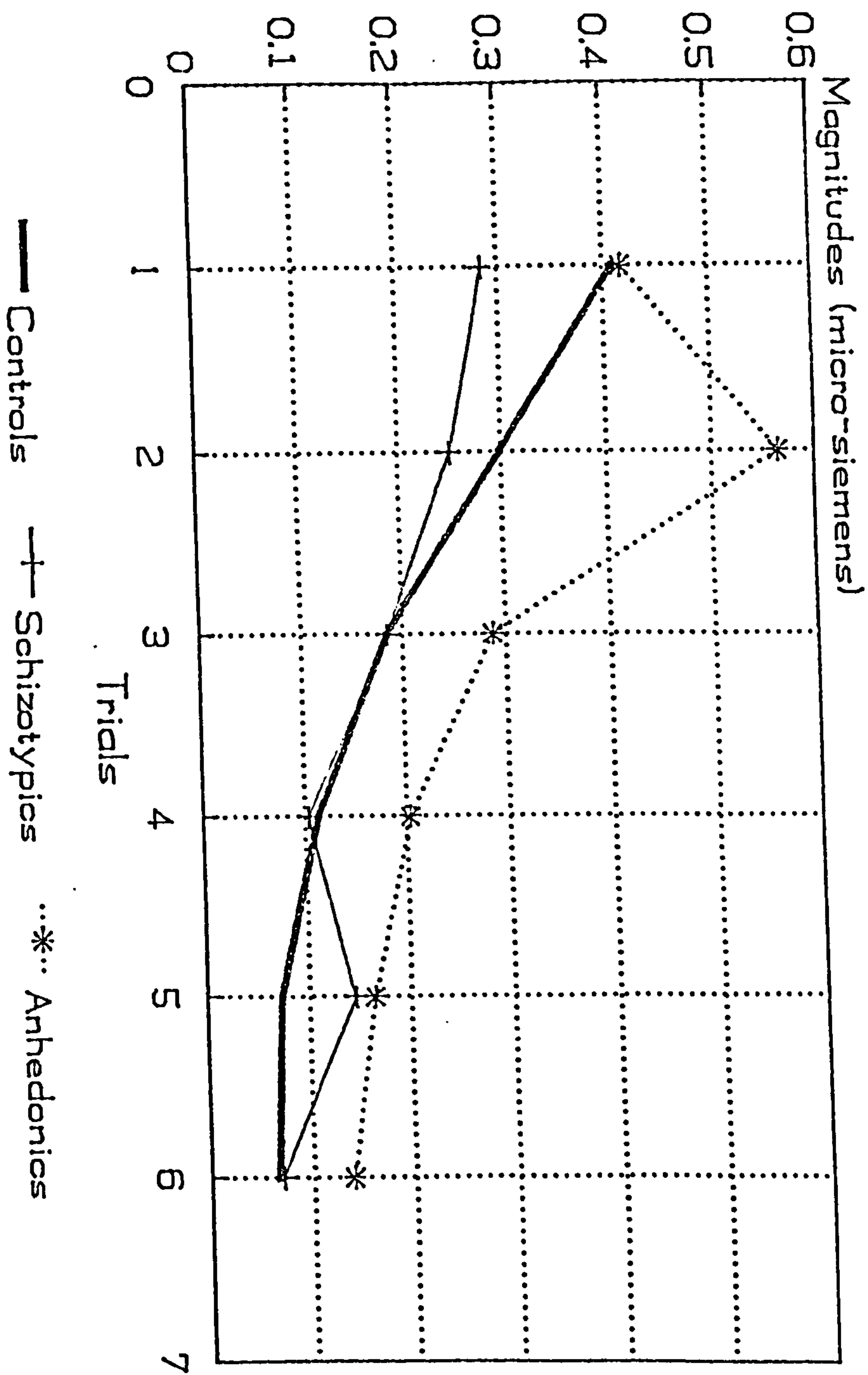


Table 12

THE CV TRIALS

The SC magnitudes for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S16	0.42	(0.29)	0.28	(0.39)	0.40	(0.35)		
S18	0.56	(0.07)	0.25	(0.50)	0.30	(0.31)		
S20	0.29	(0.49)	0.18	(0.33)	0.18	(0.24)		
S23	0.20	(0.30)	0.10	(0.16)	0.11	(0.16)		
S24	0.16	(0.15)	0.14	(0.27)	0.07	(0.12)		
S25	0.14	(0.26)	0.07	(0.11)	0.07	(0.10)		
Main effects							n.s.	
Group x trials interaction							n.s.	

Table 13

90 dB TRIALS

The SC magnitudes for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S28	0.48	(0.40)	0.26	(0.34)	0.42	(0.58)		
S31	0.30	(0.24)	0.14	(0.15)	0.40	(0.35)		
S34	0.08	(0.10)	0.08	(0.14)	0.11	(0.16)		
S37	0.20	(0.19)	0.22	(0.34)	0.31	(0.45)		
Main effects							n.s.	
Group x trials interaction							n.s.	

ORIENTING TRIALS

Trials 1, 4, 13, 16 and 30 were considered to be orienting trials because they were the first (novel) trial of each stimulus sequence. The magnitude of responses of the 3 groups for the orienting trials were examined using analysis of covariance with trials as a within subject variable. An analysis was first performed on all of the 5 orienting trials grouped together for the 3 groups of subjects. A significant group x trials interaction effect ($F = 1.88$, $P < .05$) was found. As can be seen from Table II in Appendix B, the orienting trials are different from each other in terms of characteristics such as intensity, frequency, type and so on. Therefore, it was decided to analyze separately the responses of the 3 groups for each of the OR trials. The results were as follows;

TRIAL 1

As mentioned previously analysis of covariance was performed on the magnitude of responses of the 3 groups for trial 1 (the first orienting trial). The results approached only a marginally acceptable level of statistical significance ($F = 2.98$, $P < .06$) for trial 1. The results are presented in Table 9. Post hoc analysis revealed that anhedonics produced a smaller magnitude of SCR than the control group ($F = .034$, $P < .05$). The comparison between the responses of schizotypics and control subjects was not significant.

TRIAL 4

Trial 4 was the first trial of a sequence of tones of 1311 Hz and 75 dB intensity. Analysis of covariance with the levels as the covariate compared the magnitude of responses of the 3 groups for trial 4. No significant difference was found between the responses of the 3 groups. Means, standard deviations, F ratios and P values of the orienting trials are presented in Table 14.

Inspection of the plots of the magnitudes of the responses of the 3 groups gave the impression that anhedonics produced larger mean magnitudes of SCR in response to the second rather than the first trial of this stimulus sequence. It was therefore, decided to analyze the responses of the groups for trial 5. Analysis of covariance, however, demonstrated no significant difference between the magnitude of responses of the groups in response to trial 5. These results are shown in Table 14.

TRIAL 13

Trial 13 was the first trial of a series of 500 Hz and 75 dB tone and was considered to elicit an orienting response. Analysis of covariance showed that there was no significant difference between the responses of the 3 groups for the magnitude of responses to trial 13. The results for this trial are presented in Table 14.

Table 14

ORIENTING TRIALS

The SC magnitudes for the anhedonic, schizotypic and control groups.

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S1	0.03	(0.05)	0.17	(0.22)	0.15	(0.18)	2.98	<.06
S4	0.02	(0.02)	0.08	(0.10)	0.07	(0.09)		n.s.
S13	0.10	(0.06)	0.12	(0.12)	0.09	(0.11)		n.s.
S16	0.42	(0.29)	0.28	(0.39)	0.40	(0.35)		n.s.
S30	0.30	(0.24)	0.14	(0.15)	0.40	(0.35)		n.s.
Main effects					n.s.			
Group x trials interaction					F = 1.88		P <.05	

S5	0.07	(0.08)	0.05	(0.05)	0.03	(0.03)		n.s.
S18	0.56	(0.07)	0.25	(0.50)	0.30	(0.31)	F = 5.37	<.009

TRIAL 16

Trial 16 was the first trial of a group of 5 consonant vowels (CVs) of 75 dB. Again ANCOVA revealed that there was no significant difference between the responses of the 3 groups for this orienting trial. The results are presented in Table 14.

The plots of the mean magnitudes of the groups in response to CV trials gave the impression that for trial 18, the second stimulus of the CV trials, anhedonics produced responses of significantly larger magnitude than other groups. It was therefore, decided to examine the magnitude of the responses of the 3 groups for trial 18. The results confirmed the impression gained from the inspection of Figure 5 ($F = 5.37$, $P < 0.009$).

Post hoc analyses were then carried out for the means of the responses of the 3 groups for trial 18. The comparison between the means of the responses of schizotypic and control subjects failed to demonstrate any significant difference between the two groups. A highly significant result was found for the comparison between the responses of anhedonics and control group, indicating that anhedonics produced significantly larger responses to the second CV trial. The results of trial 18 are presented in Table 14.

TRIAL 30

Trial 30 was the first white noise of 75 dB intensity. Analysis of covariance, showed no significant difference between the responses of the 3 groups for trial 30. The results are presented in Table 14.

RE-ORIENTING TRIALS

In order to compare the re-orienting of the skin conductance responses of the groups, the magnitude of responses to the paired trials 3 and 4, 12 and 13 and 15 and 16 were examined. These pairs of trials represented the points at which a change in each stimulus sequence occurred therefore, they were assumed to provide the best measure of re-orienting. For example, between stimulus 3 and 4 the frequency changed from 1000 Hz to 1311 Hz. Between stimulus 12 and 13 the frequency changed from 11311 Hz to 500 Hz and between stimulus 15 and 16 a stimulus of 500 Hz frequency changed to a CV trial (see Table III of Appendix B).

TRIALS 3 and 4

Analysis of covariance with the levels as the covariate and trials as a within subjects variable was carried out for the magnitude of responses of the 3 groups of subjects for trials 3 and 4. A significant group x trials interaction effect ($F = 5.40$, $P < .008$) was found for this pair of trials. Post hoc analysis was carried out.

A significant result was found for the comparison between schizotypics and the control group ($F = .016$, $P < .01$), indicating that both schizotypics and anhedonics showed a lack of re-orienting for this pair of trials.

TRIALS 12 and 13

The magnitudes of response to trials 12 and 13 (the strongest re-orienting trials) were subjected to analysis of covariance. The results showed neither a significant main effect of groups nor a significant group x trials interaction effect for this pair of trials.

TRIALS 15 and 16

The same analysis compared the magnitude of responses of the 3 groups for trials 15 and 16. The results failed to demonstrate a significant main effect of groups and a significant group x trial interaction effect for this pair of trials.

The final stage of the data analysis for this experiment consisted of a comparison between the overall responsivity of each group. Inspection of the plots of the mean SCR amplitude data for each group gave the impression that schizotypics tended to give responses with a more irregular pattern throughout most trial sequences in such a way that their response amplitudes did not decline but varied randomly and often orienting responses re appeared.

On the other hand, anhedonics showed an overall low degree of responsivity to the early trial blocks.

In order to compare the degree of responsivity between the 3 groups their responses to the first 15 trials were analyzed. This was done first by simply counting the number of responses given to each trial by each group. These scores were then subjected to analysis of variance. A significant difference was found between the number of responses given by each group ($F = 3.80, P < .03$). Post hoc analysis showed that schizotypics produced a large number of responses compared with the anhedonic group ($F = 1.55, P < .01$). Neither the comparison between anhedonics and the control group nor between the schizotypics and the control group were significant. The results are presented in Table 15.

Sex differences

Sex differences were not a major concern of the present study and it was therefore decided to examine the data for male and female subjects for the magnitude of their SCR responses only and for trials 1, 4, 13, 16, 28 and 30 only. A 3-way group x sex x trials analysis of covariance was carried out with the levels as the covariate. The results failed to reveal any significant differences between the responses of any of the groups for these trials. The results are presented in Table 16.

Table 15

The means and standard deviation of the number of zero responses for the first 15 stimuli for the 3 groups of subjects.

Anhedonics		Schizotypics		Controls	
M	(SD)	M	(SD)	M	(SD)
5.92	(1.88)	4.0	(1.96)	5.06	(1.58)

F = 3.80 P < .03

Table 16

The results of SCR magnitudes for male and female subjects

	Anhd/F	Anhd/M	SZ/F	SZ/M	Cont/F	Cont/M	F	P
S1	0.05	0.01	0.16	0.18	0.19	0.11		
S4	0.02	0.02	0.10	0.06	0.08	0.06		
S13	0.12	0.08	0.14	0.10	0.08	0.10		
S16	0.43	0.41	0.27	0.29	0.42	0.38		
S28	0.47	0.49	0.22	0.30	0.51	0.33		
S30	0.28	0.32	0.16	0.12	0.34	0.46		
Main effects					n.s.			
Group x sex x trials interaction					n.s.			

THE SCR LATENCY

The SCR latency was defined as the time interval between the onset of the stimulus and the response onset occurring within a latency window of 1 to 3 seconds post stimulus.

For the latency data the zero values were not included in the data analysis as, according to Venables (1978) non-responding is not meaningful for the missing temporal data such as latency and recovery time, and therefore, including zero entries for the temporal data is not justified.

The procedure used in this study for the handling of the missing latency data was to substitute the non-responses with the values estimated from the overall latency responses of each trial using a BMDP2V (twostep method). Similarly, for the quarter recovery time data, the means were calculated with non-responses eliminated and the missing values substituted with the estimated values.

The values for the mean latencies in seconds for the control group are graphically presented in Figure 7 in order to give an overall picture of the latency responses. The X axis represents the 39 stimuli and the Y axis shows the means of the latency responses in seconds. The latency data were not subjected to logarithmic transformation, as

LATENCY (SECS)

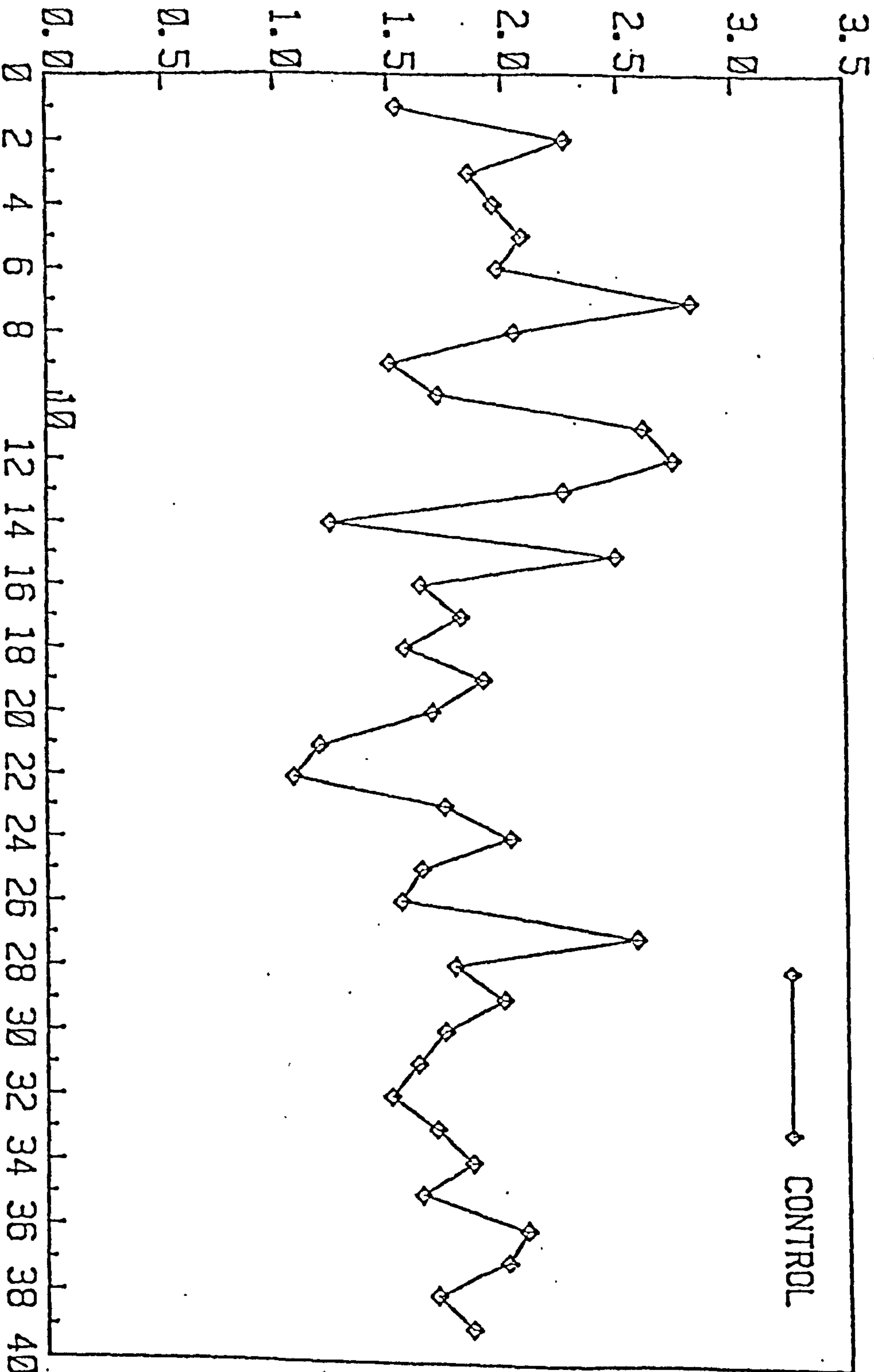


Figure 7. The latency of skin conductance responses obtained for control subjects in response to 39 stimuli.

it does not appreciably improve normality of the distribution (Venables and Christie, 1980).

DATA ANALYSIS

Data analysis was carried out using the same procedure as that employed for the analysis of the SCR magnitude data described earlier.

Habituation trials

Group x trials analysis of covariance with the levels as the covariate was carried out for the latency responses of the 3 groups, for the sequences of trials related to habituation. The results showed that in most cases the responses of the groups did not differ significantly. As shown in Tables 17 and 18 no significant differences were found between the latency responses of the groups for trials 1 to 3, and for trials 4 to 12 a group x trials interaction did not quite approach an acceptable level of statistical significance ($F = 1.18$, $P < .09$).

CV TRIALS

The only significant finding for the latency data was found to be for the CV trials in which group x trials interaction was significant ($F = 2.43$, $P < .03$). Further analysis revealed that the latencies of the responses of the 3 groups were significant for trial 16 ($F = 4.19$,

Table 17

TRIALS 1 to 3

The SCR latency for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S1	1.62	(0.57)	1.96	(0.65)	1.54	(0.49)		
S2	2.11	(0.90)	1.57	(0.71)	2.27	(1.70)		
S3	1.83	(0.72)	1.84	(0.41)	1.74	(0.35)		

Main effects

Group x trials interaction

Table 18

TRIALS 4 to 12

The SCR latency for the anhedonic, schizotypic and control subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	1.91	(0.68)	1.83	(0.59)	1.96	(0.99)		
S5	2.12	(1.47)	1.66	(0.70)	2.08	(0.37)		
S6	1.90	(1.14)	2.21	(1.02)	1.99	(0.72)		
S7	2.29	(0.84)	1.74	(0.86)	2.82	(0.81)		
S8	2.56	(1.05)	2.08	(0.99)	2.07	(1.03)		
S9	1.83	(0.43)	1.63	(0.47)	1.50	(0.64)		
S10	1.89	(0.88)	1.44	(0.62)	1.68	(0.85)		
S11	2.06	(1.07)	1.76	(0.80)	2.57	(1.12)		
S12	2.43	(0.74)	2.54	(1.04)	2.74	(2.02)		

Main effects					n.s.			
Group x trials interaction					n.s.			

Table 19

TRIALS 13 to 15

The SCR latency for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S13	2.11	(0.95)	2.04	(0.99)	2.26	(0.51)		
S14	1.93	(0.44)	2.47	(0.61)	1.19	(0.33)		
S15	2.36	(0.65)	2.39	(1.02)	2.49	(1.19)		

Main effects						n.s.		
Group x trials interaction						n.s.		

P <.02) and was marginally significant for trial 18 (F = 2.81, P <.07). The results of CV trials are presented in Table 20.

Post hoc analysis (Tukey's HSD) was then carried out for the latency responses for trials 16 and 18. The results were as follows;

S16;	schizotypics vs controls	F = .41	P <.05
S16;	anhedonics vs controls		n.s.
S16;	schizotypics vs anhedonics	F = .55	P <.01
S18;	schizotypics vs controls		n.s.
S18;	anhedonics vs controls		n.s.
S18;	schizotypics vs anhedonics	F = .56	P <.05

HIGH INTENSITY TRIALS

Analysis of covariance revealed that there were no significant differences between the responses of the 3 groups for the latency responses for the high intensity, 90 dB trials. The means and standard deviations for the 90 dB trials and for the 3 groups of subjects are presented in Table 21.

ORIENTING TRIALS

For orienting trials stimuli 1, 4, 13, 16 and 30 were grouped together and were subjected to group x trials analysis of covariance. No significant main effect of groups and no significant group x trials interaction effect

Table 20

CV TRIALS

The SCR latency for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S16	1.24	(0.44)	2.07	(0.42)	1.64	(0.44)	4.09	P < .02
S18	1.30	(0.32)	1.89	(0.50)	1.56	(0.23)	2.81	P < .07
S20	1.90	(0.62)	1.78	(0.38)	1.70	(0.61)		n.s.
S23	1.73	(0.87)	1.71	(0.54)	1.74	(0.52)		n.s.
S24	1.84	(0.49)	1.96	(0.72)	2.21	(1.14)		n.s.
S25	1.77	(0.76)	2.11	(1.52)	1.64	(0.99)		n.s.

Main effects

n.s.

Group x trials interaction

F = 2.43 P < .03

Table 21

90 dB TRIALS

The SCR latency for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S28	1.55	(0.62)	1.16	(0.39)	1.90	(0.36)		
S31	1.51	(0.47)	1.99	(0.84)	1.55	(0.57)		
S34	1.73	(0.52)	2.25	(1.39)	1.81	(0.61)		
S37	1.51	(0.66)	1.93	(0.83)	1.99	(0.52)		

Main effects					n.s.			
Group x trials interaction					n.s.			

were found for the latency responses of the 3 groups for the orienting trials grouped together. The results are presented in Table 22.

RE-ORIENTING TRIALS

For the re-orienting trials the results were not quite significant for any of the trial pairs thought to be related to re-orienting. These trial pairs consisted of trials 3 and 4, 12 and 13 and 15 and 16.

Table 22

ORIENTING TRIALS

The SCR latency for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S1	1.62	(0.57)	1.96	(0.65)	1.54	(0.49)		
S4	1.91	(0.68)	1.83	(0.59)	1.96	(0.99)		
S13	2.11	(0.95)	2.04	(0.99)	2.26	(0.51)		
S16	1.22	(0.44)	2.07	(0.42)	1.64	(0.44)		
S30	1.76	(0.76)	1.84	(0.41)	1.74	(0.35)		

Main effects					n. s.			
Group x trials interaction					n. s.			

SCR RECOVERY TIME

During the process of scoring the SCR recovery time it was noticed that in many cases it was not possible to score the half-recovery time of each response due to the interruption of the recovery of SCR by the subjects' further responsivity before the occurrence of response recovery. Therefore it was decided to analyze the quarter recovery (t/4 recovery) time instead as there was less incidence of non-scorable recovery time when t/4 recovery time were used. Log transformation of recovery time data was not used in the calculation of this variable as it does not improve the normality of the SCR recovery time distribution. (Venables & Christie 1980).

The values for the mean t/4 recovery in seconds for the control subjects are graphically presented in Figure 8 in order to give an overall picture of the recovery data.

