

**THE CONTRIBUTION OF  
EXECUTIVE  
DYSFUNCTION TO MEMORY  
IMPAIRMENT AND  
CONFABULATION IN  
SCHIZOPHRENIA**

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## ABSTRACT

**Study 1** Using a cognitive-process approach, 25 schizophrenic patients were matched with 25 healthy volunteers and compared on tests of memory and executive function. The schizophrenia group was found to have a significant impairment in immediate memory with relatively spared long-delay and recognition memory. Memory deficits were irrespective of the encoding strategies used and were unrelated to chronicity. In addition, the schizophrenic patients performed worse than controls on tests of executive function which was supported by some significant correlations between aspects of memory and executive function. The pattern of performance resembled that found in patients with subcortical or frontal lesions.

**Study 2** To examine further executive aspects of memory, an attempt to demonstrate confabulation in schizophrenia was made. Twelve schizophrenic patients were matched with 12 volunteers, 8 of whom were normal healthy subjects, with the remainder being depressed patients. The subjects were asked to recall a set of experimental narratives, with confabulation being defined as the recall of ideas not present in the narrative. Subjects were also examined on a number of neuropsychological tests and the patients were assessed on the Krawiecka scale. Variable amounts of confabulation were observed in all the schizophrenic patients while only one control subject confabulated. The form of confabulation differed from those observed in other patients in that the original ideas were spontaneously rearranged to produce new ones. Confabulation was

found to be related to difficulties in suppressing inappropriate responses and formal thought disorder.

**Study 3** Three schizophrenic patients previously identified as confabulators were intensively studied to establish the mechanisms of narrative confabulation in schizophrenia. Patients were administered experimental tasks as well as standard neuropsychological tests of memory and executive function. Assessment of current symptoms was made using the SANS and SAPS scales. The severity of cognitive impairment was found to reflect the severity of confabulation, but memory impairment was neither nor sufficient to account for confabulation. Within the spectrum of executive deficits, impairments in response suppression and response monitoring, but not planning or generation were consistently associated with confabulation. The findings from the experimental tasks suggest that faults occur at both input and output. At the input stage, narrative material is encoded in a disorganised manner while at the output stage, this disorganisation is compounded by faulty editing processes.

**Study 4** Four schizophrenic patients who were known confabulators with narrative material, were subjected to an experimental autobiographical questionnaire designed to establish whether schizophrenic patients confabulate in response to questions calling on the recollection of personal facts and events. In addition, a number of neuropsychological tests were administered and current symptoms was assessed with the SANS and SAPS scales. All patients were observed to confabulate to varying degrees, particularly in response to questions relating to personal episodes rather than facts. For two patients,



personal delusional systems were found to play a role in confabulation by providing a framework on which to base certain confabulatory recollections. Memory impairment was not found to be a necessary component to autobiographical confabulation but deficits in response suppression and response monitoring were observed to be related to the verification process performed during this task.

**Study 5** In an attempt to establish which anatomical regions may be at fault in schizophrenia when patients are engaged in response suppression tasks, six normal subjects were studied using positron emission tomography (PET) to identify anatomical regions involved when performing the Hayling Test. Subjects were also required to perform a control condition in which they had to read out the last word of given sentences. Compared to the control task, response initiation was associated with left sided activation of the frontal operculum, inferior frontal gyrus, middle temporal gyrus and right anterior cingulate gyrus, whereas response suppression was associated with left frontal operculum, inferior frontal gyrus and right anterior cingulate gyrus activation only. The difference between the two parts of the Hayling Test was in the increased activation of the left middle temporal gyrus and the left inferior frontal region (Brodmann's area 44/6) during response initiation.



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## THE EXTENT OF MY PERSONAL CONTRIBUTION

In accordance with the requirements of the University of London, the extent of my personal contribution to the work in this thesis is specified as follows:

During the period in which the work was carried out, I was employed as a full time researcher on a grant from the Rayne Foundation. The grant holder was Professor M.A. Ron, Professor of Neuropsychiatry, but the supervisor for my thesis was Professor C.D. Frith. I was substantially involved in the design of all of the studies contained in the thesis from the initial stages and collected all the data. In addition, I personally interview all the subjects and performed the neuropsychological and cognitive tests. Dr J Foong performed the independent psychiatric assessment interviews. In addition, Dr R. Corcoran and Ms K. Bilder made independent assessments of experimental material to enable the calculation of inter-rater reliability.

I also conducted five of the six functional imaging sessions. Professor Frith collected the data from the sixth subject. I performed the statistical analysis throughout with guidance on statistical parametric mapping and brain region identification from Dr P. Fletcher and Professor Frith.

This thesis is entirely my own original work and no other person should be held accountable for its contents.

David A. Nathaniel-James

I certify that this is a correct statement of David Nathaniel-James' contribution.