DATA ANALYSIS

As mentioned previously for t/4 recovery data the responses were calculated eliminating the zero values. Log conversion of the recovery time data doen not appreciably change the distribution (Venables and Christie, 1980) and therefore, was not employed in the analysis of the recovery data. Data analysis was carried out using the same procedure as the one employed for the analysis of SCR

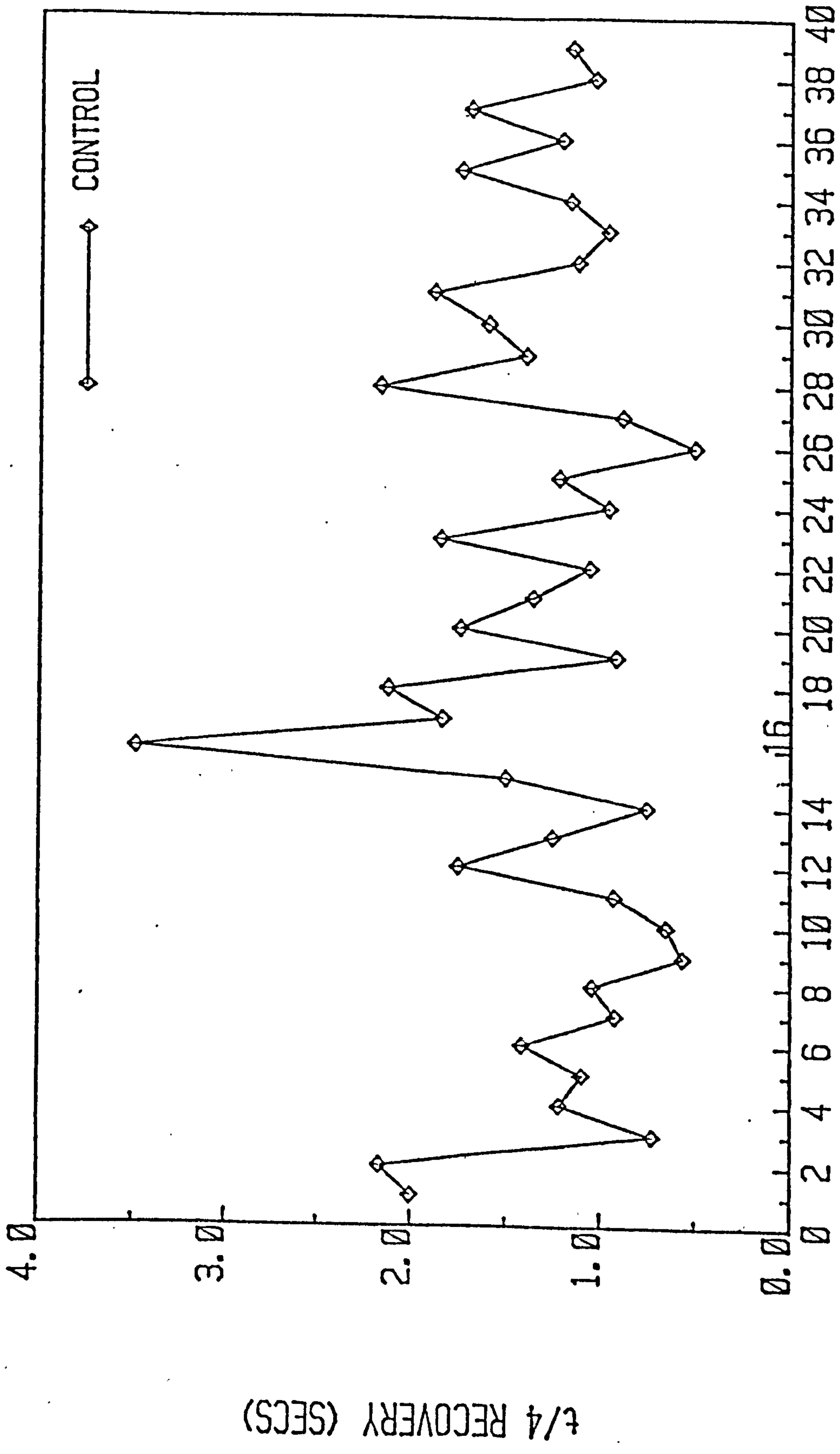


Figure 8. The t/4 recovery of skin conductance responses obtained for control subjects in response to 39 stimuli.

magnitude and latency data.

Habituation trials

Group x trials analysis of covariance with the levels as the covariate were carried out for the t/4 recovery responses of the 3 groups for the habituation trials. The results showed a significant group x trials interaction effect for the t/4 recovery responses of the groups for trials 1 to 3 ($F = 2.53$, $P < .05$). One-way analysis of covariance for each of the 3 trials showed a marginally significant result for trial 2 ($F = 3.74$, $P < .06$). Post hoc analysis was then carried out and the results showed that anhedonics produced a significantly faster recovery time than the control group ($F = 0.74$, $P < .05$). No other significant differences were found for the t/4 recovery responses of the groups for any other of the habituation sequences. The results of the t/4 recovery data for the habituation trials are presented in Tables 23 to 27.

ORIENTING TRIALS

Analysis of orienting trials (grouped together) revealed neither a significant main effect of groups nor a significant group x trials interaction effect. The results of the t/4 recovery data for the orienting trials are presented in Table 28.

Table 23

TRIALS 1 to 3

The t/4 recovery for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S1	1.42	(0.71)	1.85	(1.65)	2.00	(1.09)		n.s.
S2	1.01	(0.39)	1.47	(1.38)	2.17	(1.65)	3.74	P < .06
S3	2.66	(1.24)	1.84	(1.54)	1.59	(0.64)		n.s.

Main effects								n.s.
Group x trials interaction					F = 2.42			P < .06

Table 24

TRIALS 4 to 12

The t/4 recovery for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	1.00	(0.40)	1.31	(0.92)	1.21	(0.38)		
S5	0.88	(0.42)	1.53	(1.08)	1.09	(1.12)		
S6	1.79	(0.76)	2.21	(1.09)	1.41	(0.55)		
S7	1.81	(1.05)	1.74	(0.98)	0.98	(0.71)		
S8	1.19	(0.54)	2.08	(1.21)	1.12	(0.68)		
S9	1.62	(1.07)	1.63	(0.73)	0.64	(0.37)		
S10	1.30	(0.84)	1.44	(0.65)	0.69	(0.43)		
S11	1.52	(0.93)	1.76	(0.84)	0.98	(0.58)		
S12	0.62	(0.38)	1.04	(0.37)	1.76	(0.70)		
Main effects							n.s.	
Group x trials interaction							n.s.	

Table 25

TRIALS 13 to 15

The t/4 recovery for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S13	1.82	(1.14)	2.14	(1.55)	1.25	(1.10)		
S14	1.66	(0.96)	2.47	(0.98)	1.19	(0.79)		
S15	1.63	(1.49)	1.09	(1.11)	1.50	(0.70)		

Main effects						n. s.		
Group x trials interaction						n. s.		

Table 26

CV TRIALS

The t/4 recovery for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S16	3.11	(1.78)	2.63	(1.94)	3.49	(2.15)		
S18	2.03	(1.41)	1.63	(0.98)	2.12	(1.48)		
S20	1.63	(0.88)	1.78	(0.54)	1.76	(0.85)		
S23	1.91	(1.14)	1.71	(0.73)	1.81	(0.63)		
S24	1.28	(0.98)	1.96	(1.04)	0.97	(0.71)		
S25	1.85	(1.02)	2.06	(1.19)	1.21	(0.52)		

Main effects					n. s.			
Group x trials interaction					n. s.			

Table 27

90 dB TRIALS

The t/4 recovery for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S28	1.13	(0.82)	1.85	(1.31)	2.16	(0.65)		
S31	1.65	(1.11)	1.99	(0.94)	1.88	(0.79)		
S34	2.23	(0.72)	2.25	(1.37)	1.19	(0.92)		
S37	1.90	(1.32)	1.93	(0.88)	1.73	(1.06)		
Main effects							n.s.	
Group x trials interaction							n.s.	

Table 28

ORIENTING TRIALS

The t/4 recovery for the anhedonic, schizotypic and control groups

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S1	1.22	(0.71)	1.85	(1.65)	2.00	(1.09)		
S4	1.00	(0.40)	1.31	(0.92)	1.21	(0.38)		
S13	1.82	(1.14)	2.14	(1.55)	1.25	(1.10)		
S16	3.11	(1.78)	2.63	(1.94)	3.49	(2.15)		
S30	1.98	(1.24)	1.84	(1.54)	1.59	(0.64)		

Main effects					n.s.			
Group x trials interaction					n.s.			

RE-ORIENTING TRIALS

For the re-orienting trials the results were not quite significant for any of the trial pairs related to re-orienting.

DISCUSSION

The aim of this section of the study was to examine orienting, re-orienting and habituation of skin conductance response amplitudes, latencies and recovery times of individuals with schizotypal personality characteristics. It was hypothesized that normal subjects scoring high on the questionnaire measures of schizotypy might show a disorder of autonomic functioning similar to that exhibited by schizophrenics and children at risk for schizophrenia.

In the present study some interesting findings resulted from the skin conductance experiment. One of these was evidence of a deficit of skin conductance habituation shown by the high scorers on the SZ scale while anhedonics did not differ from the control subjects in the habituation of their SCR. The high scorers on the SZ scale produced significantly higher magnitudes of SCR in response to the early stimulus sequences and their responses did not decline over trials for trials 4 to 12 compared with the control group. Significant differences were found between the habituation of SC responses of the anhedonics and schizotypics for most of the habituation trials. The finding of impairment of habituation is in line with the findings of disorder of habituation in the high scorers on the schizophrenism scale reported by Nielsen and Petersen (1976). The lack of habituation shown by schizotypics

might therefore be considered as a trait of individuals with schizotypic personality characteristics.

When the orienting trials were analyzed it was revealed that while there was no evidence of disorder of orienting in the high scorers on the SZ scale, significant differences existed between anhedonics and control subjects on some of the orienting trials. Anhedonics exhibited some evidence of the disorder of orienting. They also showed a tendency to produce larger responses to the second rather than the first trial of the stimulus sequences. This was evident in their responses to trials 2 and 18.

On the basis of previous findings of psychophysiological studies of schizotypics it was hypothesized that high scorers on the anhedonia scale might show a lack of responsivity of electrodermal activity (Simons, 1981). On the other hand it was hypothesized that the high scorers on the SZ scale would be over responsive and would produce responses of large amplitudes (Nielsen and Petersen, 1976). When the pattern of responsivity of the 3 groups were compared it was found that schizotypics were more responsive and showed an irregular pattern of responses characterized by repeated re-orientation to the stimuli of the same type. Anhedonics on the other hand produced fewer and smaller SC responses i.e. they showed a pattern of minimal responsivity.

The tendency for anhedonics to produce a relatively low degree of SC responsivity could be considered to be similar to the finding of Simons (1981) who tested a group of students with extreme scores on the anhedonia scales and found that they showed a significantly higher incidence of SC non-responsivity than perceptual aberration and control subjects.

The finding of high SCR amplitudes in subjects with high scores on the SZ scale is consistent with the results reported from a study by Van Dyke (1972) who examined orienting responses in a group of high and low risk adult subjects and found that high risk subjects produced significantly larger electrodermal responses to orienting stimuli. Van Dyke et al. (1974) also found SC responses of large amplitude and a higher response frequency in foster children of schizophrenic parents.

A high frequency of responsivity and the tendency for the responses to reappear frequently, which was exhibited by the high scorers on the SZ scale, might indicate an abnormally broad range of attention similar to that shown by hyper-responder schizophrenics, as suggested by Venables (1964). A relatively low degree of responsivity among anhedonics could be explained in terms of a presumed, generally poor orienting reaction as a result of a narrow range of attention, also suggested by Venables (1964).

Furthermore, since anhedonics are believed to be characterized by symptoms of negative type, one of which is withdrawal, their poor OR behaviour could be an indication that they are not very attentive to environmental stimulation.

It was hypothesized that schizotypics might show a tendency to produce responses of large amplitude to the loud noise as is the case for the hyper-responder (hyper-aroused) schizophrenics. Evidence for a greater phasic responsivity to an intense and unpleasant loud noise among high risk children is also reported from the study of Mednick and Schulsinger (1968). The finding of the present study, however, did not support this hypothesis. The high intensity stimuli did not distinguish individuals with schizotypic personality from the control group which is also in contrast to the results reported by Salzman and Klein (1978) who found evidence of greater responsivity to intense stimuli in high risk children.

There were no findings of interest for the recovery time and latency data. Both anhedonic and schizotypic groups showed similar latencies and recovery times to those of the control group. Altogether there was no regular pattern in response recovery times for the groups. Similar results were reported from Van Dyke's (1972) study in which there were no differences between high risk and low risk

groups in their response latencies and recovery times. Furthermore, studies by Salzman and Klein (1978) and Prentky, Salzman and Klein (1980) did not replicate Mednick's earlier findings of more rapid SC recovery times in the high risk group. Maricq and Edelberg (1975) also found that the half-amplitude recovery times of adult schizophrenics did not differentiate between normals and schizophrenics. However, it ought to be pointed out that the values for some of the latency and t/4 recovery data in the present study consisted of estimated values from the overall responses. This, as mentioned previously was due to excluding the missing values and substituting them with the estimated values. Absence of responses to some of the trials as well as deletion of the noisy responses led to a relatively large number of missing values, in particular for the anhedonics. It is therefore, possible that using the estimated values for these variables might have obscured the group differences.

Finally the results of skin conductance study provide some support for findings concerning autonomic differences between schizotypics and non-schizotypics. It also suggests that different schizotypic subtypes exhibit differing autonomic characteristics which provides evidence for the hypothesis that anhedonia and schizophrenism might form two independent dimensions of schizotypy.

These results are consistent with the notion that the disorder of skin conductance orienting and habituation might be an index of vulnerability to schizophrenia.

HEART RATE

A number of psychophysiological studies of cardiac activity have reported a relationship between changes in heart rate, and performance in certain tasks. These studies have shown that heart rate decelerates in response to simple stimuli and accelerates in response to intense or threatening stimuli or when doing some sort of mental activity such as solving a mathematical problem (e.g. Darrow, 1929; Davis, Buchwald and Frankmann, 1955; Sternbach, 1960; Blair, Glover and Greenfield, 1959).

One of the theories concerning changes in heart rate as a result of stimulation, has been put forward by Lacey (1967). This theory is known as the 'intake-rejection' theory and suggests that changes in cardiac activities are dependent upon the characteristics of the stimulus and the type of attention it requires. Thus, in situations where the detection of environmental events is required, heart rate decelerates e.g. when one is performing a visual attention task. On the other hand, when the situation involves rejection of the environment for example, when stimulation is painful or unpleasant, heart rate accelerates. Furthermore, it is reported by Lacey et al. (1963) that tasks which require a mixture of environmental

intake and rejection do not produce any changes in heart rate.

Lacey's hypothesis emphasizes the role of heart rate as an intervening factor in various psychological and behavioural performances, especially in information processing. He suggested that cardiac deceleration does not only relate to the environmental intake per se, but also performs the role of facilitation of sensory processing while the role of cardiac acceleration is the inhibition of sensory processing. In Lacey's view heart rate deceleration signifies an orienting response and is associated with increased sensitivity to stimulation. Lacey's theory was supported in a study by Obrist (1963). However, a view contrary to Lacey's is that of Sokolov (1960). Sokolov suggested that it is the heart rate acceleration which is related to orienting and increased sensitivity to environmental inputs. As a result of this controversy, Graham and Clifton (1966) decided to test Sokolov's hypothesis against that of Lacey's by reviewing a number of studies in which simple stimuli had been used. The result of this review was the proposal that the orienting response is accompanied by heart rate deceleration and the acceleration of the heart rate is likely to be associated with a 'defensive reaction' (DR) to high intensity stimuli.

Coles (1972) designed a visual search experiment in order to test Lacey's hypothesis. He examined changes in heart rate as a function of stimulus discriminability. In this study he hypothesized that, since tasks with a low degree of discriminability would require more environmental intake it is likely that less discriminable tasks would lead to a greater tonic deceleration compared with tasks which are more discriminable. The reason being that tasks with a low degree of discriminability would require the processing of more features and the allocation of more perceptual resources.

The result of Coles study revealed that heart rate decelerated in response to less discriminable tasks. This finding thus provided support for Lacey's intake-rejection hypothesis.

A number of other studies concerning the relationship between heart rate and information processing have recently been carried out on the basis of Lacey's intake-rejection hypothesis. In these studies the relationship between cardiac activity and performance on tasks which require some form of information processing has been examined (e.g. Higgins, 1971; Coles and Duncan-Johnson, 1975). These studies have supported the hypothesis that there is a relationship between information processing and changes in the direction of heart rate.

Another theory is that of Obrist et al. (1970). They suggested that changes in the cardiac activity are related to central processes which facilitate the processing of information or the execution of responses. In Obrist's view, changes in heart rate reflect changes in the level of somatic (muscular) activity. Thus a decrease in the level of somatic activity results in a decrease in heart rate. This integration of muscular activity and level of heart rate activity is known as cardiac-somatic coupling (Obrist, Lawler and Gaebelein, 1974).

Coles & Duncan-Johnson (1975) tested Obrist's theory through examination of the degree to which somatic and cardiac activity were coupled in a HR and an EMG (muscle tension) experiment. They found that HR and EMG exhibited a similar pattern of responses during the foreperiod but changes in the degree of task difficulty had an effect only on the cardiac activity and not on the EMG. Their results therefore suggested that there is some coupling between cardiac and somatic activity and that cardiac activity is particularly related to attentional processes.

From the above it can be said that since schizophrenics are known to suffer a disorder of information processing, it is likely that this defect is reflected in their heart rate orienting responses. There is some data in support of the disorder of heart rate

orienting in schizophrenics. For example, in a study by Zahn, Rosenthal and Lawlor (1968) it was found that schizophrenics showed acceleration of heart rate to 72 dB tones. The tones of this level of intensity have frequently been reported to have produced heart rate deceleration in normals. In line with this are the findings of Dykman et al. (1968) who have shown that schizophrenics exhibit heart rate acceleration to tones of 800 Hz, 60 dB intensity.

The disorder of heart rate orienting in schizophrenics has also been examined in an experiment by Gruzelier (1973) in which he tested two groups of schizophrenics, one group consisted of subjects who were electrodermal responders and the other group were nonresponders. He found that the electrodermal responders showed an acceleration of heart rate to 75 and 85 dB tones, whereas normal subjects produced deceleratory responses. The schizophrenic subjects who were electrodermal nonresponders also showed heart rate acceleration or defensive responses to stimuli which in normal subjects produced deceleration of heart rate.

HEART RATE

Method and procedure

Heart rate was recorded using Beckman electrodes in Standard Lead I configuration, that is, one electrode placed on each arm. This method of recording normally produces an EKG with a large QRS spike compared with other EKG components, and makes the measurement of heart rate easy. Cambridge Electrode Gel was rubbed onto the skin prior to electrode attachments in order to obtain a better conductance. The electrode cups were filled with electrode jelly and were attached to the underside of the surface of the forearms half way between the wrists and the elbows. Heart rate was recorded using a Grass Model 79D Polygraph in conjunction with 7P5 preamplifier. Heart rate was recorded in response to the same 39 auditory stimuli used for the recording of skin conductance described before. The auditory tape was played from one channel of a Tandberg tape recorder and were presented binaurally through headphones. Heart rate was monitored simultaneously with skin conductance, therefore, the method of stimulus presentation and data collection was identical to that used for the recording of skin conductance as described in the chapter concerning skin conductance method and procedure.

One channel of the polygraph was used for recording heart rates trigger pulses related to the onset of each

stimulus. The heart channel and the trigger channel were connected to a Racal magnetic tape recorder to store the heart rate data. The speed of Racal was set at 3.75 inches per second.

HEART RATE DATA REDUCTION

The heart rate data stored on the magnetic tape, were played into a PDP11/40 computer via a sharp cut band-pass filter (Kemo VBF14). The output was passed through a Peak Detector which was used to ease the inspection of the 'R' waves. The R wave is the largest and the most sharply peaked wave in the EKG, when the recording is done through Lead I or Lead II electrode placement. A Schmitt Trigger (voltage discriminator) was employed to produce an output signal whenever the level of the input (EKG) signal exceeded the trigger level. This was done by setting the trigger to an appropriate level. During this procedure the heart rate data in conjunction with the stimulus triggers which occurred 10.5 sec prior to the onset of each stimulus, were monitored on the GT40 Visual Display Unit of the PDP11/40 for visual inspection. Additionally the correct triggering of the EKG waves as well as the detection of the trials contaminated by movements or other artifacts were checked. Subsequently the contaminated trials were excluded from the data analysis. A second Schmitt Trigger

was employed to demonstrate the monitoring of the stimulus triggers.

The first step in the analysis of heart rate was the sampling of the heart rate data. A sampling program was used in conjunction with a sequence file which provided information concerning the inter-trial intervals of the stimuli presented. This program calculated the means and standard deviations of the heart rate data as well as a list of the trigger deviation times for each trial. The trigger deviation times were used to check whether the sampling was carried out at the correct points. Subsequently the heart rate data were converted to Inter-Beat-Intervals (IBIs) between the consecutive beats. This is the basic unit of heart rate measurement and refers to the intervals between the R waves. The IBIs were calculated at half seconds pre- and post-stimulus. The IBIs were transferred to a Dec 10 computer. The contaminated trials which had been detected during the scanning of the heart rate data, were deleted from the IBI data files. The final conversion of the data was carried out using a program known as CHANT (Lobstein, 1978). This program is designed to calculate post stimulus data as deviations from a model of non-stimulated 'post stimulus' data calculated from pre-stimulus values. This provides measures of transient changes of the heart rate by building a model of heart rate activity from the pre-stimulus data

and used this model to predict the post-stimulus values. The differences between the observed and the predicted values are then compared. The program computed the serial correlations of the pre-stimulus data points, i.e. the correlations of each point with the previous points throughout. The prediction includes an error term, or tolerance, with which the difference between observed and expected values could be given probabilities. These differences were then produced in terms of student's 't' values.

The output of CHANT consisted of 20 seconds of post-stimulus data used on each trial. This resulted in 50 IBIs (10 pre- and 40 post-stimulus) for each trial. By employing this method, heart rate data can be measured independently of heart rate variability.

HEART RATE DATA ANALYSES

After CHANT analysis, trials related to orienting, re-orienting and habituation were selected from the total of 39 trials (the same procedure as the one employed in the analysis of the skin conductance data described in the previous chapter).

Plots were made for each trial in order to determine the latency windows. Examination of the plotted trials showed that the latency windows for these trials closely matched those used by Bull and Lang (1972). Therefore, it was decided to use the Bull and Lang latency windows. The latencies were as follows;

The first deceleration (D1). This occurs during the first 2 seconds after the stimulus onset.

The first acceleration (A1). This is the shortest IBI following the D1 and occurs between 2 and 5 seconds after the stimulus onset.

The second deceleration (D2). This occurs between 5 and 8 seconds after the stimulus onset.

The second acceleration (A2). This occurs between 8 and 13 seconds after the stimulus onset.

(An example of the plot of heart rate is presented in Appendix B).

RESULTS

Habituation trials

As before, trials 1 to 3, 4 to 12, 13 to 15 and the 6

CV trials were selected as trials related to habituation. Analysis of variance was carried out with trials as a within subject variable in order to examine the acceleration and deceleration of heart rate responses of the 3 groups of subjects. ANOVAS were carried out separately for each of the initial deceleration and acceleration (D1, A1) and secondary deceleration and acceleration (D2, A2). Analyses were performed on the responses after they had been converted to log values. The log transformation was performed in order to improve the normality of the distribution of heart rate data.

TRIALS 1 to 3

Analysis of variance was carried out for trials 1 to 3. The results showed a significant group x trials interaction effect but for the D1 only and this was only at a marginally acceptable level of statistical significance ($F = 2.20, P < .06$). Further one-way analyses of variance were carried out for the 3 groups and separately for each of the trials 1 to 3. The results showed no significant difference between the groups for the D1 in response to trials 1 and 2. The result of the analysis of D1 for trial 3 showed only a marginally acceptable level of significance ($F = 2.66, P < .07$). Tables 29 to 32 present the means, standard deviations, F ratios and P values of heart rate responses for trials 1 to 3 for the 3 groups of subjects. Post hoc analysis (Tukey's HDS) was then carried out. The

Table 29

TRIAL 1 - 3

The HR D1 for the anhedonic, schizotypic and control subjects

	Anhedonics		Schizotypics		Controls			
	M	(SD)	M	(SD)	M	(SD)	F	P
S1	1.54	(1.76)	1.91	(2.05)	2.85	(1.88)		
S2	2.10	(1.69)	1.50	(1.19)	1.78	(0.98)		
S3	1.17	(.86)	2.05	(1.46)	1.14	(1.11)	2.76	<.07

Main effects	n.s.		Group x trials interaction				F = 2.20	P <.06

Table 30

The HR A1 for the anhedonic, schizotypic and control subjects

	Anhedonics		Schizotypics		Controls			
	M	(SD)	M	(SD)	M	(SD)	F	P
S1	-0.52	(1.74)	-0.15	(1.62)	0.41	(1.65)		
S2	-0.67	(1.30)	-1.24	(1.64)	-0.80	(0.87)		
S3	-0.68	(1.48)	-1.02	(1.65)	-0.76	(1.23)		

Main effects	n.s.		Group x trials interaction				n.s.	

Table 31

The HR D2 for the anhedonic, schizotypic and control subjects

	Anhedonics		Schizotypics		Controls			
	M	(SD)	M	(SD)	M	(SD)	F	P
S1	1.75	(1.80)	1.79	(1.44)	2.62	(1.80)	P <.14	P <.22
S2	2.23	(1.53)	2.30	(2.39)	1.29	(1.38)	P <.23	P <.18
S3	1.48	(1.81)	3.60	(4.78)	1.57	(1.59)	P <.11	P <.13

Main effects	n.s.		Group x trials interaction				n.s.	

Table 32

The HR A2 for the anhedonic, schizotypic and control subjects

	Anhedonics		Schizotypics		Controls			
	M	(SD)	M	(SD)	M	(SD)	F	P
S1	-1.53	(2.59)	-1.91	(2.32)	-0.86	(2.57)		
S2	-0.96	(2.02)	-1.05	(2.11)	-0.88	(4.15)		
S3	-1.35	(1.64)	-1.90	(2.63)	-1.37	(1.49)		

Main effects	n.s.		Group x trials interaction				n.s.	

results indicated that schizotypics produced larger deceleratory responses for trial 3 compared with the control group ($F = 0.75, P < .05$). The same was the case for the comparison between the means of the D1 responses of anhedonics and the control group for trial 3 ($F = 0.79, P < .05$) which indicated that anhedonics gave larger deceleratory responses than the controls.