Professor C.D. Frith  
Professor of Neuropsychology



## PREFACE

Schizophrenia is the major form of psychiatric illness worldwide. In addition to describing the many psychiatric abnormalities, however, there have been numerous attempts to characterise the accompanying cognitive deficits, a practice that began early this century (e.g. Kraepelin 1919). The deficits vary in both form and severity and, among these, memory and executive problems are perhaps the most frequently reported circumscribed impairments. Often, these have been studied independently, but for a few exceptions and have mostly involved groups studies. The studies that have looked at memory and executive dysfunction in the same patients. These studies have often observed a pattern of memory impairment consistent with frontal lobe dysfunction with accompanying impairments on tests of executive function. This evidence suggests that the two domains may be related.

Despite these encouraging findings, a number of questions remain unanswered. Firstly, are memory and executive dysfunction in schizophrenia related? If so, what is the nature of this relationship. For instance, is the contribution of executive dysfunction to memory impairment complete or selective? Also, if frontal memory phenomenon is found to coexist with executive dysfunction we might expect that people with schizophrenia will also confabulate, given that some patients with the same deficits do. Lastly, if confabulation were observed in schizophrenia, what form would it take, what would be the mechanisms and how might this relate to the patients' symptomatology?



This thesis comprises 5 studies that address these questions. It incorporates a number of methodologies including established neuropsychological and psychiatric assessments, newly devised experimental tasks and positron emission tomography (PET), with group and case study samples. In the last chapter, I have collectively drawn on the findings from these studies to delineate the relationship between executive function and memory in schizophrenia.

**CHAPTER 1****The nature of schizophrenia**

1.1

**S**chizophrenia is one of a number of psychoses whose sufferers all demonstrate that they are not fully in touch with reality. It is also one of the most difficult psychiatric syndromes to describe and define. This is chiefly because there are many widely differing concepts of schizophrenia held in different countries and by different psychiatrists. Nevertheless there are two basic forms which appear to be universally observed in this illness, these are *acute* schizophrenia and *chronic* schizophrenia. In general, in acute schizophrenia, the major clinical features are hallucinations (auditory or visual), delusions, and interference with thinking. These are commonly referred to as 'positive' symptoms, (Crow 1980) and are considered abnormal because of their presence. The features of chronic schizophrenia are apathy, slowness, lack of drive and social withdrawal. These are called 'negative' symptoms, (Crow 1980) and are seen as abnormal because they portray a absence of behaviour which is present in normal people.

Whilst recovery is possible after an acute episode, progression to the chronic syndrome means that recovery is rarely complete. Between 30 and 50% of cases progress to the chronic state within two to five years, depending on how the definition is made, (Frith 1992). Estimates of the incidence and prevalence of schizophrenia are also dependent on how the diagnosis is made. It is estimated that the annual incidence is between 0.1



and 0.5 per 1000 of the population. This varies with age with the highest rates being amongst young men between 18 to 25 and 35 to 39-year-old women. The life time risk is approximately 1 in 100 people. The prevalence of schizophrenia in European countries is between 2.5 and 5.3 per 1000, (Jablensky 1986).

In order to be diagnosed as schizophrenic, the patient must report unusual beliefs or experiences. Ideas pertaining to having one's thoughts broadcast or hearing people talking about one in the absence of anybody being there are examples of these experiences. However the range and length of time that these symptoms should be displayed are major causes for disagreement, which makes a definite diagnosis difficult. The basis for these problems lies in the historical development of ideas about schizophrenia.

Emil Kraepelin (1855-1926) on the basis of his observations on course and symptomatology, argued against the idea of a single psychosis and proposed a division into *dementia praecox* and *manic depressive psychosis*. He initially described *dementia praecox* (which we now call schizophrenia) as consisting of "a series of states, the common characteristic of which is a peculiar destruction of the internal connections of the psychic personality. The effects of this injury predominate in the emotional and volitional spheres of mental life" (Kraepelin 1919). Originally, he divided the disorder into three subtypes (catatonic, hebephrenic and paranoid) and later he added a fourth (simple). Kraepelin saw *dementia praecox* as invariably progressing to a level of chronic deterioration from which there was no recovery, whereas

manic depressive psychosis patients shifted between periods of abnormality and normality.

Eugene Bleuler (1857-1959) who based his work on Kraepelin's was less concerned with prognosis and more with the possible mechanisms of symptom formation. In fact it was Bleuler who coined the term 'schizophrenia' to describe a 'splitting' of functions, which he believed to be of paramount importance. Bleuler believed in a distinction between two types of symptoms: *fundamental* and *accessory*. Fundamental symptoms are disturbances of associations, changes in emotional reactions and autism. Accessory symptoms on the other hand are hallucinations, delusions and abnormal behaviours. Interestingly, this classification is not too dissimilar from Crow's negative and positive symptoms (Crow 1980). Later, Kurt Schneider (1959) proposed a method to make diagnosis more reliable by identifying a set of symptoms which are characteristic of schizophrenia, but rarely found in other conditions. These are known as 'first rank symptoms' and include commentary hallucinations, thought withdrawal or insertion and thought broadcasting, to name a few.<sup>1</sup>

Contemporary psychiatry, in an attempt to resolve some of these problems relies on two major classification systems, DSM IV and ICD10. This however does not solve all the problems as there is disagreement about the duration of symptoms required before schizophrenia can be diagnosed. ICD10 requires one month whereas DSM-IV requires six months. The importance of duration of symptoms for DSM-IV means that it is the closest to Kraepelin's

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<sup>1</sup> For the full list of Schneider's first rank symptoms, see Schneider (1959).



original notion. By contrast, the ICD10 definition places more reliance on first rank symptoms than DSM-IV does. However the use of DSM-IV in the USA and other countries has resulted in a much narrower definition of schizophrenia than was previously used.

To date, the aetiology of schizophrenia is uncertain. Of the predisposing factors, genetic influences have been the most strongly implicated. Twin studies comparing the concordance rates for schizophrenia in monozygotic (MZ) and dizygotic (DZ) twins such as Gottesman and Shields (1972) and Fischer (1973) have reported higher concordance rates in MZ twins. Similarly, adoption studies (e.g. Heston 1966), portray a similar picture. In this study, 47 adults who had been born to schizophrenic mothers, but separated from them soon after birth, were compared with controls matched for circumstances of upbringing. Heston found that five of the offspring of the schizophrenic mothers were diagnosed as schizophrenic, compared to none of the controls.

Neurological damage around the time of birth has also been implicated. Retrospective studies of schizophrenic patients report more obstetric complications compared with normal controls, (Woerner et al 1973). Also, in studies of identical twins discordant for schizophrenia, the affected twin often had a more complicated birth, (Pollin and Stabenau 1968). These findings indicate that one causal factor may be a degree of brain damage resulting from obstetric complications.

One prevailing theory as to the pathophysiology of schizophrenia is the dopamine theory. This can be easily understood when compared with Parkinson's disease. In parkinsonism, the main features are movement disorders resulting from reduced amounts of the neurotransmitter dopamine. All the drugs which reduce psychotic symptoms in schizophrenics, have dopamine blocking properties, (Seeman et al 1976). These give rise to side effects consisting of movement disorders similar to those in parkinsonism. The inductive leap from these observations has been to propose that excessive dopamine is produced in schizophrenic patients, which gives rise to their psychotic symptoms. However to date, there is no direct evidence that overactivity of dopaminergic systems is *the* central disorder in schizophrenia.



## Clinical features of schizophrenia 1.2

### *Positive symptoms*

Positive symptoms occur predominately in the *acute* syndrome. However the manifestations of these symptoms are very varied. In appearance and behaviour, some patients seem normal. Others may seem preoccupied, or markedly socially withdrawn and unresponsive. Some patients can be seen talking to themselves, or laughing or smiling without obvious reason. The account reported below<sup>2</sup> illustrates one of the common positive symptoms associated with this syndrome. This is an excerpt from a patient who began to have *delusions* when he was 23. At this time, he began to believe that he was an important person.

"..... in my flat I began to get delusions. I was a store keeper at the time. I wrote out 'Supreme New Plan', a system of life which I had worked out for myself... I wrote out notebooks full of plans. I kept thinking the Mafia were after me and the F.B.I. were protecting me, ready to send me away to be trained. I kept thinking my parents were Jews. I would ask my landlady, in my loneliness, if I could watch their television and I would cry all the way through the programmes. Finally, I tried to get away to my Aunt Mary's : all I had with me was a suitcase with a bible in it. The police picked me up and I made a false confession of murder so that they would incarcerate me and protect me from the Mafia. ....my doctor said I needed a rest. Sometime, next day, a medical superintendent and my mother came to certify me at the flat.

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<sup>2</sup> This account is reproduced from *Understanding Schizophrenia* with permission of the West Birmingham Health Authority.

A social worker took me to the hospital. I didn't resist; I thought it was all part of the plan..."

Bizarre experiences and beliefs like these are only known to others if a patients tell us about them (symptoms). Delusions are among the most frequently reported positive symptoms and therefore warrant closer inspection.

### Delusions

In general a delusion is a belief which is taken to be true , while it is actually false or unreal; for example, "my thoughts affect government policy". Delusions can take many forms. A *primary* delusion is one that appears suddenly without any events leading up to it. For instance a schizophrenic may be suddenly and completely convinced that her leg is melting without ever having thought about it before and without any preceding events or ideas which could have led to this conclusion. These beliefs arrive suddenly, fully formed and in a convincing form. These are less common than other forms of delusions. *Persecutory delusions* on the other hand are very common, but not specific to schizophrenia. These are beliefs like "the FBI are after me" or "a machine from the future has come back in time to kill my unborn son". Of greater diagnostic value are delusions of *reference*, *control* and delusions about the *possession of thought*. The latter refers to delusions where the patient believes that thoughts are being inserted into or withdrawn from his mind, or broadcast to other people. These are sometimes referred to as thought insertion, withdrawal and broadcast respectively.



## Hallucinations

About 65% of patients with schizophrenia report auditory hallucinations. These sometimes take the form of whole conversations, but can include single words and noises. Some patients report voices as giving commands, whereas others hear their thoughts spoken out aloud either as they think them, or immediately afterwards. Some voices are also reported as discussing the patient either in the second person (someone talking to the patient) or in the third person (talking about the patient to someone else). These symptoms have particular diagnostic value in that both DSM IV and ICD10 diagnostic criteria such symptoms are sufficient to make a diagnosis of schizophrenia. Visual hallucinations are less common and often occur with other types of hallucination. For example, a patient may report seeing a fire following hearing a voice saying that "your time is up". Some patients also report tactile (touch), olfactory (smell) and gustatory (taste) hallucinations which may or may not be accompanied by other hallucinations.