TRIALS 4 to 12

No other significant differences were found between the responses of the 3 groups for any other of the stimulus sequences i.e. trials 4 to 12 or trials 13 to 15. The results of these analyses are presented in Tables 33 to 40.

CV TRIALS

When the responses of the 3 groups for the CV trials were subjected to analysis of variance, the results revealed a significant group x trials interaction effect but only for the A1 ($F = 1.86, P < .05$). Further one-way analyses revealed that the group differences for A1 in response to CV trials were significant for trial 20 ($F = 4.06, P < .02$) and for trial 24 ($F = 3.70, P < .03$). Post hoc analysis was then carried out. The results were as follows;

S20; schizotypics vs controls		n.s.
S20; anhedonics vs controls	$F = 1.05$	$P < .05$
S20; schizotypics vs anhedonics	$F = 1.34$	$P < .01$

Table 33

The HR D1 for trials 4 to 12 for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	1.78	(1.44)	1.23	(1.27)	1.19	(1.22)		
S5	1.44	(0.95)	1.28	(1.43)	1.59	(1.37)		
S6	1.65	(1.43)	2.49	(2.60)	1.47	(1.36)		
S7	1.54	(1.73)	0.60	(1.75)	0.68	(1.33)		
S8	0.57	(1.26)	1.36	(1.30)	1.08	(1.44)		
S9	1.05	(1.30)	1.86	(1.57)	1.21	(1.87)		
S10	1.40	(1.69)	1.87	(1.81)	1.40	(1.39)		
S11	0.87	(1.05)	1.58	(2.16)	1.29	(0.83)		
S12	1.15	(1.28)	0.22	(1.31)	1.61	(1.14)		
Main effects							n.s.	
Group x trials interaction							n.s.	

Table 34

The HR A1 for trials 4 to 12 for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	-1.29	(1.85)	-1.20	(2.26)	-1.17	(1.51)		
S5	-1.22	(1.86)	-0.88	(1.43)	-1.02	(1.23)		
S6	-1.33	(2.10)	-1.15	(1.96)	-1.30	(1.77)		
S7	-1.50	(1.55)	-1.52	(2.28)	-1.93	(2.03)		
S8	-2.41	(1.50)	-0.73	(1.51)	-1.69	(1.61)		
S9	-1.11	(1.41)	-0.39	(1.70)	-1.67	(1.38)		
S10	-1.65	(2.59)	-0.77	(2.09)	-2.00	(2.20)		
S11	-1.84	(1.49)	-0.83	(1.50)	-1.47	(1.55)		
S12	-1.38	(1.81)	-1.98	(1.68)	-1.04	(1.35)		

Main effects					n.s.			
Group x trials interaction					n.s.			

Table 35

The HR D2 for trials 4 to 12 for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	1.82	(2.16)	2.09	(2.13)	1.88	(1.69)		
S5	2.66	(2.55)	1.30	(1.11)	2.22	(1.27)		
S6	0.89	(2.00)	1.99	(1.81)	1.75	(2.10)		
S7	3.32	(4.21)	0.85	(2.20)	1.21	(1.12)		
S8	0.33	(1.98)	2.21	(1.60)	1.46	(2.07)		
S9	1.35	(1.25)	1.87	(2.03)	1.61	(1.70)		
S10	2.18	(4.38)	2.05	(2.05)	1.10	(2.51)		
S11	1.36	(1.04)	1.70	(1.55)	1.09	(1.01)		
S12	2.10	(2.60)	1.96	(2.87)	1.90	(2.21)		
Main effects							n.s.	
Group x trials interaction							n.s.	

Table 36

The HR A2 for trials 4 to 12 for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S4	-1.34	(1.60)	-1.88	(2.44)	-1.42	(1.63)		
S5	-0.93	(1.76)	-1.65	(1.48)	-1.58	(2.45)		
S6	-2.05	(2.70)	-1.68	(1.64)	-1.96	(1.87)		
S7	-2.18	(2.53)	-1.88	(2.32)	-1.75	(1.25)		
S8	-3.05	(2.27)	-1.52	(1.97)	-1.74	(1.59)		
S9	-1.63	(1.40)	-0.40	(2.06)	-1.95	(1.18)		
S10	-2.27	(3.03)	-1.31	(1.94)	-1.93	(2.36)		
S11	-2.53	(1.39)	-0.85	(1.50)	-1.70	(1.27)		
S12	-1.81	(1.83)	-1.87	(1.34)	-1.58	(2.25)		
Main effects							n.s.	
Group x trials interaction							n.s.	

Table 37

The HR D1 in response to trials 13 - 15 for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S13	1.84 (2.25)	1.84 (2.09)	2.29 (1.11)				
S14	0.50 (1.07)	0.93 (1.54)	1.04 (1.19)				
S15	1.60 (2.05)	1.54 (1.82)	1.14 (1.36)				
Main effects		n.s.	Group x trials interaction			n.s.	

Table 38

The HR A1 in response to trials 13 - 15 for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S13	-1.12 (1.80)	-0.58 (1.81)	0.81 (1.55)				
S14	-2.30 (1.90)	-1.60 (1.47)	-1.25 (1.43)				
S15	-0.67 (1.46)	-1.21 (2.24)	-1.11 (1.47)				
Main effects		n.s.	Group x trials interaction			n.s.	

Table 39

The HR D2 in response to trials 13 - 15 for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S13	2.72 (2.52)	2.28 (1.75)	1.92 (1.19)				
S14	0.82 (2.88)	1.22 (1.30)	1.13 (1.67)				
S15	1.56 (1.58)	2.37 (3.18)	1.77 (1.02)				
Main effects		n.s.		Group x trials interaction		n.s.	

Table 40

The HR A2 inresponse to trials 13 -15 for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S13	-1.51 (1.89)	-1.54 (1.38)	-1.41 (2.10)				
S14	-2.86 (1.83)	-1.53 (1.96)	-1.46 (1.81)				P
S15	-2.03 (1.31)	-1.83 (2.03)	-1.30 (1.79)				P
Main effects		n.s.		Group x trials interaction		n.s.	

S24; schizotypics vs controls	F = 1.26	P <.01
S24; anhedonics vs controls	F = 1.31	P <.01
S24; schizotypics vs anhedonics		n.s.

The results are presented in Tables 41 to 44. As can be seen from Table 42 anhedonics produced significantly larger acceleratory responses for trials 20 and 24 than the control group. Schizotypics produced smaller deceleratory responses than the control group for trial 20 and gave significantly larger responses than the control group for trial 24.

90 dB TRIALS

The 3 groups were compared with respect to different HR measures in response to high intensity trials. No significant differences were found between the groups for any of the deceleration or acceleration responses. The means and standard deviations of these trials are presented in Tables 45 to 48.

Table 41

The HR D1 in response to CV trials for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P	
	M	(SD)	M	(SD)	M	(SD)			
S16	2.21	(2.65)	2.33	(2.34)	1.46	(1.16)			
S18	1.38	(0.96)	1.77	(1.69)	1.13	(1.27)			
S20	1.13	(1.88)	1.92	(2.27)	2.37	(1.28)			
S23	1.65	(1.64)	1.92	(2.33)	1.74	(2.09)			
S24	0.96	(1.63)	1.18	(1.08)	2.09	(1.78)			
S25	0.92	(1.53)	1.46	(1.47)	1.03	(1.24)			

Main effects					n.s.				
Group x trials interaction					n.s.				

Table 42

The HR A1 in response to CV trials for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S16	-0.09 (2.30)	-0.51 (2.10)	-1.16 (1.32)				
S18	-1.12 (1.48)	-0.91 (1.45)	-0.42 (1.13)				
S20	-1.72 (1.60)	-0.02 (2.00)	-0.43 (0.97)	4.06	<.02		
S23	-1.32 (1.81)	-1.42 (1.43)	-0.79 (2.29)				
S24	-1.32 (1.10)	-1.32 (1.61)	-0.03 (1.73)	3.70	<.03		
S25	-1.76 (1.78)	-1.49 (1.95)	-2.27 (1.89)				
Main effects						n.s.	
Group x trials interaction						F = 1.86	P <.05

Table 43

The HR D2 in response to CV trials for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S16	3.14 (2.20)	2.09 (2.73)	1.81 (1.40)				
S18	1.68 (1.77)	2.05 (1.52)	1.51 (1.61)				
S20	1.85 (1.65)	2.52 (2.19)	1.72 (0.94)				
S23	0.76 (2.58)	1.30 (2.07)	1.69 (2.69)				
S24	1.42 (1.31)	1.70 (1.56)	2.42 (1.86)				
S25	1.22 (1.48)	0.69 (1.75)	1.16 (1.70)				
Main effects						n.s.	
Group x trials interaction						n.s.	

Table 44

The HR A2 in response to CV trials for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S16	-0.30	(2.17)	-1.36	(2.20)	-1.07	(1.00)		
S18	-1.37	(2.01)	-1.27	(2.48)	-1.48	(2.37)		
S20	-1.94	(1.56)	-1.47	(2.64)	-0.54	(3.46)		
S23	-2.56	(2.30)	-2.12	(1.11)	-1.64	(2.48)		
S24	-2.44	(1.87)	-2.57	(2.41)	-1.10	(2.20)		
S25	-2.67	(1.96)	-2.05	(1.95)	-2.66	(1.92)		

Main effects					n.s.			
Group x trials interaction					n.s.			

Table 45

The HR D1 in response to 90 dB trials for the 3 groups of subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
S28	2.35 (1.56)	2.19 (2.64)		1.33 (1.91)			
S31	1.16 (0.54)	1.05 (1.03)		0.33 (1.22)			
S34	2.13 (1.71)	0.82 (1.36)		1.86 (1.93)			
S37	1.58 (2.83)	0.89 (1.71)		0.97 (1.84)			

Main effects				n.s.			
Group x trials interaction				n.s.			

Table 46

The HR A1 in response to 90 dB trials for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S28	-0.06	(1.51)	-1.19	(2.76)	-1.25	(2.77)		
S31	-1.52	(2.33)	-1.99	(3.31)	-2.02	(1.48)		
S34	-0.15	(2.34)	-1.50	(1.60)	-2.03	(2.49)		
S37	-0.96	(2.13)	-1.35	(2.05)	-0.94	(1.48)		

Main effects						n.s.		
Group x trials interaction						n.s.		

Table 47

The HR D2 in response to 90 dB trials for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
S28	2.67	(1.66)	2.04	(1.58)	2.22	(3.25)		
S31	1.95	(2.83)	1.73	(3.40)	1.64	(2.35)		
S34	2.79	(2.16)	2.49	(2.25)	1.08	(1.77)		
S37	2.21	(1.72)	1.58	(1.14)	1.95	(1.13)		

Main effects						n.s.		
Group x trials interaction						n.s.		

Table 48

The HR A2 in response to 90 dB trials for the 3 groups of subjects

	Anhedonics		Schizotypics		Controls		F	P	
	M	(SD)	M	(SD)	M	(SD)			
S28	-0.77	(1.76)	-2.33	(2.27)	-0.14	(3.55)			
S31	-1.99	(2.01)	-1.85	(3.21)	-2.31	(1.45)			
S34	-0.46	(2.02)	-2.28	(2.77)	-2.43	(2.50)			
S37	-2.09	(2.78)	-1.91	(2.10)	-2.18	(2.05)			

Main effects						n.s.			
Group x trials interaction						n.s.			

ORIENTING TRIALS

As before, it was decided that in the present experiment trials 1, 4, 13 and 16 would represent orienting trials. ANOVAs compared the groups with respect to heart rate deceleration and acceleration for the orienting trials grouped together and as a within subject variable. The results showed neither a significant main effect of groups nor a significant group x trials interaction effect when the analysis of variance was performed on all the orienting trials grouped together.

RE-ORIENTING TRIALS

As described before, re-orienting trials consisted of 3 pairs of trials which were; trials 3 and 4, 12 and 13, and 15 and 16. Analysis of variance was carried out for the responses of the 3 groups of subjects and for each of these pairs of trials and for each of initial deceleration and acceleration (D1 & A1) and secondary deceleration and acceleration (D2 & A2). The results showed no significant differences between the re-orienting responses of the 3 groups for the deceleration and acceleration of their heart rates.

Sex differences

The difference between male and female subjects were examined using the same procedure as that used for the skin conductance data. That is, the data for trials 1, 4, 13,

16, 28 and 30 were subjected to a group x trials x sex analysis of variance. The results failed to reveal any significant results.

DISCUSSION

In the present experiment it was hypothesized that individuals with schizotypal personality characteristics would show a disorder of heart rate responsivity similar to that found in schizophrenics and individuals with schizotypic personality. The heart rate orienting, re-orienting and habituation of schizotypics and anhedonics were examined. Initial and secondary heart rate deceleration and acceleration were assessed.

The only finding of interest in the present study was an indication that individuals with schizotypal personality showed a disorder of initial deceleration and acceleration of heart rate on a number of trials i.e. trials 3, 20 and 24. The results of D1 in response to trial 3 demonstrated that anhedonics produced smaller deceleratory responses while high scorers on the SZ scale produced significantly larger deceleratory responses than the control group. This is in line with the finding of larger amplitudes of SC responses produced by high scorers on the SZ scale and low frequency and generally lower amplitudes of SC responses by the anhedonics. However, on the acceleratory trials (20 and 24) no such picture emerged. For trial 20 both anhedonics and high scorers on the SZ scale produced smaller responses than the control group while on trial 24

both groups produced larger responses than the control group.

It might be concluded that this finding could indicate a disorder of habituation of heart rate responses particularly in high scorers on the SZ scale and is in line with the data obtained for the magnitude of SCR in which high scorers on the SZ scale showed a disorder of habituation. However, it is important to note that these results were not sufficiently consistent to be able to draw any conclusions as to the deficit of heart rate in individuals with schizotypic personality and occurred only for a small number of trials.

In general, heart rate responses to orienting trials did not distinguish between the groups and although some differences were present between the groups for a number of orienting trials these differences were not consistent throughout. Furthermore, the results of the present study did not replicate Simons' (1981) finding that anhedonics exhibited a lack of heart rate deceleration.

Analysis of data for males and females revealed that in most cases females produced a greater magnitude of responses than the male subjects, although overall no reliable differences between male and female subjects were observed. This was also the case with the data on sex

differences for skin conductance responses which failed to show any sex differences.

In conclusion, the results of the present study did not provide evidence concerning the disorder of heart rate resposivity in individuals with schizotypal personality and requires further investigation.

Chapter 9

EVENT RELATED POTENTIALS (ERPs)

A sensory event normally produces a sequence of negative and positive voltage deflections, in the scalp-recorded EEG, that may be related to perceptual, cognitive, or motor events. The voltage deflections evoked by specific events are known as 'event related potentials' (ERPs). An important characteristic of ERPs is that they are time locked to an identifiable event. This characteristic makes possible the discrimination of ERPs from the larger EEG voltages which are spontaneous fluctuations of the brain or other sources of electrical 'noise' and do not have a regular relationship with the stimulus event. The sensory evoked potentials which are referred to as 'signals' are generally much smaller than the spontaneous EEG activity. In order to enhance the evoked responses, so that they stand out against the background activity, a technique is used known as averaging or the improvement of 'signal-to-noise ratio'. This technique was first introduced by Dawson (1954). The averaging procedure involves recording of EEG in response to the presentation of stimuli over a large number of trials, then extracting the evoked potentials occurring immediately after each by storing successive epochs of activity after stimulus presentation and averaging them. The noise effects are therefore reduced in the averaging

process because they occur randomly in relation to the stimulus.

The components of ERP waves which are the concern of the present study are; the N1 or N100 and the P3 or P300. N1 is a negative waveform which occurs at a latency of around 100 msec following the stimulus onset. Directing attention towards stimuli enhances the magnitude of the N1 wave. Changes in the N1 component of the evoked potential is believed to be related to an early stage of stimulus selection in information processing and is evoked by physical characteristics of stimuli.

P3 is a positive component with relatively large amplitude that peaks at a latency of around 300 msec. The amplitude of P3 is usually enlarged in response to tasks requiring close attention or in decision making and the selection of target or task relevant stimuli.

Theories of attention and information processing have played an important role in evoked potential studies. A considerable number of evoked potential studies have shown that changes which occur in the amplitude of ERPs are related to attentional behaviour (Hillyard, Hink and Picton, 1973; Squires, Squires and Hillyard, 1975). Most of these studies are based on the theories of 'filtering' and 'pigeon-holing'. The typical method is to randomly

present infrequently occurring target stimuli, together with frequent non-target ones. The subjects' task is usually to respond to the rare, target stimuli and to ignore the non-target ones. As mentioned earlier attending to the stimuli on the basis of their certain early identifiable physical characteristics, e.g. location, intensity, type, represents filtering and is reflected in the amplitude of N1. The role of filtering or 'stimulus set' thus appears to be the recognition of the task relevant cues. On the other hand selection of target stimuli on the basis of characteristics that require some processing represents pigeon-holing and is indexed in the amplitude of P3 and occurs following a more detailed analysis of the stimuli.

Hink, Hillyard and Benson (1978) employed the evoked potential experiments in studies of selective attention in normals. In their study evoked potentials were measured in response to auditory stimuli. In their experiment they used four consonant vowels (CVs) which were tape-recorded and were spoken to either the subjects' right or left ears in a male or female voice. One of the four CVs presented to one of the ears was used as a target stimulus. The subjects' task was to make a response to the target and to ignore the non-target CVs. The results showed that there was a significant difference between the amplitude of P3 elicited by the target and non-target stimuli. That is, a larger P3 amplitude was evoked only by target CVs.

Analysis of N1 component showed that all the target and non-target CVs presented to the attended ear elicited larger N1 amplitudes than did the CVs presented to the rejected ear.

Evoked potential studies have also been widely used in examination of the attentional behaviour of schizophrenics (Roth and Cannon, 1972; Pass et al., 1980). Of the various evoked potential studies of information processing in schizophrenia the 'continuous performance test' (CPT) method has produced consistent results over time. Pass et al. (1980) tested a number of schizophrenics and non-psychotics using a continuous performance test in which the subjects were instructed to respond to letter 'X' from a number of other letters. They found that the schizophrenic group showed a smaller amplitude of P3 in response to the target stimuli, compared with the non-psychotic group. A similar finding was reported by Roth et al. (1980). In this study schizophrenics and matched control subjects performed an evoked potential test in a reaction time experiment in which they responded to infrequent (1200 Hz) tones randomly occurring among frequent (800 Hz) tones. The results showed that schizophrenics exhibited a smaller amplitude of P3 ($6\mu\text{V}$) compared with normals ($14\mu\text{V}$). The small P3 produced by the schizophrenic indicates the disorder of pigeon-holing in schizophrenics. The amplitude of N1 was not different for schizophrenics and control

subjects in response to infrequent tones. However, schizophrenics showed a slightly smaller amplitude of N1 to frequent stimuli.

A similar study is that by Cohen, Sommer and Hermanutz (1981) in which they examined a group of chronic non-paranoid schizophrenics and a group of normal control subjects on an auditory evoked potential test in which the target (rare clicks of high intensity) were delivered among more frequent non-target clicks of lower intensity. The subjects' task was to count the clicks of higher intensity. The results showed that the amplitude of N1 in response to non-target stimuli was smaller for schizophrenics compared with those of normal subjects. Their N2 (a negative component of ERP occurring around 200 msec following the onset of stimulus) and P3 were also smaller than those of control subjects. They also made more errors in counting the target clicks. The importance of these results in relation to attention in schizophrenics is that the majority of schizophrenic subjects who show a small amplitude of N2 were also electrodermal non-responders.

From the evoked potential studies of schizophrenia mentioned above, it can be concluded that the impairment of information processing in schizophrenics could lie mainly in their inability to pigeon-hole information.

Evoked potentials in individuals at risk for schizophrenia

A number of studies have shown that individuals with a tendency for the development of schizophrenia are also known to exhibit reduced amplitude of P3 compared with control subjects. For example, as mentioned previously, in the New York high-risk project, Friedman et al. (1979) designed two CPT paradigms which differed in their processing complexity in which ERP to infrequent relevant, irrelevant and background auditory events were recorded. The subjects consisted of two independent samples of children at risk for schizophrenia who had one or two schizophrenic parents. The subjects were instructed to respond to one of the infrequent stimuli. The high risk children produced considerably smaller N1 and P3 amplitudes in response to infrequent relevant tones than the control subjects. A subgroup of high risk children showed abnormally small between-task differences in the amplitude of the P3 component. Friedman et al. (1979) suggested that these results might indicate a deficit of information processing or might be an index of difference in the way in which high risk children analyze information. Itil et al. (1974) and Saletu et al. (1975), however, reported a finding of no amplitude differences between high risk and control children.

Evoked potentials in schizotypic individuals

Simons (1982) examined the electrocortical characteristics of anhedonics and control subjects in an auditory evoked potential experiment. He hypothesized that anhedonic subjects might show a smaller amplitude of the P3 component compared with control subjects. The results provided support for Simom's hypothesis. As he predicted, anhedonic subjects produced a significantly smaller amplitude of P3 than control subjects. Miller, Simons and Lang (1984) also reported reduced P300 amplitude in response to auditory stimuli, among subjects scoring high on the physical anhedonia scale. However, a study by Ward, Catts, Armstrong, and McConaghy (1984) in which auditory evoked potential was examined in a group of university students, failed to replicate this finding. It should be noted, however, that the study by Ward et al., was not comparable in design with those of Simons and Miller et al.

A more recent psychophysiological study of individuals with schizotypic personality characteristics was that by Josiassen et al. (1985). In this study college students who scored highly on Chapmans' physical anhedonia and perceptual aberration scales, took part in an attentional study of Somatosensory Evoked Potentials (SEPs). Anhedonics and perceptual abberation subjects were compared with two matching control groups who scored low on these two scales. In addition the anhedonic group were compared

with a group of schizophrenic subjects. The task consisted of counting electrical pulse stimuli randomly delivered to one of four fingers. The stimuli consisted of square waves of .1 msec duration. Their results showed that the P400 amplitudes (a SEP late positive component which is equalent to P300) of anhedonics were lower than those of the control subjects, whereas the P400 amplitudes of high scorers on the perceptual aberration scale, did not differ from those of their matched control subjects. They also found that the amplitude of P400 for anhedonics did not differ significantly from those of the schizophrenic subjects.

This finding is in line with the finding reported by Simons (1981) in which anhedonic subjects showed a lack of responsivity of skin conductance and heart rate orienting whereas, the perceptual aberration subjects showed skin conductance and heart rate responsivity similar to those exhibited by the control subjects.

In Josiassen et al. study, the early SEP peak change which is believed to indicate impaired sensory filtering did not show any differences between any of the groups.

In conclusion it might be said that the finding of reduced amplitude of late positive components in

with a group of schizophrenic subjects. The task consisted of counting electrical pulse stimuli randomly delivered to one of four fingers. The stimuli consisted of square waves of .1 msec duration. Their results showed that the P400 amplitudes (a SEP late positive component which is equalent to P300) of anhedonics were lower than those of the control subjects, whereas the P400 amplitudes of high scorers on the perceptual aberration scale, did not differ from those of their matched control subjects. They also found that the amplitude of P400 for anhedonics did not differ significantly from those of the schizophrenic subjects.

This finding is in line with the finding reported by Simons (1981) in which anhedonic subjects showed a lack of responsivity of skin conductance and heart rate orienting whereas, the perceptual aberration subjects showed skin conductance and heart rate responsivity similar to those exhibited by the control subjects.

In Josiassen et al. study, the early SEP peak change which is believed to indicate impaired sensory filtering did not show any differences between any of the groups.

In conclusion it might be said that the finding of reduced amplitude of late positive components in

individuals with schizophrenic tendency might be one of the pre-morbid indices of schizophrenia.

EVOKED POTENTIALS

Method and procedure

EEG was recorded using the monopolar method of recording. That is, comparing the potential differences between the scalp electrodes and the reference electrode placed on an electrically inactive site. Silver/silver chloride cup electrodes of .9 cm in diameter were used. This type of electrode has a small hole in its centre through which electrode jelly can be injected. The electrodes were attached following the international 10-20 system of electrode placement (Jasper 1958), which is based on measurements made from four standard points on the head known as nasion, inion, and the left and right preauricular points. After the electrode sites were marked they were cleaned with acetone in order to remove the epidermal substances from the surface of the scalp and to obtain a good contact. The electrodes were filled with 'Neptic' electrode gel and were attached to the scalp using collodion glue, a fast drying adhesive. The glue was applied around the rim of the electrodes and an air gun was used to speed up the setting of the glue.