## Positive Signs

In contrast to the 'positive' symptoms of the acute syndrome, there are also positive signs. The excerpt provided below illustrates one of the more common positive signs.

"How old are you?"

*"Why I am centuries old sir."*

"How long have you been here?"

*"I've been now on this property on and off for a long time. I cannot say the exact time because we are absorbed by the air at night and they bring back people. They kill up everything; they can make you lie; they can talk through your throat."*

" Who is this?"

*"Why, the air."*

"What is the name of this place?"

*"This place is called a star".*

"Who is the doctor in charge of your ward?"

*"A body just like yours, sir. They can make you black and white. I say good morning, but he just comes through there. At first it was a colony. they said it was heaven. These buildings were not solid at the time and I am positive that this is the same place. They have others just like it.*

*People die, and all the microbes talk over there and prestigitis you know is sending you from here to another world..... I was sent by the government to the United States to Washington to some star and they had a pretty nice country there. Now you have a body like a young man who says he is of the prestigitis."*

"Who was this prestigitis?"

*"Why you are yourself. You can be prestigitis. They make you say bad things; they can read you; they bring back Negroes from the dead"*

This excerpt illustrates the *incoherence* often found in the conversation of schizophrenics. Although the patient makes repeated references to central ideas or a theme, the images and fragments of thought are not connected. In addition the patient used the word "prestigitis," a *neologism* or new word which he probably made up. In this excerpt it is difficult to understand exactly what the patient is trying to tell the interviewer. The term *thought disorder* is used to refer to problems of this kind.



## Thought disorder

The central problems of thought disorder include both the *form* of thought - the organisation of ideas, speaking so that a listener can understand; and the *content* - the actual ideas that are expressed. Specific disturbances in the form of thought are *poverty of speech* - either the amount of discourse is reduced or it conveys little information; *perseveration* - words and ideas are persistently repeated and *blocking* - a train of speech is interrupted by silence before an idea is completed and then the thought being conveyed cannot be recalled, indicative of some form of interference. Disturbances in the form of thought were regarded by Bleuler as the principle clinical symptom of schizophrenia and remain one of the DSM-IV criteria for the diagnosis. Disorders of thought content can be found through *lack of insight* where patient's thoughts convey that they have no appreciation of their condition or their unusual behaviour. This may also include holding beliefs that the rest of society would generally disagree with.

## *Negative Symptoms*

Negative symptoms are characteristic of the chronic syndrome in schizophrenia, although chronic patients do have positive symptoms in varying degrees. Generally the symptoms (or signs) fall into two categories, namely physical and psychological.

## Physical signs

Various movement disorders occur in schizophrenia. A patient with *stupor* is immobile, mute and unresponsive, although fully conscious. This is considered to be one of the more striking catatonic symptoms along with *excitement*. *Stereotypy* is a repeated movement that appears not to be goal

directed, e.g. rocking forwards and backwards. Slowness or psychomotor poverty, are also common signs as are odd postures and movements. There are also less common signs, for example, ambitendence, which is a very special form of ambivalence, where the patient begins to make a movement, but before completing it, starts the opposite movement; for example, putting the hand back and forth to an object, but without reaching it.

### Psychological symptoms and signs

Perhaps the most striking feature is diminished *volition* (lack of drive and initiative). If left to himself, the patient may engage in aimless and repeated activity or may be inactive for long periods. Other negative features in schizophrenia include general underactivity, few social interests, neglect of appearance, decreased spontaneous movements and lack of expressive gestures (flat or blunting of affect). All of these negative signs are more commonly *observed* in the patient during the *chronic* stages of the disease.

In schizophrenia, the symptoms and signs are combined in so many ways that the clinical picture is very variable. An account of schizophrenia in terms of the acute or chronic syndromes, or positive and negative features is an oversimplification. Different features may predominate within a syndrome; for example, in the acute syndrome, a patient may have predominately auditory hallucinations and another mainly delusions. Moreover, some patients have features of both syndromes regardless of whether they are in the early or later stages of the illness. These issues make direct comparisons between cases difficult, a point which Frith (1992) illustrates clearly, ".....each case is so different from the next that it is difficult to say what they have in common".



## The Frontal lobes and schizophrenia 1.3

During the last decade, a large body of evidence has accumulated showing evidence of disturbance of function and to a lesser extent structure of the frontal lobes as part of a widespread brain disorder in schizophrenia. The evidence stems from studies which have used cognitive neuropsychological approaches, neuroimaging technologies and neurochemical pathological methods. In addition, certain signs and symptoms have been ascribed to frontal lobe dysfunction. These include delusions (Benson & Struss 1990) and poverty of thought and poor insight, (David, 1992). Whilst this is not a universally held opinion, there is nevertheless general agreement that frontal lobe dysfunction may underlie certain signs and symptoms in schizophrenia.

Phylogenetically, the frontal lobes are the most recently developed brain region and take up nearly one third of the cortex. The prefrontal cortex lies at the confluence of subcortical and cortical circuits and, as the largest associational region, provides the substrate for integrating behaviour; both cognitive and emotional (Benson, 1993). There are four sulci in the frontal cortex, with the posterior limit of the frontal cortices being the central sulcus. The central sulcus runs from midpoint of the hemisphere circumference both inferiorly and anteriorly toward the temporal lobe. The precentral sulcus lies anterior to the central sulcus. The two other major sulci in the lateral surface of the frontal lobe are the superior frontal and the inferior frontal. These both have an anteroposterior course starting at the lower orbital border of the lateral surface of the frontal lobe and adjoining in the precentral sulcus. With

respect to the mesial surface the most important sulcus is the cingulate which runs parallel to the corpus callosum.

In addition to these sulci, there are six gyral subcomponents which are particularly important. Firstly, there is the *precentral* gyrus which runs parallel to the central sulcus and which constitutes perhaps the most caudal sector of the frontal lobe. The *superior* frontal gyrus occupies the mesial and most anterior sector of the frontal lobe. The *middle* frontal gyrus which is parallel to the superior frontal gyrus, occupies a more lateral and inferior position between the superior and inferior frontal sulci. The *inferior* frontal gyrus mostly constitutes the frontal operculum, whereas the *orbital* frontal gyri include the gyrus rectus and the orbital gyri themselves. Finally, there is the *cingulate* gyrus, which runs parallel to the corpus callosum and is separated from the remainder of the mesial frontal area by the cingulate sulcus. This gyrus continues into the region of the mesial parietal lobe. It is only the anterior half that is considered to be under the frontal lobe area.

The frontal lobes can be further broken down into cytoarchitectonic areas or divisions. Indeed, most anteriorly, the prefrontal cortex comprises many different cytoarchitectonic areas with connections to cortical and subcortical structures and several subdivisions are now well delimited. Perhaps the most often used maps of cytoarchitectonic areas are those of Brodmann (1909; 1925). However, these did not map the ventral surface of the frontal lobe so it is now common to incorporate either Becks' maps (Beck 1949) or Sanides (1964) to deal with the orbital region. Functionally, the frontal lobe has been traditionally divided into prefrontal, limbic, motor and premotor sectors.



However, because the divisions are linked directly to cytoarchitectonic structure, it is not necessarily easier to delineate them at say the microscopic level, than to assign cytoarchitectonic fields. For instance, the separation between premotor and motor is fuzzy and the border between premotor and prefrontal is still worse (Damasio 1991). Although there are no clear limits for these areas, the prefrontal region is commonly subdivided still further into dorsolateral, mesial, prefrontal and orbital prefrontal regions.

Studies of the structural integrity of the frontal lobes in schizophrenics during the last ten years have been carried out using in vivo imaging techniques such as computed tomography (CT) and Magnetic Resonance Imaging technology (MRI). However, since its first clinical application, MRI has become the method of choice in the depiction of brain anatomy, pathology and for locating brain lesions. Monographs on MRI are available (Andrew et al 1990) but a detailed description of the principles and techniques lies outside the scope of this thesis. In brief, however, MRI is a technique whereby images of objects such as the brain, are created using nuclear magnetic resonance. This technique describes the interaction between nuclei (those with single or odd numbers of protons or neutrons) and radio frequency pulses in a strong magnetic field. Hydrogen nuclei can be regarded as single protons and are ideal for the purpose of nuclear MRI. Hydrogen is an abundant element in human tissue. Protons, in their natural state, have both spin and a magnetic field. When placed in a strong uniform external magnetic field, their axes of spin are tilted and rotated, resulting in a motion known as precession. When an additional oscillating magnetic field of a particular resonant frequency in the radio frequency range of the electromagnetic spectrum is applied, the protons first absorb and then

re-emit the radio waves. Nuclear magnetic resonance describes this phenomenon of resonant absorption and re-emission of radio frequency energy and it is this interaction which is utilised to produce cross-sectional images. MRI is therefore fundamentally different from computerised tomography (CT).

With the introduction of MRI, structural abnormalities in the frontal lobes and elsewhere in the brains of schizophrenics have been identified. The particular areas which have been found to be abnormal include the lenticular nuclei and cerebral cortex, (Jernigan et al 1991), the temporal-limbic regions (DeLisi et al 1988; Bogerts et al 1990; Harvey et al 1993) and the pre frontal cortex (Andreasen et al 1986; Zipursky et al 1992). The identification of structural abnormalities in the frontal cortex however have not been found in all studies. Indeed Andreasen et al. (1990) were unable to replicate their earlier findings when a better matched control group was examined. MRI studies examining cerebral volume have been even less conclusive to date (e.g. Nasrallah et al 1990). This is largely due to methodological problems such as inferring global volumetric measurements from single slice studies (e.g. Coffman et al 1989). Other studies such as Seidman et al (1994) have taken MRI techniques a step further by trying to correlate cerebral volume with neuropsychological test results. For example, Seidman et al (1994) found both executive and memory test performance to be associated with left dorsal lateral prefrontal cortex (DLPFC) volume. Maher et al (1995) also found associations between DLPFC volume and memory. Whilst this technique is indeed fruitful, the relationship between structure and function (if found) is indirect and therefore tells us little about the functional aspects