The electrodes were placed at Cz (vertex) that is, the central midline site. The reason for the selection of these sites was that Cz is considered to be the best recording sites for both N1 and P3 components of evoked potentials. In addition, previous evoked potential studies

of schizophrenics have consistently reported a diminished amplitude of P3 component in schizophrenic subjects, at the central electrode site (e.g. Levitt et al., 1973; Roth and Cannon, 1972). The EEG electrodes were referred to linked mastoids (behind the ears) and the ground electrode was attached to the middle of the forehead using an adhesive collar.

EOG (electro-oculography), which is an electrical technique used for recording potential differences from electrodes placed around the eyes, was recorded from Beckman miniature silver/silver chloride disc electrodes of 1 cm in diameter. Electrodes were placed immediately above and below the left eye in order to record eye blinks and to enable the EEG segments contaminated by eye blinks to be omitted. Adhesive collars were used to attach the EOG electrodes. The resistance of the electrodes was then checked using an electrode impedance measurement device. This was done to insure that for both EEG and EOG electrodes the impedance was less than $5K\Omega$ (kohm) and roughly similar for all electrodes. Any of the electrodes which showed impedance exceeding $5K\Omega$ were re-adjusted. EEG and EOG were recorded using a Grass Model 79D Polygraph. High and low frequency cut off points were set at 75 Hz and .3 Hz, respectively. A Racal Store 4 magnetic tape recorder was used to record EEG and EOG data. Subjects sat alone in a light and sound attenuated room. They were

asked to sit in a comfortable position and they were then given instructions. There then followed a brief practice of 20 trials for task familiarization.

STIMULUS PRESENTATION (EPs)

In the present study the paradigm employed consisted of a Continuous Performance Test (CPT). The CPT task consisted of 5 stimulus letters as follows; letter B, D, G, P, and T which were presented randomly on a display scope. A mask was placed over the face of the scope with a central aperture of 2.5 cm². The letters appeared within this aperture either to the right or left of its' centre. The task therefore, consisted of ten conditions. Each condition contained 50 trials, a total of 500 trials in all. The stimulus sequence was identical for all the subjects. The inter-stimulus interval was 1 second and the exposure time .14 seconds. The target letter was varied randomly for each subject. The viewing distance was approximately 2 metres. The subjects wore headphones which delivered a constant white-noise of low intensity during the experiment in order to mask external noises.

The subjects were instructed to press a response button each time and only when a designated target stimulus appeared and to ignore the non-target stimuli. The target stimulus was one of the five letters presented to one of the two locations and constituted 10% of the trials. The

rest of the trials were considered as non-target and were to be ignored. Ten per cent of the non-target letters were identical to the target letter but were presented in a different location from that of the target stimulus and therefore were to be ignored.

The response button was connected to the marker channel of the polygraph in order to record the subjects' responses. They were also instructed to minimize eye blinks and body movements. The testing time for the CPT was approximately 15 minutes.

A PDP11/40 computer was used to present the stimuli and to record the behavioural measures of reaction time and target detection accuracy. A buttonpress in response to the target stimulus was considered to be a 'hit' and to the non-target irrelevant stimuli a false alarm.

ERP DATA REDUCTION

In order to sample the recorded EEG stored on the magnetic tape, the data was fed into the PDP11/40 computer after passing it through a filter (Kemo VBF8) and an analogue-to-digital converter. The high frequency filter was set at 75 Hz. Prior to sampling, the EOG data were displayed on a GT-40 screen for visual inspection and in order to keep a record of the ERP trials contaminated by

eye blinks. This file was used by the sampling program to delete the contaminated trials from the EEG data before averaging.

The EEG segments related to incorrect behavioural responses on the target detection task were also deleted. Incorrect responses consisted of either errors of commission (when the subjects pressed the response button when the target letter was not present), or errors of omission (when the subjects failed to respond at the occurrence of the target letter).

The EEG data were sampled for 1000 msec, beginning 200 msec prior to the stimulus onset. The sampling program was used in conjunction with another program which provided information concerning the inter-trial intervals and the stimulus conditions and other relevant details. The averaging program computed averaged evoked potentials for each of the 10 conditions separately. ERPs were averaged separately for each stimulus condition. The resulting output were stored in a data file on a disk.

Finally a scoring program was employed to measure the amplitude and latencies of the evoked potential waveforms. The averaged ERP waves were displayed on the GT-40 screen in order to score the relevant peaks and troughs. This was done using two hand set cursors positioned at each side of

a given component. The resulting values were saved on a file. ERP amplitudes; the maximum positive or negative deflection within the specified latency windows were scored. The latency window for the N1 component ranged from 80-110 msec and the latency window for P3 was between 290 and 350 msec.

EVOKED POTENTIAL RESULTS

THE EP COMPONENTS

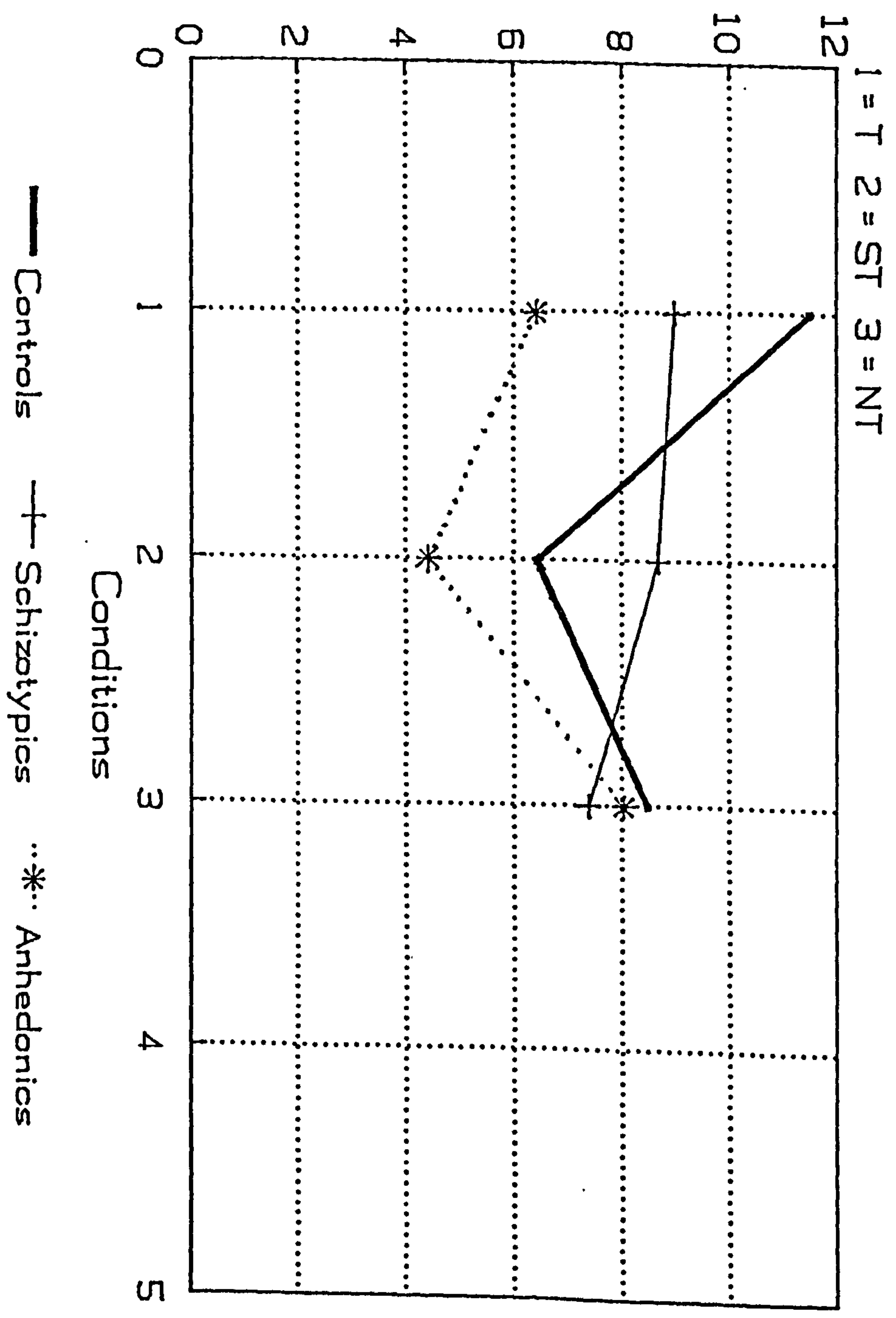
As described previously, the subject's task was to respond only to one particular type of stimulus out of 10 types of stimuli. The other 9 types of stimuli were irrelevant and were to be ignored.

The scores for the P3 amplitudes were grouped into; P3 evoked by target stimuli, P3 evoked by non-target stimuli and P3 evoked by stimuli which were similar to the target letters but were to be ignored on the basis of the location of their presentation. The same classification was used for the amplitude of the N1 component.

The P3 component was defined as a positive wave occurring in the latency window of 290-350 msec after the stimulus onset, relative to a pre-stimulus baseline. The N1 wave was defined as a negative wave in the latency window ranging from 80 to 110 msec.

The plots of the mean amplitudes of the P3 waves for anhedonics, schizotypics and control subjects are presented in Figure 9 and show the means associated with each of the three conditions. T refers to target stimuli, NT refers to non-target stimuli and ST to trials which were similar to target stimuli but were not to be responded to.

Fig 9 P3 amplitudes (micro-volts)



RESULTS OF P3 COMPONENT

A group x conditions analysis of variance was performed on the amplitudes of the P3 component for the three groups of anhedonics, schizotypics and control subjects and for the three experimental conditions (target stimuli, non-target stimuli and trials similar to target stimuli). A significant main effect of groups ($F = 3.38$, $P < .04$), and a significant group x trials interaction effect ($F = 2.80$, $P < .03$) were found.

P3 amplitude in response to target stimuli

A one-way analysis of variance was carried out to compare the amplitude of responses of the three groups in response to the target trials. A significant group x trials interaction effect was found between the responses of the three groups ($F = 4.79$, $P < .01$).

It is clear from Figure 9 that while control subjects produced a large mean amplitude of P3 in response to target stimuli, schizotypics and in particular anhedonics produced a considerably smaller mean amplitude of P3 in response to these trials. Post hoc analysis (Tukey's HSD) was carried out to compare the means of the P3 components for the groups. Significant differences were found ($F = 3.64$, $P < .01$) for the comparison between the amplitude of P3 evoked by the target letters for anhedonics compared with control subjects. The data for the schizotypics and

Table 49

The amplitude of P3 component for the three groups of subjects in response to target, non-target and trials similar to target stimuli

	Anhedonic		Schizotypic		Control		F	P
	M	(SD)	M	(SD)	M	(SD)		
TA	6.41	(3.46)	8.98	(4.56)	11.50	(4.50)	4.79	<.01
ST	4.44	(2.56)	8.67	(4.39)	6.43	(3.75)	4.36	<.02
NT	8.03	(4.21)	7.37	(4.23)	8.48	(4.25)		n.s.

Main effects $F = 3.38$ $P < .04$

Group x condition interaction $F = 2.80$ $P < .03$

control subjects were subjected to the same analysis. The difference between the amplitude of the responses of the schizotypics and control subjects for the target trials were not statistically significant. The means, standard deviations and P values of the evoked responses for the three groups in response to target stimuli are presented in Table 49. TA refers to target stimuli, NT to non-target, and ST refers to trials similar to target stimuli.

P3 amplitude in response to non-target stimuli

ANOVA was performed on the amplitude of responses of the three groups for non-target trials. No significant differences were found between the responses of the groups for the non-target stimuli. These results are presented in Table 49.

P3 amplitude in response to trials similar to target stimuli

Analysis of variance compared the amplitude of responses of the three groups of subjects obtained from trials in which the non-target letters were similar to target letters but were to be ignored. The results showed that there was a significant difference between the groups for the amplitude of P3 in response to trials similar to target stimuli ($F = 4.36$, $P < .01$). Post hoc analysis compared the means of responses of anhedonics versus control subjects. No significant difference was found

between the responses of the two groups. Similar analysis revealed that the differences between schizotypics and control subjects were also not significant. A highly significant result was found for the comparison between anhedonics and schizotypics ($F = 3.18, P < .01$). Means, standard deviations, F ratios and P values of these trials are presented in Table 49 for the three groups.

THE RESULTS OF N1 COMPONENT

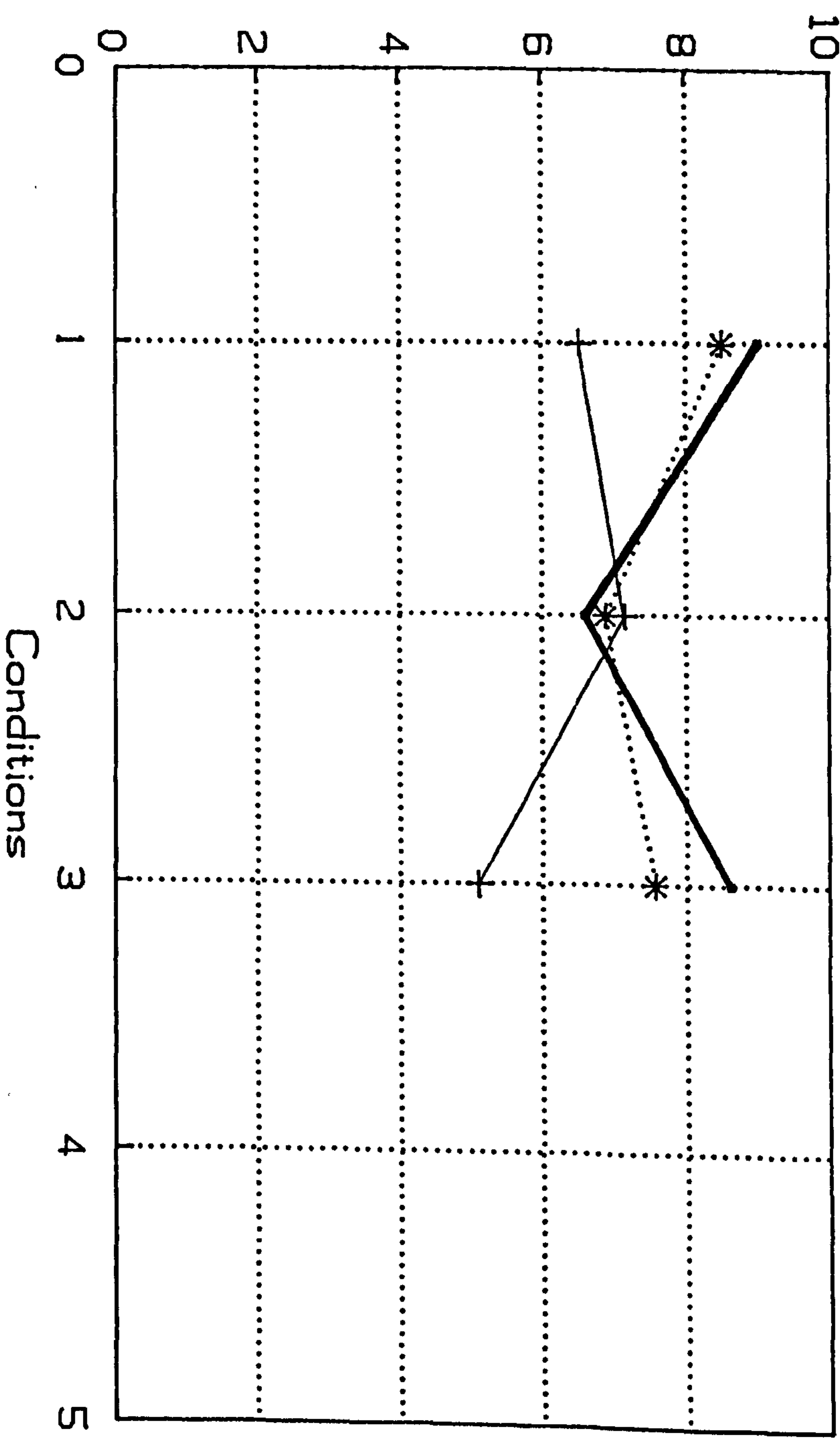
A group x conditions analysis of variance compared the amplitude of N1 for the 3 groups of subjects. As shown in Table 50 neither any significant main effect of groups nor any significant group x conditions interaction effect was found between the responses of the 3 groups for the 3 experimental conditions. The means for the amplitude of N1 are graphically presented in Figure 10.

Behavioural data

In order to examine the accuracy of subjects' responses for the CPT, the number of incorrect responses were calculated for all of the trials and for each subject. The error responses were then grouped into two separate error scores i.e. errors of omission calculated from the number of misses and errors of commission made up of the number of false alarms. These values were then subjected to a group (3 groups) x errors (2 types) analysis of variance. A significant main effect of groups ($F = 3.60,$

Fig 10 N1 amplitudes (micro-volts)

1 = T 2 = ST 3 = NT



— Controls + Schizotypics ...*... Anhedonics

Table 50

The amplitude of N1 component for the three groups of subjects in response to target, non-target and trials similar to target stimuli

	Anhedonic		Schizotypic		Control		F	P
	M	(SD)	M	(SD)	M	(SD)		
TA	8.50	(6.04)	6.52	(4.40)	9.01	(4.31)		
ST	6.88	(4.37)	7.15	(3.09)	6.60	(4.95)		
NT	7.56	(5.26)	5.10	(4.42)	8.62	(4.30)		
Main effects						n. s.		
Group x conditions interaction						n. s.		

P <.03) and a highly significant group x error interaction effect (F = 6.30, P <.004) were found. The means of the error data are graphically presented in Figure 11.

One-way analyses were carried out for each of the error conditions separately. The results were as follows;

Errors of commission

Analysis of errors of commission revealed a significant difference between the error responses of the 3 groups (F = 3.04, P <.05). Post hoc analysis, HSD procedure, indicated that the significant difference between the groups was due to the schizotypic group making significantly more errors of commission (F = 1.27, P <.05). The comparison between the responses of anhedonics and control subjects revealed no significant difference between the error responses of the two groups. The difference between the means of the responses of anhedonics and that of the schizotypics was also significant (F = 1.34, P <.05). The results are presented in Table 51.

Errors of omission

Analysis of variance was carried out for the errors of omission for the 3 groups of subjects. The results showed that there was a significant difference between the error responses of the 3 groups (F = 5.85, P <.006). Post hoc analysis revealed a significant difference between the means of responses of schizotypics and the control group

Fig 11 ERP errors

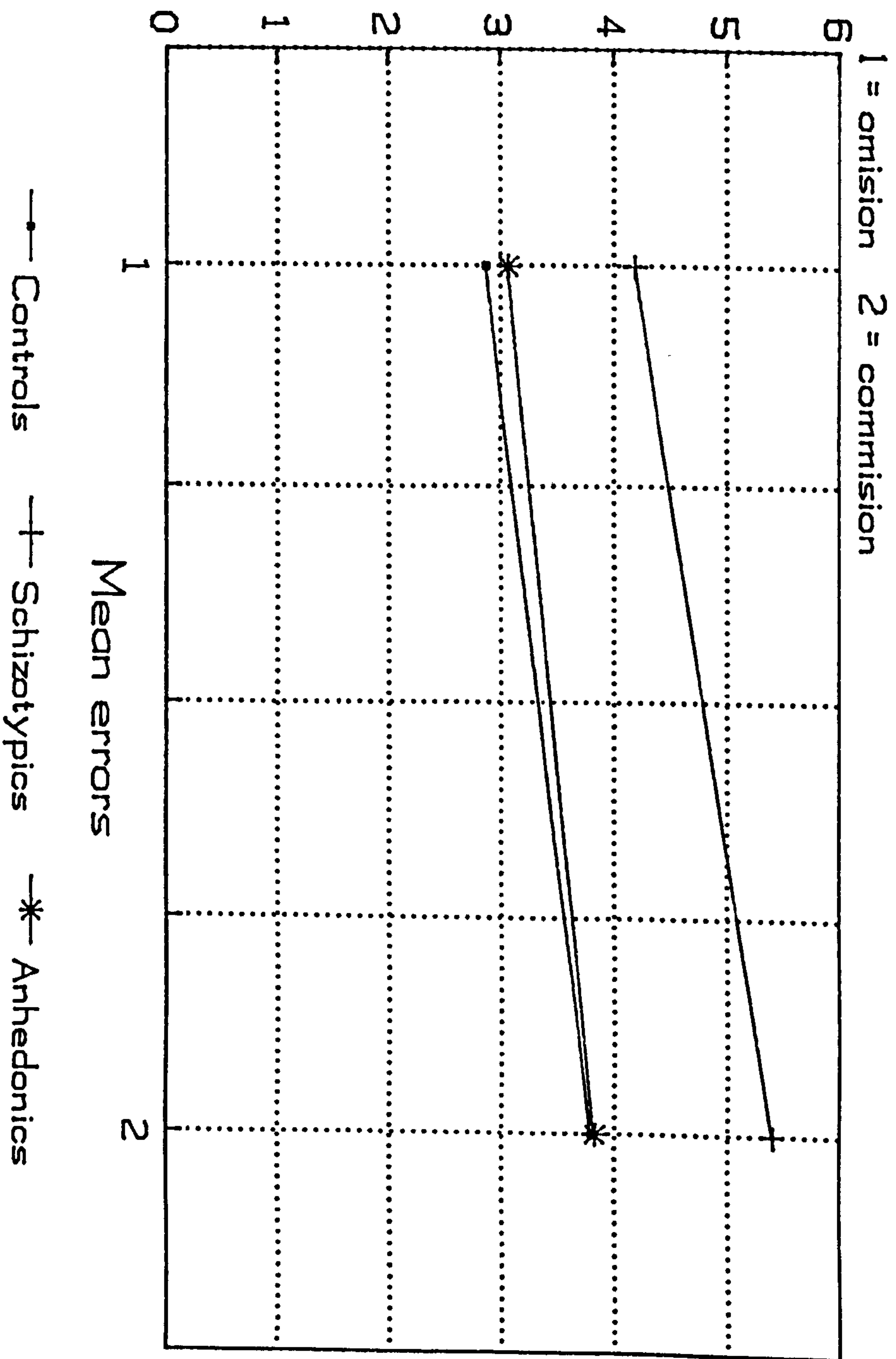


Table 51

The errors of omission and commission for the three groups of subjects

	Anhedonic		Schizotypic		Control		F	P
	M	(SD)	M	(SD)	M	(SD)		
Omission	3.07	(1.49)	4.19	(2.27)	2.87	(1.24)	5.85	<.006
Commission	3.83	(2.59)	5.40	(1.88)	3.80	(1.52)	3.04	<.05

Main effects					F = 2.45	P <.09		
Group x errors interaction					F = 6.30	P <.004		

($F = 1.36$, $P < .01$). The same was true for the comparison between schizotypics and anhedonics ($F = 1.43$, $P < .01$). No significant difference was found between the errors of anhedonics compared with that of the control group. The results are shown in Table 51.

The reaction time performances of the 3 groups for the CPT were also examined. No significant differences were found between the 3 groups.

Sex differences

In order to examine the differences between the responses of male and female subjects the P3 and N1 data for each group of subjects obtained from the three classes of stimuli were divided into male and female responses. A 3 way, group x sex x conditions analysis of variance compared the responses of male and female subjects for the amplitudes of P3 and N1 (separately). A significant group x conditions x sex interaction was found for the amplitude of the N1 component ($F = 3.34$, $P < .01$). Post hoc analysis revealed that the significant result was due to male anhedonics producing significantly smaller amplitudes of N1 in response to trials similar to target stimuli ($F = 3.81$, $P < .01$). No other significant differences were found between male and female subjects.

DISCUSSION

It has been consistently found that in a paradigm known as the 'oddball' in which subjects are instructed to detect target stimuli and ignore the non-target ones, the target stimuli elicits a large amplitude of the P3 component in normal subjects and a significantly smaller amplitude of P3 in schizophrenics.

In the present experiment anhedonics produced a considerably smaller amplitude of P3 compared with the control subjects. This was also the case for the stimuli which were similar to the target letters but were classed as irrelevant. In response to non-target stimuli the amplitude of P3 did not differ among groups.

The result of a reduced amplitude of P3 in anhedonics is in line with the finding of Simons (1982), Miller, Simons and Lang (1984) and Josiassen et al. (1985) in which high scorers on the anhedonia scale produced significantly smaller amplitudes of P3. This has also been consistently reported to be the characteristic of some but not all schizophrenics (Levit, Sutton and Zubin, 1973) and children at risk for schizophrenia (Friedman et al., 1979)

As mentioned before, a more complex stage of information processing and an active discrimination and

recognition of each single stimulus is believed to be related to pigeon holing or focal attention and is indexed by the amplitude of the P3 component. The results concerning the amplitude of P3 evoked by the target stimuli, therefore indicate that anhedonics showed the deficit of pigeon holing or response set. In addition, they produced a smaller amplitude of P3 in response to non-target trials which had a similar characteristic to those of the target stimuli. This as described previously, is in line with the low degree of responsivity of their electrodermal activity and is to an extent similar to the findings by Cohen, Sommer and Hermanutz (1981) which showed that a group of schizophrenic patients who were electrodermal non-responders showed a smaller amplitude of the P3 component compared with normals.

These results therefore indicate a psychophysiological resemblance between schizophrenics and anhedonics and are consistent with previous findings concerning the disorder of pigeon holing in schizophrenics (Pass et al., 1980). It could therefore, be suggested that anhedonics show an impairment of central mechanisms similar to that found in schizophrenics shown by their P3 amplitude.

In the present study it was also hypothesized that the analysis of information on the basis of a simple characteristic such as it's location is regarded as a

filtering task, and the acceptance or rejection of a stimulus is based on an early level of stimulus processing which is indexed by the size of the N1 component. It was presumed that if stimuli are rejected by the filter the N1 amplitude to the rejected stimuli would be smaller. The results of the present study failed to find significant differences in the early stage of information processing between individuals with schizotypal personality and control subjects and it was found that the amplitude of N1 did not differ between groups. This therefore, might indicate that the hypothesized disorder of filtering mechanism might not be present in individuals with schizotypic personality characteristics. This finding is in line with the results of the review by Helmsley and Richardson (1980) which suggested that schizophrenics appear adequate with regard to filtering.

Another finding of the present study was that the high scorers on the SZ scale made significantly more errors of omission and commission than the control group, whereas the button press performance of anhedonics was comparable with that of the control subjects for the error of commission even though they showed a smaller P3 amplitude than the control subjects. It was unusual to find, that although it was schizotypics who showed greater behavioural deficit on CPT, it was the anhedonics who showed the P3 deficit. Furthermore, the present result is in line with the findings

of high risk studies reported by Rutschmann, Cornblatt and Erlenmeyer-Kimling (1977) and Nuechterlein (1983) in which children and siblings of schizophrenics showed poor performance of CPT. It is also in line with the result of a study by Nuechterlein, Asarnow and Marder (In preparation) who found that individuals identified as schizotypics selected on the basis of their scores on questionnaires measuring schizotypic tendencies, showed deficit of performance of CPT.

In conclusion the present results provide further evidence for a deficit of selective attention in individuals with schizotypal personality characteristics.

ATTENTION AND INFORMATION PROCESSING

Disorder of attention and information processing is considered as a major symptom of schizophrenia. In order to understand the nature of the information processing disorders in schizophrenia various investigators have employed information processing theories developed in cognitive psychology. One of these theories is that of Broadbent (1958 & 1971). Broadbent's model was derived from a vast amount of work with normal subjects. According to this theory information processing occurs through selection of relevant cues from a large amount of information available. This process is called 'filtering' and has the function of reducing the information load and ensuring that only relevant information will be selected. The filter mechanism screens out irrelevant stimuli from a so-called 'limited-capacity decision channel'. The filter acts on the basis of the physical attributes of stimuli and excludes irrelevant information at an early stage of processing. According to this model the selected information is then fed into the 'long-term memory store' where the incoming cues are compared against the previously stored information (Broadbent, 1958). Filtering therefore, refers to an early stage of information processing.

Broadbent's theory of filtering has greatly influenced the work of a number of investigators who have been

interested in the study of information processing in schizophrenics. This model resulted in two opinions concerning the nature of the disorder of information processing in schizophrenia; one is that schizophrenics possess a defective filter mechanism (e.g. McGhie and Chapman, 1961) and the other is that schizophrenics are slow in processing information (Yates, 1966). Yates suggested that when information enters the limited capacity channels, it is retained in the short term store for only a limited period of time and because schizophrenics are slow to use the stored information, most of it will be lost.

Both of the above formulations i.e. a disorder of selective attention and the slowness of cue utilization have been supported by a number of studies as being the characteristics of schizophrenics. The consistent finding that schizophrenics show slowness of performance on masking tasks or require a longer interval between a target stimulus and a subsequently presented visual noise mask in order to reach unmasked levels of performance, provides support for the theory that schizophrenics are deficient in their speed of information processing (Saccuzzo et al., 1974). A typical backward masking paradigm consists of a briefly presented relevant stimulus, known as the test or target stimulus, followed by a masking noise stimulus. This is believed to allow for the assessment of the speed of information processing. The backward masking procedure

is based on a theory of information processing put forward by Neisser (1967). According to this theory briefly presented target stimuli enter in parallel into a storage system of short duration and large capacity called 'iconic storage' or iconic memory. The information in iconic memory does not immediately reach awareness until it is transferred serially, by a hypothetical scanning mechanism, to a more permanent short term memory. The theories of backward masking mainly assume that the masking noise stimulus limits the duration or quality of information in iconic memory and therefore, provides a means of measuring the speed of information transfer from iconic memory to more permanent memory processes (Kahneman, 1968; Spencer 1969 and Spencer and Shuntich, 1970). Furthermore, by determining the interval between the test and mask stimulus at which the mask no longer interferes with processing of the test stimulus, an individual's speed of information transfer from iconic storage can be estimated.

Backward masking studies of schizophrenics have shown that schizophrenics have impaired critical stimulus durations and slowed processing from iconic memory to short term memory (Saccuzzo and Braff, 1981).

More recent models of information processing emphasize a late stage of information processing which concerns response selection. This view was first put forward by

Deutsch and Deutsch (1963) and was later developed by Broadbent (1971) suggesting a 'pigeon holing' or 'response set' stage of information processing which involves a more detailed analysis of incoming information and uses more complex cognitive processing (Broadbent, 1971).

The application of Broadbent's theories of filtering and pigeon holing to work on schizophrenia was examined by Helmsley (1975) and Helmsley and Richardson (1980). In 1975 Helmsley reviewed various experiments in which both filtering (stimulus set) and pigeon holing (response set) had been tested in schizophrenics. The conclusion from this review was that most of these studies had not been designed to differentiate between filtering and pigeon holing or to determine the locus of the disturbance in schizophrenics. He also suggested that the evidence from these studies indicating a disorder of filter mechanism in schizophrenics was particularly weak and did not allow for a conclusion as to whether a response set or a stimulus set was the locus of the dysfunction of information processing in schizophrenics. In a recent study Hemsley and Richardson (1980) reported a deficit in the pigeon holing stage of information processing in schizophrenics. They tested a group of schizophrenics, depressed and normal subjects on a binaural listening task in which pairs of simultaneous continuous prose passages were presented to the subjects. Their task was to shadow (repeat) one

passage of each pair and ignore the other. The experiment was therefore, designed to examine pigeon holing or a relatively late stage of processing. The results indicated that schizophrenics performed significantly worse than both normals and depressed subjects. Further evidence concerning the disorder of pigeon holing in schizophrenia could be cited from a review by Venables (1981) in which he examined the data on evoked potential studies of schizophrenics. He suggested that schizophrenics show a disorder of pigeon holing indicated by their diminished amplitude of the P3 component of ERPs.

Another theory has been proposed by Neisser (1967) who suggested that information processing consists of two features. One he called the 'pre-attentive process' and the other 'focal attention'. The function of the pre-attentive process, he believes, is the segmentation of sensory information. The role of focal attention on the other hand is the analysis of the separated parts in a more detailed manner. In other words he sees information processing as a fast intake of input cues which can be thought of as the stage of registration and storage, followed by a slow and detailed examination of these cues which involves analysis of information and production of responses.

Kahneman (1973) combined some of the theories of mechanisms of attention and information processing into a theory known as "allocation policy". This theory emphasized the role of effort in information processing and suggested that individuals have a limited capacity and effort to use for attending to incoming information. The method by which individuals allocate their effort among all stimulus inputs is called allocation policy and is determined by the task requirements, as well as by the individual's capacity to attend to certain stimuli. Furthermore, in Kahneman's theory the allocation policy is influenced by the individuals' interpretation of their immediate environment.

Information processing therefore, is seen as a mechanism with various hypothesized stages which might be impaired in schizophrenics. A breakdown in any of the mechanisms could result in a disorder of information processing and attention.

Another theory of attention and information processing is that of arousal or activation. Arousal level is believed to play an important role in performance efficiency. According to arousal theory the individuals' state of alertness varies along a continuum from sleep to excitement. When people's arousal levels are too low they are inattentive and therefore, their performance is likely

to suffer. On the other hand if the level of arousal is too high it results in an excessive amount of tension and anxiety which affect performance. A mild level of arousal results in an optimal level of alertness and attentiveness and performance is likely to be highly efficient.

The deficit of performance of schizophrenics in various attention demanding and information processing tasks is believed to be related to abnormalities in their arousal mechanism. Claridge (1967) suggested that there are two functionally related systems involved in the arousal mechanism. The 'tonic arousal system' and the 'arousal modulating system'. He suggested that the function of the tonic arousal system is to maintain the gross level of arousal while the arousal modulating system regulates and controls the level of activity in the tonic arousal system. It also controls the stimulus input through facilitation and inhibition of incoming stimuli. Claridge suggested that the abnormal arousal of schizophrenics could be attributed to a breakdown in this relationship and to a dissociation of function between these two systems.

In the present study it is hypothesized that individuals with schizotypal personality might show a disorder of information processing similar to that shown by adult schizophrenics. There is increasing evidence which

suggests that children at risk for schizophrenia suffer from an impairment of information processing similar to that shown by schizophrenics. Garmezy (1974) in a review of the studies of attentional disorder in high risk populations also found evidence to indicate that children at risk for schizophrenia show a poor performance on tasks demanding attention.

INFORMATION PROCESSING IN INDIVIDUALS AT RISK FOR
SCHIZOPHRENIA

A number of investigators have studied children at risk for schizophrenia using measures that have successfully distinguished between schizophrenics and normals. These studies have repeatedly shown various attentional and information processing deficits in high risk populations. For example, in a doctoral dissertation by Marcus (1972) children of schizophrenic mothers and children of non-schizophrenic psychiatrically disturbed mothers were examined using a reaction time experiment. They found that children of schizophrenic mothers showed slow overall simple reaction time. The overall reaction time of children at risk was significantly slower even under 'high incentive' conditions or when they were given information about the length of preparatory intervals. Marcus (1972) suggested that an impairment of attention might characterize children at risk for schizophrenia.

A similar finding could be cited from the results reported by Van Dyke, Rosenthal and Rasmussen (1975). In their cross-fostering study of children at risk for schizophrenia they studied four groups consisting of children born to one schizophrenic parent, children born to a non-schizophrenic parent, children brought up by a schizophrenic parent and children brought up by a non-schizophrenic parent. All subjects except those born and

brought up by a schizophrenic parent were adopted children. The results of their reaction time study revealed that the groups brought up by a schizophrenic parent were significantly slowed in overall mean reaction time compared with those brought up by non-schizophrenic parents. Phipps-Yonas (1978) extended Marcus' study using a cross-modal reaction time paradigm consisting of auditory and visual stimuli with brief preparatory intervals. Her results however, did not confirm Marcus's findings. This failure to replicate Marcus's findings has been attributed to the differences between the procedures employed in the two studies. Spring (1980) also found that overall simple reaction time did not distinguish siblings of schizophrenic patients from normal subjects in a cross-modal reaction time paradigm.

Several other studies have demonstrated that children at risk for schizophrenia show a disorder of attention similar to that shown by adult schizophrenics. For example, Asarnow, Steffy, MacCrimmon and Cleghorn (1978) tested three groups of subjects;

- 1) Children who had schizophrenic mothers but were raised in foster homes.

- 2) Foster home children with no family history of psychiatric illnesses.

- 3) Normal adolescents living with their normal parents.

Various attention demanding tasks were used in this study consisting of; competing voices, a concept attainment task, CPT, digit symbol substitution from the Wechsler Adult Intelligence Scale, simple reaction time, forced choice span of apprehension, spokes test and the stroop colour-word test. The results showed that five out of nine foster home children who had schizophrenic mothers showed significant impairment on some attention-demanding tasks. These were in particular the forced-choice span of apprehension task, spokes test and the simple conditions of the concept attainment task indicating a performance deficit among high-risk children. However, this applied to only one foster control subjects and none of the community control subjects. One of the children at risk showed a poor performance on seven out of eight tasks used in this experiment and his reaction time latencies were very similar to those shown by adult schizophrenic patients.

Another area of attention and information processing in which children at risk for schizophrenia have been found to show a deficit is sustained attention as examined by the Continuous Performance Test (CPT). A CPT task is usually designed in such a way that it requires continuous processing and it involves selection of specific, relevant stimuli from a series of relevant and irrelevant stimuli. CPT has been extensively employed in the examination of performance deficit in schizophrenia and some of the

chronic hospitalized schizophrenics have been found to show significantly greater response errors than other psychiatric patients or normal subjects (Orzack and Kornetsky, 1966). Remitted schizophrenic patients have also been found to show a poor performance on CPT (Asarnow and MacCrimmon, 1978; Wohlberg and Kornetsky, 1973).

In a study by Grunebaum, Weiss, Gallant and Cohler (1974) children of psychotic mothers (schizophrenic, schizo-affective or affectively disordered) and children of normal parents were tested. Grunebaum et al. (1974) employed a relatively simple version of CPT using the colour red as the target stimulus in a series of colour stimuli. They found that a 5-year old sample of children of schizophrenic mothers made more errors of commission than children of affective disorder mothers and children of non-psychiatric control mothers. They suggested that their CPT version, even though it was quite a simple target detection task could identify a deficit of sustained attention in very young children of schizophrenic mothers because the task requires a large processing load at an early age. Grunebaum et al. (1978) reported follow up data from this same high risk project on examination of children of 6 to 12 years old. They failed to find significant differences between children of schizophrenic mothers and children of normal mothers in performance on a CPT version with a clearly focused, single letter target.

In research reported by Asarnow et al. (1977) a version of CPT was used in which they designated a single number as the target stimulus. That is, the subjects were requested to respond to digit 7 from a random sequence of single digits. Asarnow et al. (1977) found no CPT deficit among children of schizophrenic mothers compared with the control subjects. The negative finding of this study, however, could be attributed to the nature of the task and the relative ease of the CPT version employed. Contrary to the negative findings, mentioned above, are the results from CPT versions that entail a greater processing load. Rutschmann, Cornblatt and Erlenmeyer-Kimling (1977), conducted a CPT study which formed a part of the New York Project. Their study was particularly concerned with neurointegrative dysfunctions in children at risk for schizophrenia. They hypothesized that this dysfunction would be continuous with deficiencies observed in adult schizophrenics. They employed a modified version of CPT from a children's version by Anderson et al. (1969) which involved automatic presentation of a sequence of visual stimuli in the form of slides of playing cards. The subjects were required to respond only when identical stimuli followed each other. The test was administered to 58 children of schizophrenic parents and 92 control subjects who were children of normal parents. The playing card version of the CPT unlike the conventional CPT designs demanded processing of two stimulus dimensions i.e. number

and suit. The results of their study showed that a sample of children with one schizophrenic parent in the 7 to 12 year age group, detected significantly fewer targets and made significantly more errors of commission. The calculation of the signal detection accuracy measure (d') showed that the differences in performance between the two groups were due to poorer d' (signal/noise discrimination) by the high-risk subjects.

Erlenmeyer-Kimling and Cornblatt (1978) employed the same version of the CPT as that used by Rutschmann et al. (1977) for children at risk for schizophrenia (described above). They found that the experimental subjects exceeded control subjects on both errors of omission and commission.

From these results it may be concluded that the contradictory findings of CPT could indicate that the deficit of sustained attention in children at risk for schizophrenia, may not be manifest when the task is too easy to perform.

Nuechterlein (1983) used the playing card version as well as 5 versions of CPT which required the detection of a single digit target stimulus. These CPT tasks were administered to a sample of 9 to 16 year old children of schizophrenic mothers and children of non-psychotic, psychiatrically disturbed mothers and hyperactive children.

The results showed that the five conditions of the CPT with such increased processing requirements, including the playing card CPT, Children of schizophrenic mothers showed lower mean scores on the sensitivity factor and included more extremely poor scorers than normal children. The degraded-stimulus CPT considered alone also achieved significant differentiation of children of schizophrenic mothers and normal children and was the most effective condition for isolating a disproportionately large group of high-risk children with poor signal noise discrimination. The fact that the degraded stimulus CPT version, in contrast to the playing card CPT, does not involve a target that demands memory for successive stimuli suggests that processing load, rather than memory load per se, might be important in the detection of vigilance performance deficits in children at risk for schizophrenia. Lower sensitivity and fewer target hit

Information processing in schizotypic individuals

High scorers on the questionnaire measures of schizotypy have also been found to show performance deficit on CPT. In a study by Asarnow, Nuechterlein and Marder (1983) it was found that subjects who had significantly high scores on the MMPI Schizophrenia (Sc) scale, Physical Anhedonia scale, Schizoid scale and Schizophrenism scale, showed poor performance on the CPT. College students with high scores on scales 2-7-8 of the MMPI were also found to

show poor target detection on a CPT task compared with a group of subjects with low scores on the 2-7-8 scale (Nuechterlein, Edell and West in preparation).

As mentioned previously, backward masking tasks have been employed in the investigation of certain stages of information processing related to the initial sensory memory stage. Individuals vulnerable to the development of schizophrenia are hypothesized to show the disorder of information processing as tested by backward masking tasks. In order to test this hypothesis, Saccuzzo and Schubert (1981) in a backward masking experiment employed three groups of adolescents consisting of; schizophrenics, schizotypal personality and borderline personality adolescents. The 3 groups of subjects took part in an experiment in which their ability to identify masked and unmasked stimuli were examined. The target stimuli consisted of letter Ts and As (in capitals). The masking stimuli used, consisted of four letter Ws positioned side by side and above and below each other. Saccuzzo and Schubert hypothesized that vulnerability to a masking stimulus may be an index of a predisposition to schizophrenia. Their results showed that subjects with schizotypal personality, as well as schizophrenic subjects, required a longer interval to recognize the masked stimuli. These findings were in line with the slow information processing hypothesis for schizophrenics. A similar result

was reported from a study by Steronko and Woods (1978) in which college students with MMPI 2-7-8 profiles were examined for their ability to recognize briefly presented, single letters which were followed by pattern masks of various brief intervals. The 2-7-8 subjects required a significantly longer interval between target stimuli and the mask in order to recognize the single letter targets compared with subjects without high scores on the MMPI. The performance of schizotypics was affected by the presence of the masking pattern and as a result they showed slow processing of information but they differed from the schizophrenics in that schizophrenics showed a more marked vulnerability to masking stimuli. The results suggested a continuum between the performance of schizophrenic, schizotypal and control subjects.

Data supporting the hypothesis that schizotypal individuals require a longer interval to recognize single letters under backward masking conditions have also been reported by Braff (1981) for groups identified by DSM-III criteria as schizotypics.

From the findings mentioned above, it could be concluded that disorder of information processing might form a major characteristic of individuals with schizotypic personality.

REACTION TIME

Reaction time studies have been extensively used in research into schizophrenia and it has been consistently shown that schizophrenics exhibit a considerably longer reaction time than normals on various reaction time tasks. Many studies have shown that schizophrenics are slow on simple reaction time as well as choice reaction time and that they are progressively slower with increased task complexity. Schizophrenics are also known to be significantly slow in performing tasks which require shifting attention from one modality to another, or when required to ignore irrelevant stimuli in favour of task relevant inputs.

The present study aimed to investigate the reaction time performance of individuals with schizotypal personality and to determine whether high scorers on the physical anhedonia and schizophrenism scales would show a similar deficit to that of schizophrenics. The reaction time experiments carried out in the present thesis consists of; cross-modal reaction time, choice reaction time, and reaction time in the presence of distracting stimuli. This chapter concern cross-modal reaction time in individuals with schizotypic personality.

CROSS-MODAL REACTION TIME

The typical procedure in cross-modal reaction time consists of random presentation of stimuli in different sensory modalities (e.g. visual and auditory) with the subject's task being to respond as quickly as possible to the presentation of each stimulus. Cross-modal reaction time therefore involves shifting attention from one sensory modality to another.

The use of cross-modal reaction time experiments in the study of schizophrenics was first put forward by Mettler (1955). Mettler found that schizophrenics have great difficulty in switching attention from one sensory modality to another. Various studies since have supported this finding (Sutton et al., 1961; Sutton and Zubin, 1965; Waldbaum, Sutton and Kerr, 1975; and Spring, 1980). The deficit of shifting attention across sensory modalities has been shown to persist even when the schizophrenic and control subjects have been matched for their general speed of reaction time. (Sutton and Zubin, 1965; Waldbaum, Sutton and Kerr, 1975) or even when the subjects were told in advance which stimulus would come next (Spring, 1980).

The deficit of schizophrenics in shifting attention is reported to be stronger in crossing to auditory than to visual stimuli (Sutton et al., 1961; Kristofferson, 1967;

Sutton and Zubin, 1965; Venables and O'Connor, 1959; Verleger and Cohen, 1978).

The longer reaction time exhibited by schizophrenics in shifts from visual to auditory stimuli, was described by Mannuzza (1980) as follows;

"-Perhaps auditory processing in schizophrenics is generally more vulnerable to impairment. The auditory modality (as compared with other modalities) seem to make the best clinical sense as a site of dysfunction: auditory hallucinations are the most frequently encountered form of hallucination in schizophrenics." However, studies by Spring (1980) and Spring and Zubin (1977) showed that the deficit of schizophrenics in cross-modal reaction time is evident both in visual and in auditory changes of stimuli. These contradictory findings were suggested by Venables and Tizard (1956) to result from the differences in the levels of stimulus intensities employed by different researchers. Venables and Tizard showed that with high levels of visual stimulation chronic, non-paranoid, schizophrenics showed a longer reaction time in response to visual stimuli. Whereas, in a study conducted by Venables and O'Connor (1959) in which they used visual stimuli of moderate intensities, subjects showed less dysfunction of the visual rather than the auditory modality.

The deficit of schizophrenics in reaction to cross-modal changes in stimuli was described by Zubin (1975) in terms of the 'Neural Trace Theory'. Zubin suggested that the so-called 'facilitatory' and 'inhibitory' neural mechanisms determine the efficient processing of a particular stimulus in a given sensory modality. The nervous system provides a facilitatory trace for the processing of non-identical stimuli. Therefore, reaction time to a sequence of identical stimuli is supposed to be the fastest. The second fastest reaction time is produced in response to ipsi-modal non-identical stimuli and the slowest reaction time is expected to occur in response to cross-modal changes in stimuli. In schizophrenics, according to Zubin, the facilitatory and inhibitory neural traces have a stronger effect on the forthcoming stimuli and have a longer duration. This could interfere with a quick response to the subsequent stimulus, which is different from the current stimulus.

A factor which appears to have particular importance in Zubin's theory is the inter-trial interval (ITI) of a given stimulus sequence. He pointed out that with the passage of time the influence of the trace is likely to decrease and the sequences of stimuli which have longer ITIs are therefore likely to produce less cross-modal retardation. This was tested in an experiment by Waldbaum, Sutton and Kerr (1975) in which they increased the duration

of ITIs. The results of their study, however, did not support Zubin's theory.

Individuals at risk for the development of schizophrenia have also been the subject of study in several cross-modal reaction time experiments. For example, Spring (1980) tested siblings of schizophrenic mothers and a group of control subjects. The subjects were given advanced information about the modality of each incoming stimulus. The results, however, showed no significant difference between the reaction time performance of the siblings of schizophrenics and control subjects. The overall simple reaction time did not differ among the two groups. In addition the slowing associated with the shift between the sensory modalities was not greater than normal in persons at risk for schizophrenia on switching attention to either sound or light stimuli, despite the fact that such cross-modal retardation is a characteristic of schizophrenics.

Phipps-Yonas (1978) carried out another study in which cross-modal reaction time in children at risk for schizophrenia was examined. This study was a part of the Minnesota project in which children of schizophrenic mothers were studied. The task consisted of a modified version of the Sutton et al. (1965 & 1978) cross-modal design. In addition, a series of conditions was included

in which the subjects were given information concerning the modality of the stimulus. Phipps-Yonas included this condition in order to examine the subjects' ability to benefit from the information concerning the upcoming stimuli. The results failed to show any difference between children of schizophrenic mothers and their matched controls in the speed of their reaction times and the individual variability of performance. Phipps-Yonas (1979) in a further examination of her data concluded that these negative results could be due to the fact that the high risk sample used in this study consisted of a subsample of a healthier group as indexed by their scores on peers ratings, sociometric status and achievement test scores.

CROSS-MODAL REACTION TIME EXPERIMENT

Method and procedure

A cross-modal experiment was designed consisting of auditory and visual stimuli. The experimental design and measurement strategies closely resembled those employed by Sutton et al. (1961).

A random series of red and green lights, and high and low frequency tones were presented to the subjects, one signal at a time. The light stimuli were inside two small boxes. Each box had a semi-transparent circular plastic cover of 5 cm in diameter behind which the light stimuli were mounted. The auditory stimuli consisted of tones of 1200 and 400 Hz respectively. The boxes were placed in front of the subjects, on a table, approximately 30 cm apart, and were located at the subjects' eye level. The subjects were seated at a distance of approximately 1½ meters from the stimulus lights and were instructed to make their responses by pressing a response key as soon as possible at the presentation of each stimulus. The response key was connected to the stimulus boxes and was placed in front of the subjects at a comfortable distance near their preferred hand. The same response key was pressed every time a light or a tone was presented. A key press terminated the current stimulus and started off the onset of the time interval of a new stimulus. No ready signal was given but the termination of a signal indicated

that a new stimulus was about to appear. If the subjects failed to respond within 5 seconds the stimulus was automatically terminated and a new stimulus appeared. Any responses occurring after 5 seconds were regarded as errors.