of the underlying processes associated with these areas. However despite such findings, the body of evidence for *structural* abnormalities in schizophrenia, is highly debatable as far as the frontal lobes are concerned. David (1992) in a review paper based on the work of Andreasen et al (1990) and others argued that the frontal lobes were "all right" when compared with those of appropriate controls. He goes on to say that researchers nevertheless are unhappy about this state of affairs, such is the strength of the frontal hypothesis. Why are they unhappy? In general this may in part be explained by the fact that although there is little evidence of structural abnormalities in the prefrontal cortex of schizophrenics, studies continue to accumulate demonstrating patterns of cognitive impairment which resemble patients with prefrontal involvement (e.g. Goldberg et al 1989; Crawford et al 1993). These studies give rise to the hypothesis that whilst there may be no structural damage to the frontal cortex in schizophrenics, performance on various task demonstrates that the frontal lobes of schizophrenics are dysfunctional.

Magnetic resonance imaging as a research tool has a number of problems which may also be fuelling this debate. For example, imagers vary widely across centres both in type of pulse sequence available and in the strength of the magnet used. These differences will inevitably reduce cross-centre comparability. In addition, the most widely used method of analysing MRI data has been to use ratios, which assume constant levels of the neuronal markers used as denominators. This technique has been criticised by Maier et al (in press) as lacking sensitivity.

Another potential contributor to the discontent expressed over the validity of structural damage in schizophrenia concerns the heterogeneity of schizophrenic samples in studies. Variations between schizophrenic samples whether intra (chronic or acute) or inter (symptomatology) may be so great that their brain measurements in one study may not be replicated by another, (e.g. Andreasen et al 1990). Indeed, most researchers assemble a sample of patients diagnosed by a standard set of criteria not known to identify distinct types (e.g. DSM-III-R or RDC). As Andreasen et al. (1990) point out, this practice is acceptable since we do not know which subtypes of schizophrenia have neurobiological basis. However, in practice this could mean that groups of patients with essentially identical phenomenology may have inherent and unperceived differences in brain structure and neurochemical factors.

In conclusion, it is difficult to draw firm conclusions as to the extent of structural abnormalities in the frontal lobes in schizophrenics. Such is the hold on psychiatric thinking that studies continue to accumulate accompanied by plausible hypotheses. It is worth noting, however, that it is hard to find a region which is not, in one way or another, linked to the frontal lobes (e.g. Reading 1991). In the words of David (1992), "the frontal lobe hypothesis of schizophrenia is rapidly becoming irrefutable."

In view of the inconsistent finding of structural abnormalities in the frontal lobes of schizophrenics, the most recent addition to neuroimaging technology, Positron Emission Tomography (PET) is currently being used to locate precisely where in the brain certain processes are mediated or



dysfunctional. PET usually relies on the measurement of regional cerebral blood flow (rCBF). In brief, a small amount of radioactive tracer namely oxygen 15- labelled water ( $H_2^{15}O$ ), is injected intravenously into the subject which is taken up by the brain and detectable by the PET camera. As blood flow increases wherever activity of nerve cells increase, any increase in blood flow is taken as an index of increased cerebral activity and is interpreted as having localising significance. Earlier PET studies focused on measurements taking during the *resting state*, where the subject had no task to perform during the scanning period. However due to the variance of the resting state within individuals, recent studies have tended to use *activation testing conditions*. These are commonly referred to as *activation studies*. This technique requires the subject to perform cognitive tasks that involve both experimental and control conditions whilst they are being scanned. This approach has two main advantages. Firstly, each subject acts as their own control which reduces subject variability and secondly by measuring changes in cerebral activity in conscious subjects whilst performing cognitive tasks, one can begin to uncover the functional aspects underlying certain cognitive operations.

To date, many of the PET studies in schizophrenia have attempted to evaluate frontal metabolism, for example Buchsbaum et al (1982) and Wolking et al (1988), have reported reduced absolute and relative frontal glucose metabolism. This finding has been supported by activation studies, (e.g. Cohen et al 1987; Buchsbaum et al, 1990). Perhaps of even more value however, is the study of Liddle et al (1992), where PET was used to study the patterns of rCBF in schizophrenics with the view of establishing a relationship with symptom profiles. Following the segregation of symptoms

into three syndromes, relations were found to exist between psychomotor poverty, disorganisation and reality distortion (hallucinations and delusions) with differing patterns of perfusion. In particular, psychomotor poverty and disorganisation was associated with different patterns of cerebral blood flow at different locations in the prefrontal cortex, whereas reality distortion was associated with altered perfusion in the medial temporal lobe. This study is of particular importance as it indicates that not only do brain function abnormalities underlie syndromes in schizophrenia, but that these syndromes relate to a distributed neuronal network.