The stimuli consisted of 64 trials, with 16 trials in each stimulus type. The stimuli were presented with random inter-trial intervals (ITIs) which varied from 1.5 to 3.5 seconds in order to reduce the possibility of anticipation that occurs with fixed ITIs. Stimuli were presented in a semi-randomized order in such a way that there were no more than three successively occurring stimuli in a given modality. The subjects were uncertain about what stimulus to expect on each forthcoming trial. The order of stimulus presentation was identical for all the subjects. Each subject was given a standard set of instructions and in such a way that it would not impose any particular strategy on the subjects' performance. The experiments were carried out in a sound attenuated room. A series of 5 practice trials were then given to the subjects in order to make sure that they understood the instructions. When it was clear that the subjects understood the task requirements the experiment started.

The presentation of stimuli, timing and data collection were controlled by an LSI computer. The response key was connected to the LSI and the reaction

times produced by key presses, were measured in msec as the interval between the onset of a stimulus to the subjects' response. A data file was created for each subject containing their reaction time to each individual trial. The responses that occurred before the subjects actually saw the stimulus were discarded. Subjects worked continuously throughout the task.

CROSS-MODAL REACTION TIME

DATA ANALYSIS

Data files containing the reaction time scores on individual trials were created for the 42 subjects. The data files were then transferred to the Dec 10 computer for analysis.

The reaction time scores of each subject were classified in terms of their relationship with the preceding trials. That is, the trials were grouped into; 'cross-modal' or 'ipsi-modal'. Cross-modal stimuli were subdivided into trials which involved either a shift from auditory to visual modality or from visual to auditory modality. That is to say, the cross-modal trials consisted of sounds which were preceded by lights, and trials consisting of lights which were preceded by sounds. The ipsi-modal trials were also further subdivided into two groups of ipsi-modal stimuli. Lights preceded by lights, or sounds preceded by sounds.

Results

A group x conditions analysis of variance compared the reaction time performances of anhedonics, schizotypics and control subjects. A highly significant main effect of groups ($F = 7.51, P < .001$) and a significant group x conditions interaction effect ($F = 2.98, P < .009$) were found indicating that the reaction time performances of the

3 groups differed. The means, standard deviations, F ratios and P values of the reaction time data for anhedonics, schizotypics and control group in response to cross-modal and ipsi-modal trials are presented in Table 52. These values are graphically presented in Figure 12.

Visual inspection of Figure 12 gives the impression that both anhedonics and schizotypics produced considerably longer reaction times to the cross-modal sequences compared with control subjects. These slow reactions do not appear to be as marked in response to changes in stimuli in the same modality as they are in reaction to changes across modalities.

Analyses of variance were carried out separately for each of the cross-modal and ipsi-modal conditions. The results revealed a highly significant difference between the reaction time performances of the 3 groups for the cross-modal reaction to sound i.e. the condition under which sound stimuli were preceded by light stimuli ($F = 21.56$, $P < .0001$). A post hoc analysis (Tukey's HSD) was carried out and it was revealed that there was a significant difference between the mean reaction times of anhedonics compared with control subjects ($F = 30.61$, $P < .01$). This indicated a lengthening of cross-modal reaction to sounds, which were preceded by lights, for anhedonics compared with

Fig 12 Cross-modal reaction time
RTs (msec)

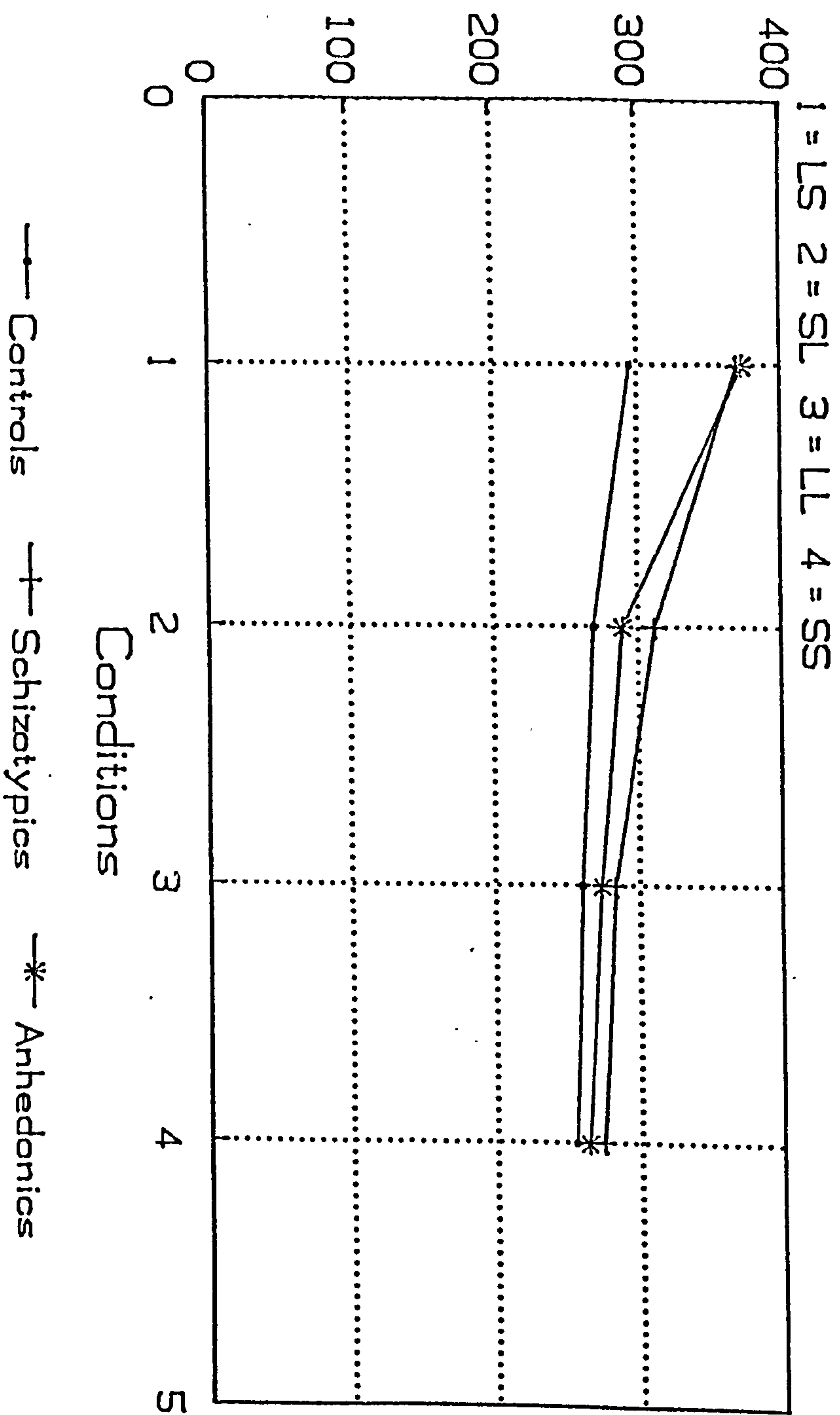


Table 52

Crossmodal and ipsimodal reaction times for the anhedonic, schizotypic and control subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
LS	373 (34.57)	369	(47.92)	296	(18.03)	21.56	<.0001
SL	290 (38.81)	313	(36.09)	270	(43.28)	4.61	<.02
LL	275 (57.50)	284	(62.79)	261	(43.43)		n. s.
SS	262 (33.20)	275	(55.12)	256	(35.90)		n. s.
Main effects						F = 7.51	P <.002
Group x conditions interaction						F = 2.98	P <.009

control subjects. The same was true for the comparison between schizotypics and the control group ($F = 29.04$, $P < .01$). As shown in Table 52 the means of the reaction times of anhedonics and schizotypics are very similar for cross-modal reaction to sound stimuli, indicating that the deficit of crossing to auditory modality was a characteristic of both groups of schizotypics.

Analysis of variance compared the responses of the 3 groups for cross-modal reaction to light. The results showed that a significant difference existed between the responses of the 3 groups ($F = 4.61$, $P < .01$). The post hoc analysis, however, revealed that only the difference between schizotypics and control subjects was significant ($F = 32.14$, $P < .01$), indicating that the deficit of cross-modal reaction to visual stimuli was only characteristic of schizotypics, and that anhedonics did not show such a deficit.

The responses of the 3 groups for the ipsi-modal reaction time conditions were subjected to analyses of variance. No significant differences were found between the reaction time performances of the 3 groups for the ipsi-modal conditions. This was the case for ipsi-modal reaction to light as well as to sound stimuli. The results are presented in Table 52.

The error responses of the 3 groups for the 4 conditions was subjected to a group x errors analysis of variance. No significant difference was found between the groups for the error data.

Sex differences

Sex differences were examined using a group x conditions x sex analysis of variance. The results showed no significant differences between the reaction times of males and females groups, indicating that the significant differences obtained were not due to the effect of sex differences.

DISCUSSION

It was hypothesized in the present study that a disorder of switching attention might characterize anhedonics and high scorers on the SZ scale in a similar fashion to that of schizophrenics. Disorder of switching attention was measured using visual and auditory cross-modal reaction time and it was found that both anhedonics and high scorers on the SZ scale showed significantly longer reaction times in switching attention across sensory modalities compared with the control group. High scorers on the SZ scale showed a significantly longer reaction time for cross-modal changes from light to sound as well as from sound to light stimuli, whereas, the deficit of cross-modal reaction time in anhedonics was only evident for cross-modal changes from sound to light stimuli. No significant differences were found between the groups for ipsi-modal reaction time to sound or to light stimuli.

Perhaps the best explanations for the results of this study could be given in terms of Zubin's Neural Trace Model according to which a greater duration of facilitatory and inhibitory neural traces in schizophrenics result in facilitation of similar stimuli and inhibition of dissimilar stimuli. The results of the present study provide some evidence that the same might be the case for individuals with schizotypic personality. The reaction

times of anhedonics, schizotypics and control subjects were comparable in response to ipsi-modal sequences which indicated that anhedonics and schizotypics did not show the same sort of retardation that they exhibited when subjected to stimuli which required switching of attention.

An alternative explanation is that when the four stimuli were presented in a random order consisting of identical and non-identical sequences, it could be assumed that the control subjects might have been more capable of forming an expectation to receive either of the four stimuli at each presentation and were therefore more ready to react to stimuli presented to any of the modalities. Anhedonics and in particular the schizotypics might not have been able to form such an expectation and therefore were less ready to direct their attention to the relevant modality.

The present results are in line with the previous findings of cross-modal reaction time in schizophrenics e.g. Sutton and Zubin (1965) which indicated that schizophrenics are slower to respond to a stimulus which is preceded by one in a different sensory modality than to a stimulus preceded by one in the same sensory modality. However, as described previously in the majority of the cross-modal studies of schizophrenics there is a reliable difference between schizophrenics and normals only for

reactions to sounds as the second stimulus. In the present study the high scorers on the SZ scale appeared to show a deficit in switching to auditory as well as to visual modality.

The implication of the present findings is that these results provide support for the hypothesis that individuals with schizotypic personality characteristics show a deficit of switching attention similar to that shown by schizophrenics. Further research would help to confirm that a defective cross-modal switching of attention might be regarded as an index of vulnerability to schizophrenia.

CHOICE REACTION TIME

Broadbent's (1958) model of the limited-capacity decision channel, mentioned previously, was developed under the influence of studies suggesting a linear relationship between reaction time and the log of the number of equiprobable stimulus choices. The slope of the reaction time against different choices has been considered as an inverse measure of the capacity of the decision channel. This theory of choice reaction time (after some modifications) has remained popular in the studies of choice reaction time in schizophrenics.

Sternberg's (1969) stage model of choice reaction time performance is a closely related theory. According to Sternberg's (1969) theory choice reaction time is made up of the sum of the decision times related to the processing of each of the choices. The time from the onset of a stimulus to the time of the response consists of a number of processing stages. Therefore, the reaction time is the sum of the duration of these processing stages. An increase in the number of choices results in an increase in the duration of processing stages which in turn increases the reaction time.

experiments have examined the effect of stimulus as well as response complexity on the performance of schizophrenics. The general findings have been that the reaction time of schizophrenics becomes slower as the number of choices increases. This is believed to be related to the presence of more information which requires attention (Huston, Shakow and Riggs, 1937; King, 1954).

A theory concerning the slow performance of schizophrenics in choice reaction time is that by Yates (1966). As mentioned in a previous chapter, Yates attributed the long reaction time of schizophrenics to a general 'slowness' of information processing. On the basis of the slow information processing theory, several investigators have hypothesized that it is likely that a 'sequential matching' between the stimulus and response which normally occurs in the processing of information, takes longer for schizophrenics to complete. However, the results of studies based on these theories have been fairly inconsistent. For example, Karras (1967a) and Court and Garwoli (1968) found that the performance of schizophrenics in a choice reaction time task was similar to that of normal subjects. On the other hand Benton, Jentsche and Wahler (1959) have observed a better performance in choice reaction time for schizophrenics than for normals. Nuechterlein (1977) from a review of studies of reaction time in schizophrenics concluded that these contradictory

findings resulted from factors such as differences in experimental procedures, methods of data analysis and the schizophrenic samples used.

It is important to note that the studies mentioned above have mainly focused on tasks consisting of only two levels of stimulus complexity and none of these studies have examined a wider range of task complexity. One study in which a greater number of choices were employed was that of Venables (1958).

Venables tested two schizophrenic samples and a control group who took part in a choice reaction time task with eight degrees of stimulus complexity. The task consisted of a display of eight stimulus lights on which numbers one to eight were painted. The subjects' task was to read out the number on a light as soon as it was lit. The number of lights used in each block of trials varied from one to eight, and the subjects responded to eight equally probable stimuli. The results of this study did not support the hypothesis that schizophrenics would show a progressively greater slowness than normals with an increase in task complexity. Similar findings are those of Court and Garwoli (1968) and Scherer (1972). These studies, however, employed a different procedure in that the task involved various degrees of response complexity. That is, each stimulus had a corresponding response and

CHOICE REACTION TIME EXPERIMENT

Method and procedure

This experiment consisted of a choice reaction time task with eight degrees of stimulus and response complexity. The experimental design and procedure was a slightly modified version of a choice reaction time task employed by Venables (1958). The apparatus consisted of eight square boxes of 4 by 5½ inches each. The boxes contained the light stimuli which were mounted at the centre of each box, behind a semi-transparent plastic cover of 5 cm in diameter. The boxes were placed in a straight line and at eye level. Each plastic cover had a number written on it and the numbers were visible only when the lights inside the boxes were turned on. Numbers from one to eight were used, one number per box. The boxes were connected to a set of eight keys mounted on a horizontal board on which the numbers from one to eight were also written, one number per key. The keys were placed about 15 cm apart, corresponding to the position of the light boxes and were arranged in such way that they could be operated comfortably. The depression of a response key terminated a stimulus and this was only possible by pressing the correct key. The subjects therefore immediately obtained feedback on their performance and realized when they had made a mistake. The termination of each stimulus then led to the onset of the next trial following the inter-stimulus interval.

Subjects sat approximately 1.5 metres from the display which was placed on a table. They were instructed to press a corresponding key at the onset of each stimulus and were asked to respond as quickly as possible while trying not to make too many errors. Each subject was presented with all eight choice conditions. In each choice situation the stimuli were presented in a random order which was predetermined by means of random number tables and was the same for all the subjects. There was a different response for each stimulus.

At the start of each block of trials the subjects knew how many letters were to be used, but they did not know which letters there would be and therefore were uncertain about which response key they would have to press. At the end of each block of trials subjects were informed of an increase in the number of choices. The experiment consisted of 192 trials in 8 blocks of 24 trials in each. The inter-trial-interval (between a response and the following signal) was variable, averaging about 2½ seconds. At the start of the experiment the task was explained to the subjects. Prior to the start of the experiment the subjects were given practice until there was no uncertainty about the task. A low intensity white noise was delivered through headphones in order to mask any external noise. Subjects worked continuously throughout each series, but rested for a few minutes half way through the experiment.

The stimulus presentation and recording of the reaction time and error responses were controlled by an LSI computer. The reaction time was measured in msec. At the end of the eight blocks of trials, a data file was created for each subject containing their reaction times and their error data. The responses that occurred before the subjects actually saw the stimulus were discarded. If the subjects did not respond within 5 seconds, the stimulus was terminated and the next trial proceeded. The subjects were asked to make each decision as quickly as possible.

Choice reaction time

Results

The reaction time scores were obtained for each subject on each trial. These data which consisted of reaction times for 8 choice conditions were then transferred to the Dec 10 computer for analysis. The mean reaction times of the correct responses were then computed for each subject and for all the conditions.

The mean reaction time of each group for each trial block is graphically presented in Figure 13. The labels C1 to C8 refer to the 8 choice conditions. Condition 1 represents a simple reaction time task.

In order to examine the increase in reaction time with increase in task complexity, the mean reaction times for each of the eight choices for each group were plotted against log of the number of choices. Plotting the data showed a linear relation of reaction time with the log of the number of choices for the 3 groups. Figure 14 presents the log of mean reaction times for each of the eight choices plotted against the log of the stimulus number. The intercepts and slopes for each subject were then calculated. The scores obtained for each group for the slope and intercept were subjected to analysis of variance. No significant differences were found between the intercept of the reaction time data of the three groups. Neither

Fig 13 Choice reaction time
RTs (msec)

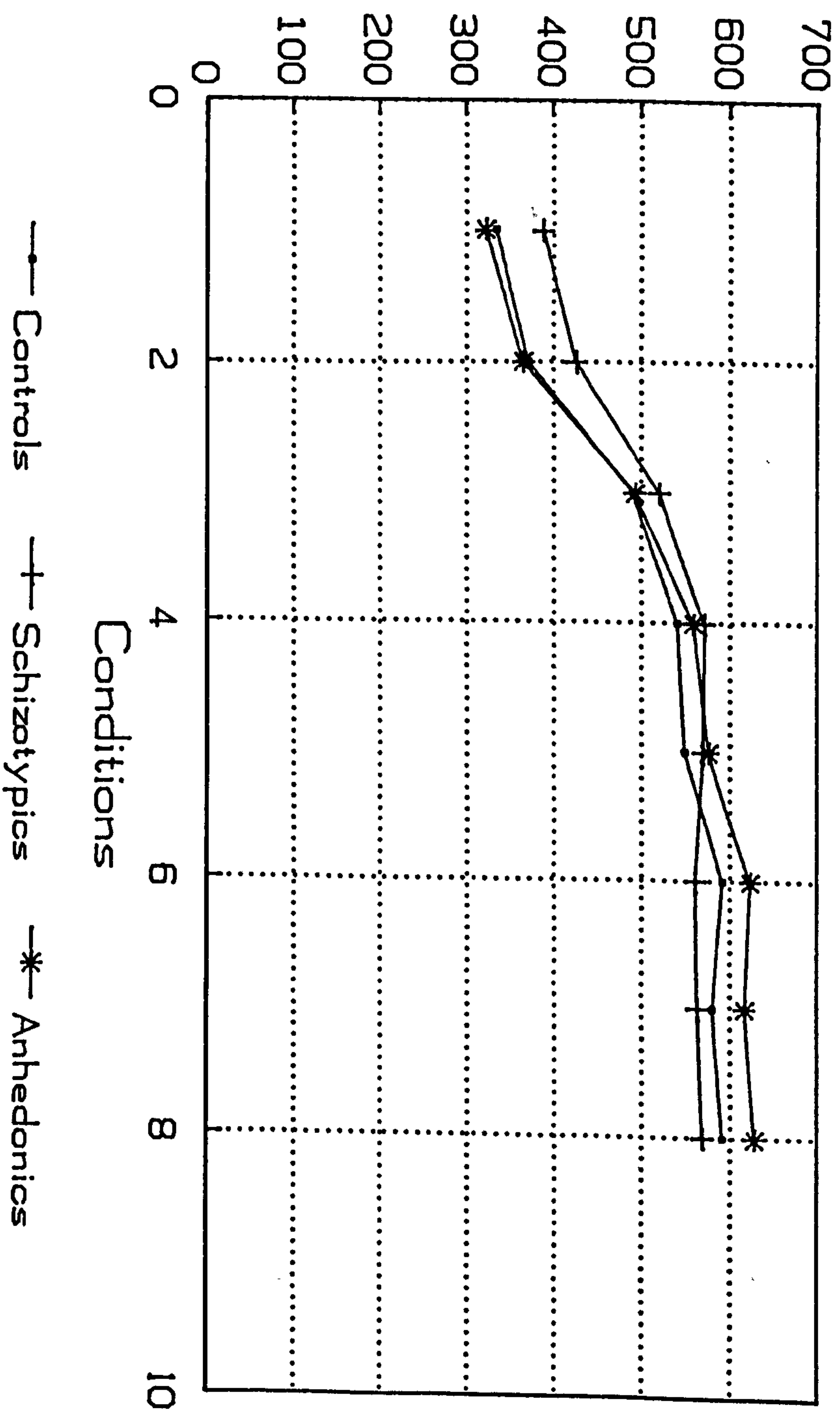
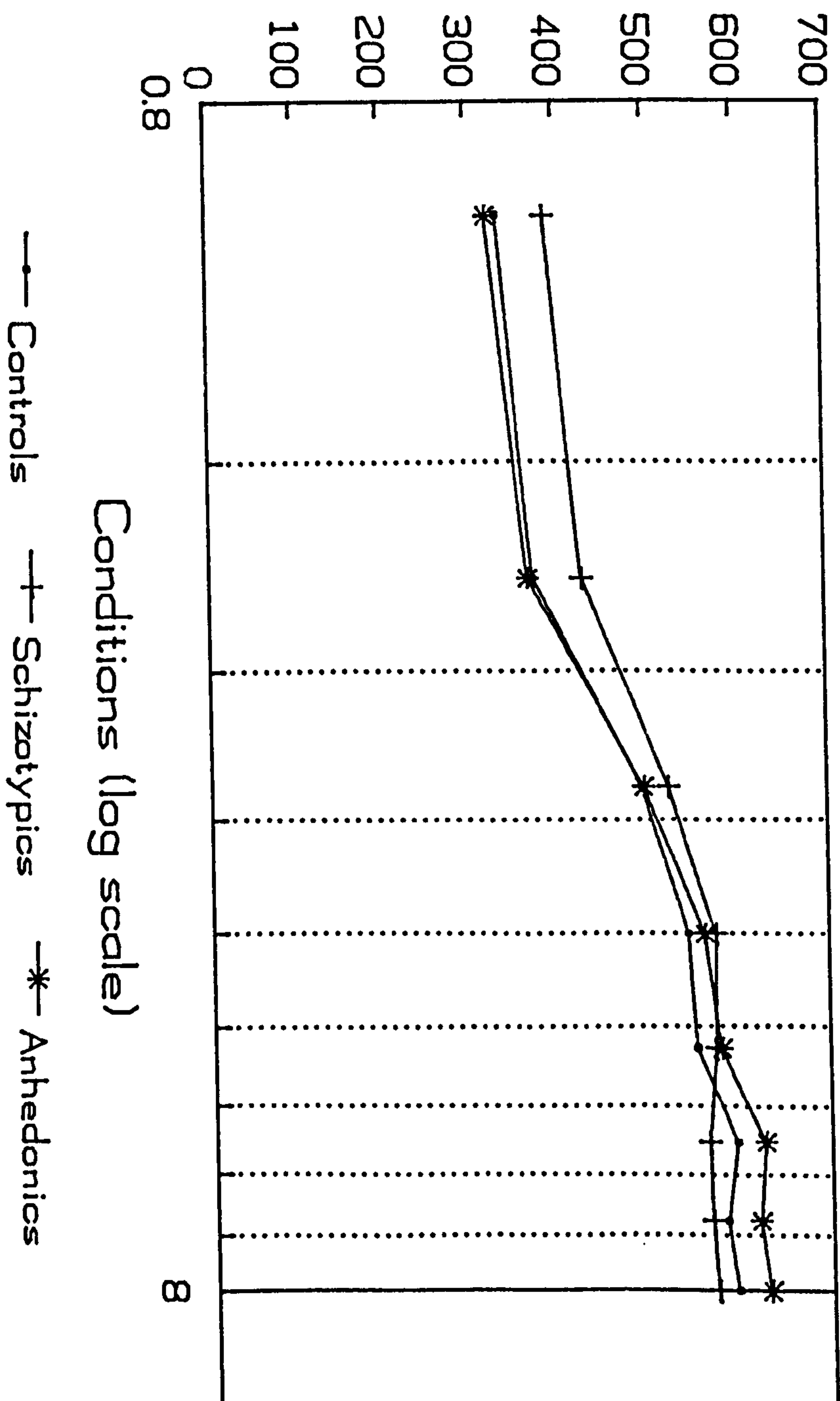


Fig 14 Choice reaction time
RTs (msec)



were the differences between the slope of the reaction time data for the three groups significant. The means, standard deviations of the reaction time responses of the 3 groups are presented in Table 53 and the results of the slope and intercept data are presented in Table 54.