Perhaps the greatest body for evidence of problems within the frontal lobes of schizophrenics comes from neuropsychological studies. Neuropsychological evidence of frontal lobe dysfunction in schizophrenia came into prominence following the classic cerebral blood flow studies of Weinberger (1986). By linking the Wisconsin Card Sort Test (WCST) with *in vivo* measures of cerebral activity, Weinberger demonstrated that schizophrenic patients fail to activate their dorsolateral prefrontal cortices (DLPFCs) while attempting to carry out this 'frontal lobe' or 'executive' test compared to normal controls. The WCST is now the most widely used 'frontal lobe' or 'executive' test in schizophrenia research. However it should be noted that some studies have failed to find schizophrenics showing a deficit on this test (e.g. Nathaniel-James et al. 1994). But what is the functional significance of the frontal lobes? It is generally agreed that the frontal lobes carry out an 'executive function' (e.g. Shallice, 1988). These functions are argued to include planning, decision making, error correction or trouble shooting, producing novel sequences of actions and overcoming strong habitual responses or resisting temptation. In essence, whilst other



cognitive functions such as language are localised elsewhere in the brain, the frontal lobes are believed to be responsible for the appropriate use and integration of these functions.

The 'frontal deficit' hypothesis in schizophrenia has to date been supported by a number of studies which have shown impairment on various tests of executive function, (e.g. Goldberg et al 1989; Liddle et al 1991; Shallice et al 1991; Beatty et al 1993). These tests have included the Cognitive Estimates (Shallice and Evans 1978), Wisconsin Card Sorting Test (Milner 1976; Nelson, 1976), Verbal Fluency (Benton 1983), Stroop (Perret 1974) and Design Fluency (Jones-Gottman and Milner 1977).

In conclusion, the implications from neuroimaging and neuropsychological studies are that the frontal lobes may be dysfunctional in schizophrenia and that careful study may provide clues as to the nature of the deficits in this disorder. It will be interesting to see if further research can establish links between various features of schizophrenia and neuropsychological impairment, particularly functions mediated by frontal pathways.

## Memory impairment in schizophrenia 1.5

Historically, memory impairment was not considered to be a central feature of schizophrenia except in a few chronic, deteriorated patients. Bleuler (1911) stated that "memory as such does not suffer in this disease". Even recently Cutting (1990) argued that memory was intact in acute schizophrenia, although he conceded that memory impairment may be common in chronic patients. However, memory is not a single entity but describes a wide range of associated cognitive processes. It involves learning as well as forgetting, encoding strategies, susceptibility to interference etc. Just as memory is not a single entity, so too there are several different patterns of memory dysfunction.

The pattern of memory deficit shown by patients with temporal lobe/ hippocampal damage is referred to as the classic amnesic syndrome (Baddeley 1982). This is characterised by a relative sparing of immediate free recall and wide ranging deficits in recognition, free and cued recall following a delay, indicating rapid forgetting of acquired information. This pattern of memory deficit implies both encoding and storage deficits (Cermak et al 1972; Welsh et al 1991). However, learning and memory are not dependent solely on the temporal / hippocampal system. Recent studies with Positron Emission Tomography (PET) (e.g. Grasby et al 1994; Fletcher et al 1995) indicate the involvement of a distributed system of brain regions including areas of prefrontal cortex, anterior cingulate and cerebellum. In agreement with this model, memory dysfunction is also found following damage to the



frontal cortex and associated structures (e.g. Butters et al., 1986., Jetter, et al., 1986., and Janowsky, et al., 1989). This pattern of memory deficit is referred to as the frontal amnesic syndrome (Benton et al 1991). The features of this pattern are wide ranging deficits in immediate free recall memory, with relatively spared recognition memory and free recall following a delay. This pattern is seen to reflect a retrieval deficit as suggested by the improvement in performance in the recognition format, although inefficient encoding strategies may also be involved.

McKenna et al (1990) in a study of 60 schizophrenic patients of varying severity and chronicity, observed that the pattern of memory impairment in schizophrenia (using the Rivermead Behavioural Memory Test; Wilson et al. 1985) resembled that of the classic amnesic syndrome with relative sparing of immediate recall of names, prose and a simple route, but wide ranging deficits in delayed recall. These general findings have been supported by other recent studies (e.g. Tamlyn et al 1992; Duffy et al 1994), and have been attributed to medial temporal lobe dysfunction (Saykin et al 1991). In contrast, others ( Koh 1978; Nachmani & Cohen 1969; Goldberg et al 1989; Beatty et al 1993 and Paulsen et al 1995), have reported groups of schizophrenics where the main deficit was on tests of immediate memory. In these studies recognition performance (the ability to detect a target item from a distracter item) was relatively preserved. This pattern of memory impairment is similar to that seen in the frontal lobe amnesic syndrome. This apparent contradiction between studies may result from differences in sampling, but the heterogeneity in the assessment tools may have also contributed to the inconsistent findings. In addition the greater difficulty of recall tasks

compared to recognition tasks may magnify this apparent dissociation (Neale & Oltmanns, 1980).