Examination of the error data showed that there was no significant difference between the groups in terms of their errors. The results of error data are presented in Table 55.

Sex differences

The reaction time scores of male and female subjects were subjected a 3-way group x conditions x sex analysis of variance. No significant main effects or interaction effects were found.

Table 53

Choice reaction time data for the anhedonic, schizotypic and control subjects

Anhedonics		Schizotypics		Controls	
M	(SD)	M	(SD)	M	(SD)
C1	323 (93)	389	(111)	335	(106)
C2	366 (81)	426	(66)	372	(53)
C3	493 (129)	520	(142)	491	(150)
C4	559 (168)	571	(168)	541	(155)
C5	576 (173)	569	(156)	550	(147)
C6	624 (175)	561	(165)	592	(168)
C7	617 (165)	563	(152)	580	(147)
C8	629 (151)	569	(180)	592	(169)

Table 54

Choice reaction time data for the anhedonic, schizotypic and control subjects.

	Anhedonics	Schizotypics	Controls		
	M	M	M	F	P
Slope	115.69	88.29	96.23		n.s.
Intercept	311.50	377.53	332.76		n.s.

Main effects				n.s.	
Group x condition interaction				n.s.	

Table 55

The errors for the choice reaction times for the anhedonic, schizotypic and control subjects

	Anhedonics	Schizotypics	Controls		
	M (SD)	M (SD)	M (SD)	F	P
C1	1.25 (0.39)	0.73 (0.30)	0.33 (0.49)		
C2	1.17 (0.50)	0.93 (0.58)	0.73 (0.79)		
C3	1.50 (0.41)	1.60 (1.40)	0.80 (0.68)		
C4	1.00 (0.14)	0.87 (0.58)	0.93 (0.88)		
C5	1.07 (0.74)	1.40 (0.76)	1.07 (0.69)		
C6	0.83 (0.41)	0.92 (0.90)	1.00 (0.57)		
C7	1.25 (1.04)	1.13 (0.58)	1.13 (1.12)		
C8	0.67 (0.81)	1.63 (1.11)	0.73 (1.01)		

Main effects				n.s.	
Group x condition interaction				n.s.	

Discussion

The aim of this experiment was to examine the deterioration in the performance of schizotypics and anhedonics compared with control subjects when performing a choice reaction time task of increasing stimulus and response complexity.

It was hypothesized in the present study that increases in the complexity of the task would affect the reaction time performance of schizotypics and anhedonics more than it would affect the performance of the control subjects. This hypothesis was not supported by the results of the choice reaction time experiment and was contrary to the previous findings which suggested that individuals vulnerable to the development of schizophrenia show slow performance on choice reaction time (Wood and Cook, 1979). It is difficult to interpret these results bearing in mind that schizophrenics and children at risk have been found to show a significant increase in their reaction time with an increase in the number of choices.

One possible explanation might be given in terms of the experimental design. As described before the experiment was designed in such a way that all the subjects had to do was to scan a display and as soon as a stimulus appeared press the corresponding key. Therefore, each

stimulus required only a single response. It is likely that since the stimuli were presented one at a time and were easily distinguishable even increasing the number of choices might not have introduced any increases in the task complexity. Furthermore, while an increase in the number of conditions led to an increase in the task complexity, there was a high level of S-R compatibility (the degree to which the relations between stimuli and responses are 'natural' or 'obvious'). Under these conditions not much processing would have to take place and hence the deficiency of schizotypics in this area would not show. It is therefore quite likely that performing such a task might not have been sufficiently sensitive to distinguish between the different groups. Furthermore, it is possible that the deficit of reaction time in schizotypics is not sufficiently severe to result in an inadequate behavioural response in a task which is very easy to perform. However, further research in this area is necessary before any firm conclusions can be made.

REACTION TIME AND DISTRACTION

Schizophrenics are believed to be easily distracted and in the presence of irrelevant stimuli they show a poor performance and a significantly slow reaction time (Chapman and McGhie, 1962; Lawson, McGhie and Chapman, 1967; McGhie, Chapman and Lawson, 1965a and Ludwig, Wood and Downs, 1962). One of the first studies of distractibility in schizophrenics was that of J. Chapman and McGhie (1962). In a digit-span task they found that the presence of distracting voice stimuli produced a performance deficit in schizophrenics. A number of subsequent studies reported similar findings e.g. Rappoport (1967). It has been argued by L. Chapman and Chapman (1973) that in these studies the distractor condition usually produced a test with greater discriminatory power compared with a neutral condition and therefore, this could be the cause for the difference between the performance of schizophrenics and controls in the conditions in which distractors are present. However, further studies have shown that at least some schizophrenics are distractible. For example, Oltmanns and Neale (1975) employed pairs of neutral and distractor digit-span tasks that were matched for their discriminatory power. The subjects listened to a series of tape recorded digits and were instructed to write them down after the sequence had been read. In the distraction condition, irrelevant digits were spoken by a second voice together

with the relevant digits. In this study Oltmanns and Neale (1975) made the non-distraction task as difficult as the distraction task in order to match the difficulty of the two tasks. That is, they varied the length of lists of digits in order to examine whether the deficit in the performance of schizophrenics was greater either in response to increased distraction or in response to greater list length. The results showed that the presence of distracting stimuli significantly affected the performance of schizophrenics. In a further study by Oltmanns et al. (1978) these findings were replicated. Moreover, distractibility was found to be related to thought disorder and varied according to the symptoms and the use of neuroleptic drugs.

These results indicate that schizophrenics are incapable of attending to the relevant aspects of information only and are unable to screen out the distracting stimuli. They attend to the irrelevant together with the relevant stimuli and therefore, become overloaded with information.

Additional evidence concerning the distractibility of schizophrenics could be cited from studies in which schizophrenics are found to be characterized by over-inclusive way of information processing (Payne, 1961). The vulnerability of schizophrenics to distracting stimuli

could be related to their overinclusive thinking which makes them unable to screen out irrelevant information. This is evident from reports given by schizophrenics, tested by McGhie and Chapman (1961). Examples are; "I can not concentrate -- everything distracts me -- everything seems to grip my attention. I am speaking to you just now but I can hear noises going on next door. My trouble is that I have got too many thoughts. There are too many things coming to my head at once and I can not shut things out".

Payne and Caird (1967) examined the distractibility of paranoid and non-paranoid schizophrenics using various simple and choice reaction time tasks in which they introduced different degrees of distraction from mild to severe. The results showed that the performance of schizophrenics was significantly affected by distracting stimuli with paranoid schizophrenics showing the slowest reaction time on the task in which the highest degree of distraction was present. This was also reported from a study by McGhie, Chapman and Lawson (1965b), in which they presented the schizophrenics and normal subjects with an auditory and visual simple reaction time task. Distracting auditory sounds from a metronome as well as visual flashing lights were randomly introduced. The schizophrenic group showed a significantly longer reaction time compared with the control subjects and were considerably more affected by both visual and auditory distracting stimuli.

Broadbent's theory of selective attention in the study of information processing in schizophrenia was first used by Payne (1966). Using Epstein's (1953) test of selection of associated words, Payne found that schizophrenics included too many words in the word association. He suggested that schizophrenics may suffer from a breakdown in their filter mechanism. The dysfunction of the hypothesized filter mechanism in schizophrenics was also indicated by Venables (1964) who suggested that certain subtypes of schizophrenics (the acute, reactive, paranoid type) might be characterized by a lack of ability to restrict the extent of their attention, and they are therefore flooded by stimuli from all aspects of the environment. An overinclusive way of responding to stimuli by schizophrenics therefore, indicates that they might be suffering from a lack of ability to selectively attend to the relevant aspect of the environmental stimulation. Schizophrenics are also characterized by a different type of 'input dysfunction'. That is, a narrow range of attention or 'restriction of attentional field' (Venables, 1964). This type of disorder of attention is mainly shown by chronic, process, non-paranoid schizophrenics.

It is of interest to note that several studies have shown that the overinclusive method of information processing which leads to an inability to exclude

irrelevant from relevant information, is not only shown by schizophrenics. Creative individuals are also overinclusive in their information processing. They seem to attend to a wide range of stimuli and do not screen out the irrelevant information. (e.g. Dellas and Gaier, 1970). Dykes and McGhie (1976), in a study using a dichotic shadowing test, found that acute schizophrenics perform similarly to highly creative individuals on a number of tests and differently from non-creatives. Lehmann (1966) suggested that schizophrenics might have a constitutional vulnerability to be faced with a greater number of discrete sensory stimuli in a given situation than non-schizophrenics. He pointed out that individuals who are capable of coping with the higher number of discrete sensory stimuli perform at a better than average level. On the other hand individuals whose receptive sensitivities are not equally matched and integrated with the function of their central processing apparatus might become psychotic.

The creative individuals are capable of coping with a wider range of stimuli in comparison with schizophrenics. It was suggested by Claridge (1972) that although people who are highly creative might have a pre-disposition to schizophrenia, they benefit from a high level of general intelligence and therefore remain clinically well.

Finally, evidence shows that children at risk for schizophrenia also exhibit a performance deficit in the presence of distracting stimuli. In the Stony Brook longitudinal study of children at risk for psychosis (Weintraub and Neale, 1978) which was based on the diathesis-stress approach, young school age children who had schizophrenic or depressed mothers or fathers were studied. Measures of distractibility were included among the measures of precursors of schizophrenia used in this study. The results indicated that the children with one schizophrenic parent proved to be highly distractible. Similar results were reported from the study by Neal, Winters and Sheldon (1984).

In the present study it was hypothesized that, in the presence of distracting stimuli, individuals with schizotypic personality might show a similar deficit of performance similar to that found in schizophrenics and children at risk for schizophrenia.

REACTION TIME AND DISTRACTION

Method and procedure

This experiment was a 5-choice reaction time task which was to be performed in the presence of distracting stimuli. The apparatus consisted of the same eight boxes and response keys as used in the 8-choice experiment described in the previous chapter. The presentation of this set of stimuli was identical to that described for the 8-choice reaction time experiment, with the exception that only five of the eight numbers served as the reaction time stimuli. The remaining three numbers were used as the irrelevant, 'noise' stimuli and the subjects' task was to ignore them. Therefore, the number of equally probable stimuli varied from one to five.

The irrelevant distracting stimuli consisted of three stimulus numbers. The experiment therefore contained 5 conditions ranging from 1 to 5 degrees of complexity presented together with from 1 to 3 distracting stimuli. The distracting stimuli were presented as follows; for conditions 1 to 3, which consisted of from 1 to 3 choices of relevant stimuli, there were also from 1 to 3 choices of irrelevant distracting stimuli present. For condition 4 the number of irrelevant stimuli increased to 2 out of 3 choices and for condition 5 all of the 3 irrelevant distracting stimuli were presented. The stimulus numbers, used as the distracting stimuli and their order of

presentation was fixed for all the subjects. The stimuli consisted of 120 trials, with 24 trials in each block. The distracting stimuli consisted of 70 stimuli ranging from 13 to 15 distracting stimuli in each block of trials. The presentation of stimuli and recording of the reaction time and error responses were controlled using an LSI computer.

If the subjects failed to respond the light remained on for 5 seconds before the next stimulus appeared. The experiment lasted for one hour. When it was clear that the subject understood the task's requirements the experiment started. Only five response keys were used in the five-choice experiment. Subjects were told each time the number of choices or distractions increased.

DISTRACTION REACTION TIME

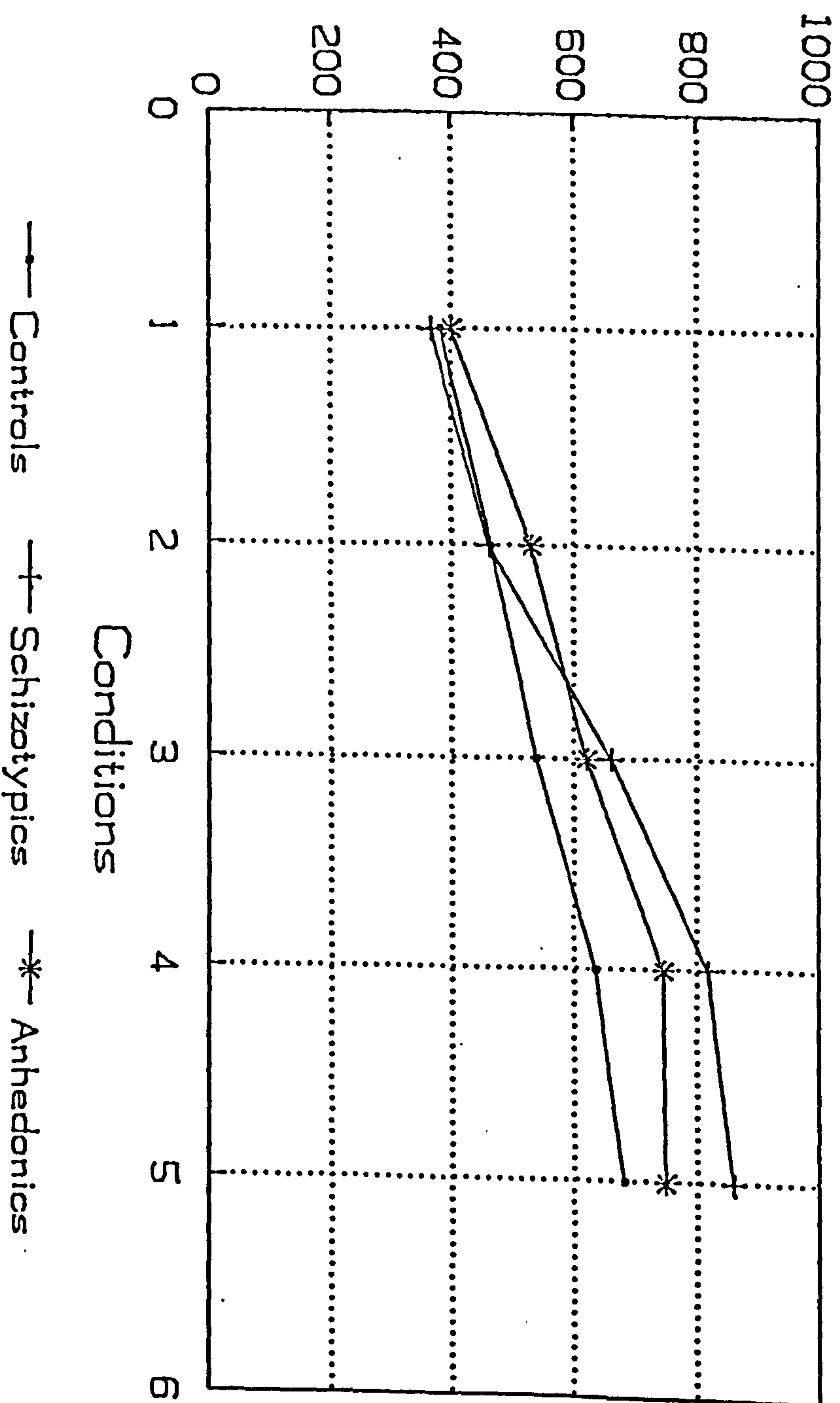
Results

The reaction time scores of each subject on each trial were transferred from a disk to the Dec 10 computer for analysis. The data consisted of reaction time data for 5 conditions and for all of the subjects. At this stage the data were reduced by extracting only the trials which were presented together with distracting stimuli. The mean reaction times of the extracted reaction time responses were then computed for each block of trials and for each subject. These means were subsequently employed in the analyses of variance.

The reaction time scores were subjected to analysis of variance for the 3 groups of subjects and for all 5 conditions. A significant main effect of groups ($F = 7.38$, $P < .001$) and a highly significant group x conditions interaction effect ($F = 5.57$, $P < .0001$) were found.

Figure 15 presents the means of the reaction time responses of each group and for each 'noise' condition and gives the impression that the presence of distracting stimuli had an effect on the reaction time performance of both schizotypic and anhedonic groups. It appears that the mean reaction times of the schizotypic group obtained for conditions 1 and 2 were similar to those of the control

Fig 15 Distraction reaction time
RTs (msec)



subjects and as the number of distractions increased they became slower.

In order to examine the significance of these differences, one-way analyses of variance were carried out separately for each condition and for the 3 groups. No significant differences were found between the groups for conditions 1 and 2 in which the mild distractions were present. ANOVA was computed for the reaction time scores of the 3 groups for condition 3 in which the number of choices of distracting stimuli increased to 3. The results showed a significant difference ($F = 6.94$, $P < .002$) between the reaction time performance for the 3 groups. The results are presented in Table 56. A post hoc analysis (Tukey's HSD) was then carried out. The results showed that the comparison between the means of responses of schizotypics and control subjects for condition 3 was highly significant ($F = 73.34$, $P < .01$). The difference between the reaction time responses of anhedonics compared with control subjects was also significant ($F = 77.38$, $P < .01$). No difference was found for the comparison between the means of responses of anhedonics and those of the schizotypics.

Analysis of variance compared the responses of the three groups for condition 4 in which 2 (out of 3) of distracting stimuli were present. A highly significant difference

Table 56

The distraction reaction times for the anhedonic, schizotypic and control subjects

Anhedonics		Schizotypics		Controls		F	P
M	(SD)	M	(SD)	M	(SD)		
D1	401 (66.33)	369 (77.57)	384 (93.66)				n.s.
D2	531 (91.10)	461 (119.9)	466 (99.14)				n.s.
D3	621 (77.22)	661 (97.69)	540 (92.28)			6.94	< .003
D4	745 (116.4)	819 (143.6)	636 (72.34)			9.69	< .0004
D5	749 (105.7)	861 (104.2)	682 (124.8)			9.62	< .0004
Main effects						F = 7.38	P < .002
Group x condition interaction						F = 5.57	P < .0001

($F = 9.69$, $P < .0004$) was found between the responses of the groups for condition 4 in which the number of distractions increased. Post hoc analysis revealed a significant difference between the mean reaction times of anhedonics compared with those of the control subjects ($F = 98.04$, $P < .01$). The same was true for the comparison between the mean responses of schizotypics with those of the control subjects ($F = 93.01$, $P < .01$). The difference between the means of the responses of anhedonics and schizotypics for condition 4 was not significant.

Finally ANOVA was carried out for the responses of the three groups for condition 5 in which 3 (out of 3) of the distracting stimuli were present. The results revealed that there was a highly significant difference between the responses of the three groups ($F = 9.62$, $P < .0004$). The results are presented in Table 56. Post hoc analysis showed a highly significant difference between the means of the reaction time performances of schizotypics and control subjects in response to condition 5 ($F = 91.36$, $P < .01$). No significant differences were found between the means of responses of anhedonics compared with that of control subjects for condition 5. The difference between the responses of anhedonics and schizotypics was highly significant ($F = 96.31$, $P < .01$).

The error scores obtained for the trials in which distracting stimuli were present were calculated for each

of the 5 conditions and for each group of subjects. The error data were then subjected to group x errors analysis of variance. The results showed a highly significant main effect of groups ($F = 2.16$ $P < .03$) and a significant group x errors interaction effect ($F = 2.59$, $P < .08$).

Further one-way analyses were carried out separately in order to compare the error responses of the 3 groups for each of the 5 conditions. Analysis of variance revealed no significant difference between the groups when their responses to condition 1 were analyzed. For condition 2 the difference between the groups approached only a marginally acceptable level of statistical significance ($F = 2.39$, $P < .07$). The results of error data are presented in Table 57. The means of errors for the 3 groups are graphically presented in Figure 16.

Post hoc analysis was then carried out and the results were as follows;

Condition 2; schizotypics vs controls $F = .92$, $P < .05$.

Condition 2; anhedonics vs controls n.s.

Condition 2; schizotypics vs anhedonics n.s.

Analysis of variance showed a significant difference between the groups for condition 3 ($F = 14.75$, $P < .0001$).

The results of post hoc analysis for condition 3 were as follows;

Condition 3; schizotypics vs controls $F = 1.31$, $P < .01$.

Condition 3; anhedonics vs controls $F = 1.38$, $P < .01$.

Fig 16 Distraction reaction time
(mean errors)

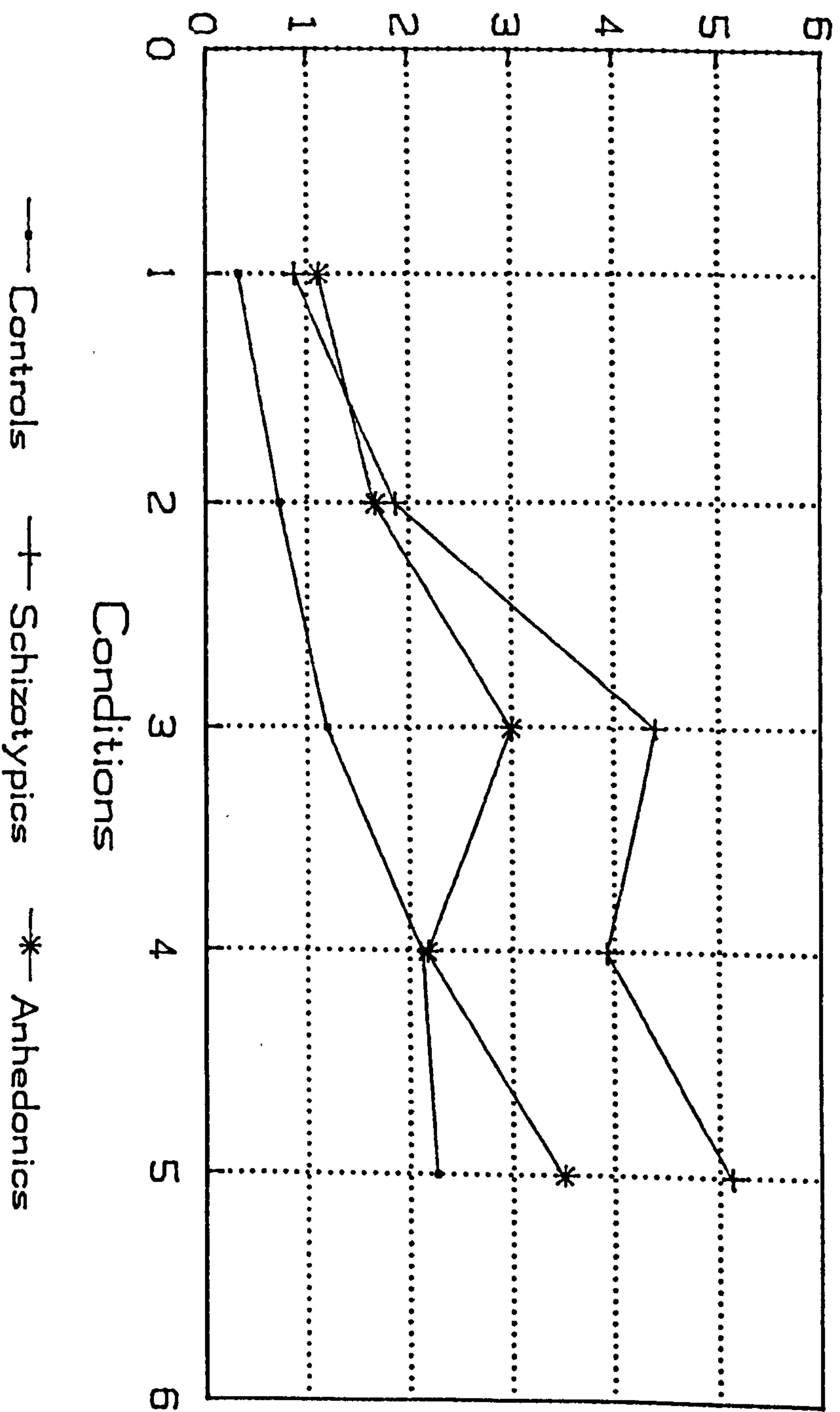


Table 57

The errors for the distraction reaction times for the anhedonic, schizotypic and control subjects

	Anhedonics		Schizotypics		Controls		F	P
	M	(SD)	M	(SD)	M	(SD)		
D1	1.12	(1.39)	0.88	(1.30)	0.33	(0.49)		n.s.
D2	1.67	(1.50)	1.87	(1.85)	0.73	(0.79)	2.59	<.08
D3	3.0	(2.41)	4.40	(1.40)	1.20	(0.86)	14.75	<.0001
D4	2.17	(2.04)	3.93	(2.58)	2.13	(1.50)	3.52	<.04
D5	3.50	(2.47)	5.13	(2.67)	2.27	(1.44)	6.18	<.05

Main effects					F = 2.16		P <.03	
Group x condition interaction					F = 2.59		P <.08	

Condition 3; schizotypics vs anhedonics $F = 1.09$, $P < .05$.
One-way ANOVA revealed that there was a significant difference between the error responses of the 3 groups for condition 4 ($F = 3.52$, $P < .04$). The results of post hoc analysis for condition 4 were as follows;

Condition 4; schizotypics vs controls $F = 1.70$, $P < .01$.

Condition 4; anhedonics vs controls n.s.

Condition 4; schizotypics vs anhedonics $F = 1.40$, $P < .05$.

A significant difference was found between the error made by the 3 groups for condition 5 ($F = 6.18$, $P < .005$). The results of post hoc analysis for condition 5 were as follows;

Condition 5; schizotypics vs controls $F = 1.82$, $P < .01$.

Condition 5; anhedonics vs controls n.s.

Condition 5; schizotypics vs anhedonics $F = 1.50$, $P < .05$.

Sex differences

A three-way group x conditions x sex analysis of variance compared the reaction time performances of the 3 groups for the 5 conditions. No significant differences were found between the responses of male and female subjects.

DISCUSSION

The presence of distracting stimuli affected the reaction times of anhedonics and the high scorers on the SZ scale. The results of the reaction time and the error responses of anhedonics and schizotypics revealed that they performed significantly worse than the control group in the presence of distracting stimuli and demonstrated an inability to deal with relevant information when the relevant stimuli were presented together with irrelevant, distracting stimuli and for all the groups both errors and slowness increased together therefore, there was no speed/accuracy trade-off. Although anhedonics and schizotypics became much slower as the number of distracting stimuli increased, this did not become apparent until the number of choices of irrelevant, distracting stimuli increased to three. In addition, when the maximum number of distracting stimuli were presented, only the high scorers on the SZ scale showed a deficit of performance and the reaction time performance of anhedonics was significantly faster than that of the schizotypic group when the maximum number of distractions were present.

This could be explained in terms of a limitation in the capacity for information handling in anhedonics and in particular in the high scorers on the SZ scale who are overburdened by an increase in the number of distracting stimuli. Therefore, when they attend to only a small

number of distracting stimuli their performance is not affected by the presence of irrelevant stimuli.

The result of the present experiment is in line with the previous findings of distractibility in schizophrenics which suggest that vulnerability to the effects of distracting input is a major aspect of attentional disorder in schizophrenics (Chapman and McGhie, 1962; Lang and Buss, 1965; Neale and Cromwell, 1970; Oltmanns and Neale, 1977).

The result obtained for the high scorers on the SZ scale was very much as predicted since high scorers on the SZ scale are believed to be characterized by symptoms of positive type in which disorder of attention is regarded as a fundamental feature. This result also indicates once again that they exhibit the characteristic of an abnormally broad range of attention shown by certain subtypes of schizophrenics (Venables, 1964). Furthermore, it is in line with the results of a study by Spring et al. (1983) who found that schizophrenic patients, in particular those with florid psychotic symptoms, are more distracted by irrelevant stimuli than normal subjects. This result also confirms the findings reported from the Stony Brook project (Weintraub and Neale, 1984) in which children with one schizophrenic parent were found to be highly distractible and suggest that individuals with schizotypic personality might share with children at risk for schizophrenia the

same difficulty in focusing on the relevant stimuli and block out the irrelevant stimuli.

The results obtained for the performance of individuals with schizotypic personality might indicate a deficit of attention in schizotypics. However, given a lack of data concerning reaction time in the presence of distraction obtained for schizotypic individuals, this area deserves further exploration.

CONCLUSION

The study of pre-schizophrenic individuals is believed to facilitate a better understanding of the development of schizophrenia. The present study was guided by the assumption that the identification of individuals vulnerable to schizophrenia by their traits might produce a more representative sample for study. Furthermore, this study was based on the hypothesis that there might exist different dimensions of schizotypy which might correspond to different subtypes of schizophrenia. The results of the questionnaire data indicated the existence of four orthogonal factors from which three , or possibly all of the four factors appeared to be related to different aspects of schizotypal personality characteristics.

The schizophrenism factor in the present study appeared to be measuring an aspect of schizotypy which is related to Meehl's (1962) cognitive slippage, interpersonal aversiveness and ambivalence as one dimension of schizotypy. The items of the schizophrenism factor appeared to tap the sort of characteristics which are related to disorder of attention and concentration, perceptual aberration, ambivalence and social anxiety.

As far as the psychophysiological results of the present study are concerned, the findings of importance were as follows:

The present study revealed that high scorers on the SZ scale showed a disorder of habituation of SCR whereas, anhedonics exhibited an orienting deficit.

High frequency of responsivity and larger amplitudes of responses was produced by the high scorers on the SZ scale while a low amount of responsivity and smaller SC amplitudes were given by anhedonics.

The evoked potential study of selective attention revealed that anhedonics exhibited a dysfunction of pigeon-holing or response set as indexed by the low amplitude of the P3 component in response to target stimuli.

The reaction time studies revealed that both anhedonics and high scorers on the SZ scale have more difficulty in switching their attention across modalities.

Anhedonics and in particular high scorers on the SZ scale proved to be highly distractible when performing a test of distractability.

A number of points are of importance amongst these findings. The high scorers on the SZ scale showed a pattern of responsivity characterized by a repeated re-orientation and over-responsivity and a lack of habituation of the SCR. The over-responsivity and lack of habituation of the SCR exhibited by the schizotypic group matched their

poor performance on the test of distractability. On the other hand the high scorers on the anhedonia scales exhibited a relatively low degree of skin conductance responsivity which parallels with their overall smaller amplitude of the P3 component.

Since stimuli with high intensity and fast rise time may elicit startle responses or defensive reaction (DR), SCR and heart rate response to high intensity tones were examined. The results showed no differences in DR between the groups. This is in contrast with the results of the study by Nielsen and Petersen (1976) which suggested that "high schizophrenism might be related to high sensory reactivity to high intensity stimuli due to a lack of adequate sensory defences against disturbing stimuli."

The general conclusions from the electrodermal data appear to support the hypothesis that electrodermal activity is related to vulnerability to schizophrenia. The heart rate data were less able to discriminate between the groups, but did show a slight parallel to skin conductance measures.

Another finding of interest in this study was that there was no evidence for a deficit of filtering for schizotypics and anhedonics in the present study as the amplitude of N1 did not distinguish any of the schizotypic

groups from the control group which could be suggested to indicate that schizotypics do not show the deficit of filtering. However, this requires further investigation as both anhedonics and high scorers on the SZ scale showed a deficit of attention in the presence of distracting stimuli. This might be suggested as indicating a deficit of filtering.

In the present study some of the psychophysiological findings for schizotypics and anhedonics were in line with the results of earlier high-risk studies and also the results from work with schizophrenic patients e.g. disorder of habituation of SCR and small amplitude of CPT. In addition, schizotypics and to some extent anhedonics performed more deviantly than the control group on measures of distractibility, switching attention and behavioural performance on CPT.

The finding indicating that anhedonics and in particular, high scorers on the SZ scale were distractible might be interpreted as evidence of having an abnormally wide range of attention and might reflect an inability to inhibit responses to irrelevant stimuli. For the high scorers on the SZ scale, this result is in parallel with their skin conductance over-responsivity and their failure to habituate which gives an indication of a deficit in schizotypic individual's ability to restrict the range of

their attention. This supports the hypothesis proposed by Venables (1964) which suggested that acute schizophrenic patients are characterized by an inability to restrict the range of their attention and are "flooded by sensory impressions".

The results of present study indicate that certain aspects of information processing and attentional functioning might be deficient in individuals with schizotypic personality and provide support for the hypothesis that there might be a continuity between schizotypic personality characteristics and schizophrenia. Furthermore, disorder of attention and information processing might be considered as an index of vulnerability to schizophrenia.

In conclusion the procedure employed in the present research for the selection of subjects, resulted in the selection of two schizotypic groups who demonstrated notable differences in a number of psychophysiological and behavioural measures compared with the control group. These results indicate that anhedonia and high schizophrenism might form two separate dimensions of schizotypy each one representing a different type of predisposing characteristics related to a different type of schizophrenic disorder.

Finally it is important to note that although it could be suggested that the present research provides some evidence for a possible relationship between schizotypy and future development of schizophrenia, such conclusions require further investigation. Follow-up studies of individuals with schizotypic tendencies might provide the best method of examining the theory of continuity between schizotypy and schizophrenia and might help to ascertain whether any of these individuals would develop schizophrenia. Furthermore, follow-up studies of schizotypics might provide a useful research strategy for the study of the etiology of schizophrenia. Since the data is collected before the onset of the symptoms, it is not contaminated by the outcome of schizophrenia illness, drug treatment and hospitalization. Therefore data gathered in such a way might also be useful in early detection, and intervention methods such as the training of vulnerable individuals to cope with stress.

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Appendix A

Table I

The questionnaire used for the selection of subjects.

SURVEY OF ATTITUDES AND EXPERIENCES

Name..... Date..... Subject.....
 Sex..... Age..... Year.....

Below, and on the following pages, are a list of statements about attitudes and experiences that some people would consider to be personally descriptive. Please indicate which of these statements are descriptive of you by reading each one carefully and circling either the TRUE or FALSE printed next to it according to whether you feel the statement is true or false in your case. There are no right answers to give and no trick statements. If you feel unsure about how to respond to a statement, you should circle the answer that you feel is most nearly true for you. Make sure that you record an answer for every statement, and work quickly and do not spend too long considering the meaning of each one. Do not start until you are sure that you know what to do.

- | | | |
|--|------|-------|
| 1. I stop to think things over before doing anything. | TRUE | FALSE |
| 2. I have gone out of my way to watch children play even when I didn't know them. | TRUE | FALSE |
| 3. The sounds of a parade have never excited me. | TRUE | FALSE |
| 4. Being in debt would worry me. | TRUE | FALSE |
| 5. I have had very little fun from physical activities like walking, swimming, or sports. | TRUE | FALSE |
| 6. I am not easily confused if a number of things happen at the same time. | TRUE | FALSE |
| 7. I have thoroughly enjoyed laughing at jokes with groups of other people. | TRUE | FALSE |
| 8. I lock up my house carefully at night. | TRUE | FALSE |
| 9. When I pass flowers I have often stopped to smell them. | TRUE | FALSE |
| 10. My plans have frequently seemed so full of difficulties that I have had to give them up. | TRUE | FALSE |
| 11. It would upset me a lot to see a child or an animal suffer. | TRUE | FALSE |
| 12. I attach very little importance to having close friends. | TRUE | FALSE |
| 13. I do not like to be interrupted when I am concentrating. | TRUE | FALSE |
| 14. I have never cared much about the texture of food. | TRUE | FALSE |
| 15. I believe insurance schemes are a good idea. | TRUE | FALSE |
| 16. Beautiful scenery has been a great delight to me. | TRUE | FALSE |
| 17. The sound of organ music has often thrilled me. | TRUE | FALSE |
| 18. I often change between positive and negative feelings towards the same person. | TRUE | FALSE |
| 19. I would take drugs which may have strange or dangerous effects. | TRUE | FALSE |
| 20. Writing letters to friends is more trouble than it's worth. | TRUE | FALSE |
| 21. My body, or some part of it, occasionally seems dead or unreal. | TRUE | FALSE |
| 22. The first winter snowfall has often looked pretty to me. | TRUE | FALSE |
| 23. I enjoy hurting people I love. | TRUE | FALSE |
| 24. I often get a restless feeling that I want something but do not know what. | TRUE | FALSE |

25.	I like to make long distance phone calls to friends and relatives.	TRUE	FALSE
26.	I have enemies who want to harm me.	TRUE	FALSE
27.	I am never so nervous that my mind 'goes blank'.	TRUE	FALSE
28.	The sound of rustling leaves has never much pleased me.	TRUE	FALSE
29.	When I've been extremely happy, I have sometimes felt like hugging someone.	TRUE	FALSE
30.	I do not find it difficult to telephone in a noisy place.	TRUE	FALSE
31.	I enjoy practical jokes that can sometimes really hurt people.	TRUE	FALSE
32.	I do not find it difficult to tolerate waiting for the outcome of something.	TRUE	FALSE
33.	Good manners and cleanliness matter much to me.	TRUE	FALSE
34.	It has often felt good to massage my muscles when they are tired or sore.	TRUE	FALSE
35.	Getting together with old friends has been one of my greatest pleasures.	TRUE	FALSE
36.	I am not much worried by humiliating experiences.	TRUE	FALSE
37.	I think marriage is old-fashioned and should be done away with.	TRUE	FALSE
38.	In the course of my life I have usually tried to avoid romantic involvements.	TRUE	FALSE
39.	The sound of rain falling on a roof can make me feel snug and secure.	TRUE	FALSE
40.	People who drive carefully annoy me.	TRUE	FALSE
41.	I suddenly feel shy when I want to talk to a stranger.	TRUE	FALSE
42.	Most things taste the same to me.	TRUE	FALSE
43.	I'd just as soon go to the cinema alone as with a companion.	TRUE	FALSE
44.	It worries me if I know there are mistakes in my work.	TRUE	FALSE
45.	I have had very little desire to try new kinds of foods.	TRUE	FALSE
46.	I am not usually self-conscious.	TRUE	FALSE
47.	Ordinary colours sometimes seem much too bright to me (without taking drugs).	TRUE	FALSE
48.	I like to arrive at appointments in plenty of time.	TRUE	FALSE
49.	I don't understand why people enjoy looking at the stars at night.	TRUE	FALSE
50.	My mother is (or was) a good woman.	TRUE	FALSE
51.	In the course of my life it has generally been very unusual for me to feel lonely for someone.	TRUE	FALSE
52.	I find it difficult to concentrate; irrelevant things seem to distract me.	TRUE	FALSE
53.	There are several people who keep trying to avoid me.	TRUE	FALSE
54.	Sunbathing isn't really much more fun than lying down indoors.	TRUE	FALSE
55.	Although there are things that I enjoy doing by myself, I usually seem to have had more fun when I've done things with other people.	TRUE	FALSE
56.	I think people spend too much time safeguarding their future with savings and insurances.	TRUE	FALSE
57.	The warmth of an open fire has not especially soothed and calmed me.	TRUE	FALSE

25.	I like to make long distance phone calls to friends and relatives.	TRUE	FALSE
26.	I have enemies who want to harm me.	TRUE	FALSE
27.	I am never so nervous that my mind 'goes blank'.	TRUE	FALSE
28.	The sound of rustling leaves has never much pleased me.	TRUE	FALSE
29.	When I've been extremely happy, I have sometimes felt like hugging someone.	TRUE	FALSE
30.	I do not find it difficult to telephone in a noisy place.	TRUE	FALSE
31.	I enjoy practical jokes that can sometimes really hurt people.	TRUE	FALSE
32.	I do not find it difficult to tolerate waiting for the outcome of something.	TRUE	FALSE
33.	Good manners and cleanliness matter much to me.	TRUE	FALSE
34.	It has often felt good to massage my muscles when they are tired or sore.	TRUE	FALSE
35.	Getting together with old friends has been one of my greatest pleasures.	TRUE	FALSE
36.	I am not much worried by humiliating experiences.	TRUE	FALSE
37.	I think marriage is old-fashioned and should be done away with.	TRUE	FALSE
38.	In the course of my life I have usually tried to avoid romantic involvements.	TRUE	FALSE
39.	The sound of rain falling on a roof can make me feel snug and secure.	TRUE	FALSE
40.	People who drive carefully annoy me.	TRUE	FALSE
41.	I suddenly feel shy when I want to talk to a stranger.	TRUE	FALSE
42.	Most things taste the same to me.	TRUE	FALSE
43.	I'd just as soon go to the cinema alone as with a companion.	TRUE	FALSE
44.	It worries me if I know there are mistakes in my work.	TRUE	FALSE
45.	I have had very little desire to try new kinds of foods.	TRUE	FALSE
46.	I am not usually self-conscious.	TRUE	FALSE
47.	Ordinary colours sometimes seem much too bright to me (without taking drugs).	TRUE	FALSE
48.	I like to arrive at appointments in plenty of time.	TRUE	FALSE
49.	I don't understand why people enjoy looking at the stars at night.	TRUE	FALSE
50.	My mother is (or was) a good woman.	TRUE	FALSE
51.	In the course of my life it has generally been very unusual for me to feel lonely for someone.	TRUE	FALSE
52.	I find it difficult to concentrate; irrelevant things seem to distract me.	TRUE	FALSE
53.	There are several people who keep trying to avoid me.	TRUE	FALSE
54.	Sunbathing isn't really much more fun than lying down indoors.	TRUE	FALSE
55.	Although there are things that I enjoy doing by myself, I usually seem to have had more fun when I've done things with other people.	TRUE	FALSE
56.	I think people spend too much time safeguarding their future with savings and insurances.	TRUE	FALSE
57.	The warmth of an open fire has not especially soothed and calmed me.	TRUE	FALSE

Appendix A
Table II

SURVEY OF ATTITUDES AND EXPERIENCES

Name..... Date..... Subject No.....

Sex..... Age.....

Below, and on the following page, are a list of statements about attitudes and experiences that some people would consider to be personally descriptive. Please indicate which of these statement are descriptive of you by reading each one carefully and circling either the TRUE or FULSE printed next to it according to whether you feel the statement is true in your case. If you feel unsure about how to respond to a statement, you should circle the answer that you feel is most nearly true for you. make sure that you record an answer for every statement.

- | | | |
|--|--------|---------|
| 1. I often have grave difficulties controlling my thoughts when I am thinking. | (TRUE) | (FULSE) |
| 2. A brisk walk has sometimes made me feel good all over. | (TRUE) | (FULSE) |
| 3. The idea of going out and mixing with people has always pleased me. | (TRUE) | (FULSE) |
| 4. I find it difficult to concentrate, irrelevant things seem to distract me. | (TRUE) | (FULSE) |
| 5. Sometimes people who I know quite well begin to look like strangers. | (TRUE) | (FULSE) |
| 6. The sound of rustling leaves has never much pleased me. | (TRUE) | (FULSE) |
| 7. I attach very little importance to having close friend. | (TRUE) | (FULSE) |
| 8. I prefer others to make decisions for me. | (TRUE) | (FULSE) |
| 9. I am not usually self Concious. | (TRUE) | (FULSE) |
| 10 The sound of rain falling on the roof can make me feel snug and secure. | (TRUE) | (FULSE) |
| 11. Now and then when I look in the mirror my face seems quite different from usual. | (TRUE) | (FULSE) |
| 12. The sounds of parade have never excited me. | (TRUE) | (FULSE) |
| 13. When I pass flowers I have often stopped to smell them. | (TRUE) | (FULSE) |

- | | | |
|---|--------|---------|
| 14. I suddenly feel shy when I want to talk to a stranger. | (TRUE) | (FULSE) |
| 15. When anticipating a visit from a friend I have often felt happy and excited. | (TRUE) | (FULSE) |
| 16. I am not much worried by humiliating experinecs. | (TRUE) | (FULSE) |
| 17. When I'm extremely happy I have sometimes felt like hugging someone. | (TRUE) | (FULSE) |
| 18. The warmth of an open fire has not especially soothed and calmed me. | (TRUE) | (FULSE) |
| 19. People can pretty well influence me even though I thought my mind was made up on a subject. | (TRUE) | (FULSE) |
| 20. I am not easily onfused if a number of things happen at the same time. | (TRUE) | (FULSE) |
| 21. Getting together with friends has been one of my reatest pleasure. | (TRUE) | (FULSE) |
| 22. I am never so nervous that my mid goes blank. | (TRUE) | (FULSE) |
| 23. I do not find it difficult to switch my attention quickly from one task to another. | (TRUE) | (FULSE) |
| 24. My body or part of it occasionally seems dead or unreal. | (TRUE) | (FULSE) |
| 25. I often change between positive and negative feelings toward the same person. | (TRUE) | (FULSE) |
| 26. I have throughly enjoyed laughing at jokes with other people. | (TRUE) | (FULSE) |
| 27. I often get a restless feeling that I want something but do not know what. | (TRUE) | (FULSE) |
| 28. I have been fascinated with the dancing of flames in a fire place. | (TRUE) | (FULSE) |

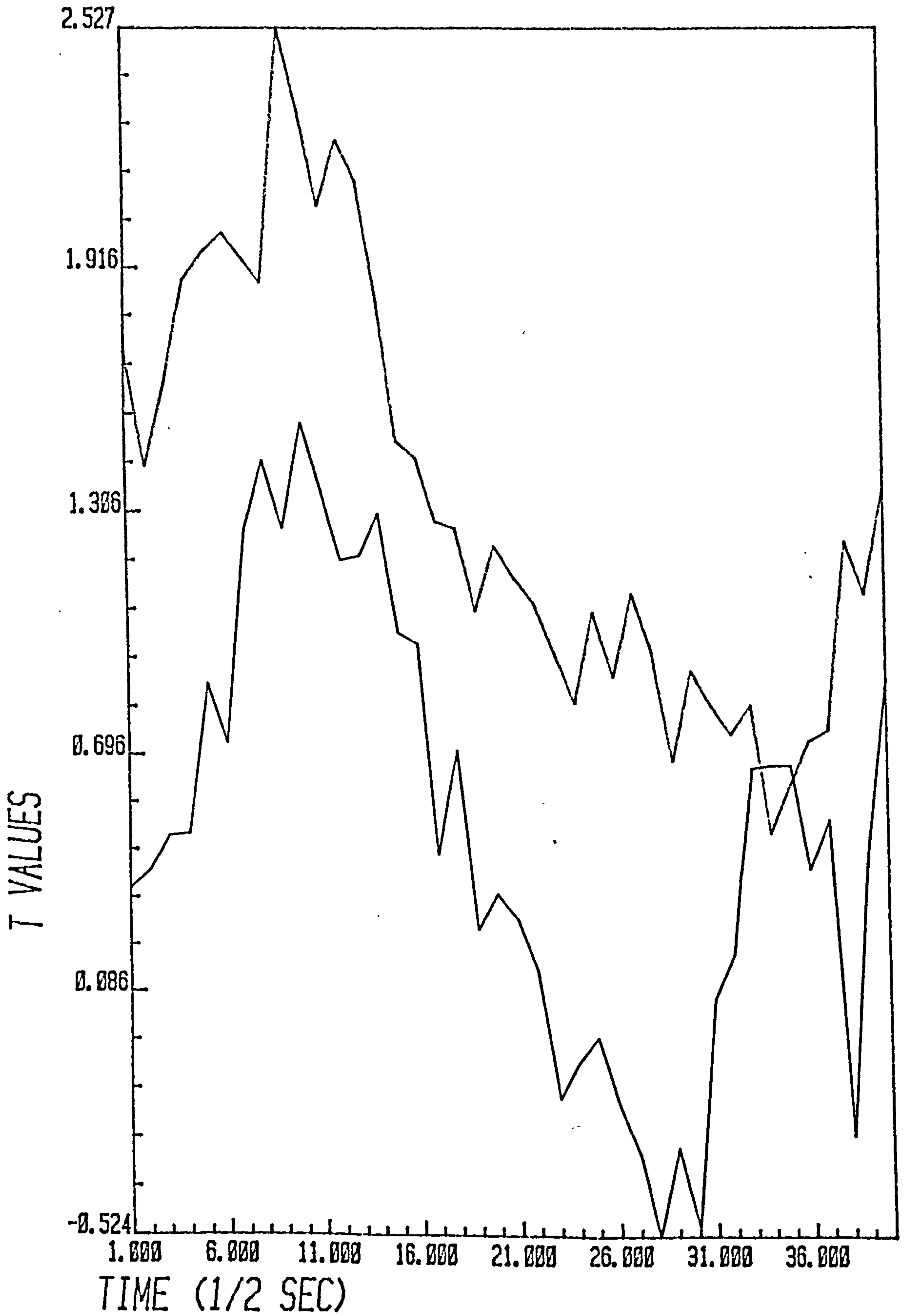
Appendix B The 39 auditory stimuli used in the skin conductance
 Table III experiment.

	Stimulus Type	Intensity dB	Rise Time msec	ISI
1	1000 Hz	75	25	35
2	1000 Hz	75	25	42
3	1000 Hz	75	25	36
4	1311 Hz	75	25	50
5	1311 Hz	75	25	47
6	1311 Hz	75	25	38
7	1311 Hz	75	25	40
8	1311 Hz	75	25	36
9	1311 Hz	75	25	39
10	1311 Hz	75	25	50
11	1311 Hz	75	25	48
12	1311 Hz	75	25	50
13	500 Hz	75	25	35
14	500 Hz	75	25	40
15	500 Hz	75	25	50
16	CV1	75	-	45
17	480 Hz	75	100	35
18	CV2	75	-	38
19	480 Hz	75	100	40
20	CV3	75	-	37
21	380 Hz	75	100	42
22	450 Hz	75	100	50
23	CV4	75	-	45
24	CV5	75	-	44
25	CV6	75	-	37
26	290 Hz	75	100	44
27	420 Hz	75	100	40
28	4000 Hz	90	5	35
29	500 Hz	90	5	45
30	WN	75	25	50
31	WN	90	5	36
32	500 Hz	75	25	42
33	4000 Hz	75	25	47
34	4000 Hz	90	5	38
35	500 Hz	90	5	35
36	WN	75	25	39
37	WN	90	5	43
38	500 Hz	75	25	49
39	4000 Hz	75	25	-

CV = consonant vowel synthetic speech

WN = white noise

Stimulus duration 1 sec except for CV stimuli where the duration is 360msec.



1 = CONTROL

2 = SCHIZOTYPIC