The degree to which one can account for both the executive impairment and the patterns of memory impairment in schizophrenia by putting forward suggestions of frontal lobe dysfunction is debatable. It is nevertheless plausible to speculate that, given the anatomy of the frontal lobes, particularly the prefrontal cortex with its massive array of interconnections with other sites involved in memory, the frontal lobes are fundamental to any adequate account of memory impairment in schizophrenia.



## The use of neuropsychological tests in schizophrenia research

1.6

Using neuropsychological tests, there is little dispute that schizophrenic patients are cognitively impaired in a number of different domains, in particular executive functioning as mentioned earlier and memory functions as will be addressed later, are examples of cognitive functions which when compared with appropriate controls are poorly performed. More recently, perceptual deficits have also been reported, for example Shallice et al (1991) reported a patient who performed poorly on the Object Naming Test, in addition to a mild general cognitive impairment and Nathaniel-James et al (1994) reported a set of monozygote twins concordant for schizophrenia, who both demonstrated a specific deficit in facial recognition, assessed by the facial recognition component of the Recognition Memory Test (Warrington, 1984). In practice though, schizophrenic patients may perform poorly on any task for a number of different reasons. Medication, particularly anticholinergics have been argued to cause memory impairments, (e.g. Frith 1984). More subtly, given the nature of schizophrenia, it is entirely feasible that patients may interpret the task demands differently from normal subjects due to thought disorder or other current symptoms. In addition to these potential problems, interpretation of neuropsychological test results, particularly in schizophrenia research is a hazardous affair. For example, what does it mean when a patient performs poorly on a task which assesses verbal learning or long term memory? Does this mean that the patient has a *damaged*, or *dysfunctional* hippocampus, or is it that they have attentional problems which would make concentration difficult? These are some of the issues which I will now address.

A common approach to understanding the underlying problems in schizophrenia is by way of an analogy with neurological patients. In addition to other features, many cognitive abnormalities seen in schizophrenics are also observed in patients with brain damage. The specific approach employed is cognitive neuropsychology where a wide range of tests are applied to patients with various localised lesions. Whilst there are very few tests which have a high degree of specificity, the idea is that patients with lesions in *certain* locations will perform *certain* tests badly, whilst performing other tests within the normal range. These tests have been used in schizophrenia research on the premises that if a patient performs poorly on a particular test which is known to have localising significance, then the patient has brain damage in that region. The reported evidence on deficits in schizophrenia would suggest that on this basis almost every part of the brain is implicated in schizophrenia.

Frith (1992) has pointed out that the problem of applying the classical neuropsychological approach to the study of schizophrenia, arises because studies use groups of schizophrenic patients with varying signs and symptoms. Moreover, as certain cognitive deficits are associated with particular signs and symptoms, the average performances of any one group will give a false picture as to the nature of the neuropsychology of schizophrenia. Justification for this stance has been provided by Liddle & Morris, (1991) who have demonstrated that differing neuropsychological profiles are seen with patients who differ in current signs and symptoms.



The nature of psychological tests and cognitive processes are such that many tests are non-specific with respect to localisation and the cognitive processes involved. For example, the most widely used test in schizophrenia research, the Wisconsin Card Sort Test (Heaton 1981) requires many processes for adequate performance such as changing set, working memory and shape perception. A deficit in any one of these *specific* processes on this *non-specific* test will result in poor performance. Moreover, whichever process is believed to be at fault will suggest a different circumscribed area of brain damage.

In the studies described in this thesis I have attempted to identify the cognitive impairments that underlie poor test performance and to relate these to particular signs and symptoms of schizophrenia.

## CHAPTER 2

### Study 1: Memory and executive function

#### INTRODUCTION

The presence of memory impairment in schizophrenia has frequently been documented but much less attention has been given to the qualitative aspects of this impairment. Moreover, although a number of studies have reported 'frontal' or 'executive' dysfunction in schizophrenia using various tests (e.g. Liddle et al 1991; Shallice et al 1991; Beatty et al 1993 and Elliot et al 1995), there have been few studies which have looked at both memory and executive function in the same patients. This approach was adopted by Shallice et al. (1991), Beatty et al. (1993) and Seidman et al. (1994). These studies have reported a pattern of memory impairment consistent with frontal dysfunction. In particular, Shallice and colleagues, using a case study approach, reported 5 patients who were all impaired to varying degrees on frontal tests (particularly stroop colour naming and the Trail making Test). Of these, three also showed a pattern of memory dysfunction analogous to patients with frontal lobe lesions with deficits on list learning, known to have a strong frontal component (e.g. Luria 1966). Beatty et al (1993), using a group study approach, found schizophrenic patients to be impaired on various frontal tests (Wisconsin Card Sort, Verbal Fluency and Design Fluency tests), as well as verbal memory tests



(immediate and delayed recall), with a dissociation between poor recall and normal recognition memory. However these studies did not examine the relationship between memory and executive function and therefore they provide no direct evidence that the two sets of deficits are in any way related.

An explicit correlational approach would lead to the following prediction. If a pattern of memory impairment which resembles the frontal amnesic pattern is observed in schizophrenia, performance on executive function tests should be associated with immediate free recall, but not with long-delay memory processes which are thought to be subserved by medial temporal structures. Furthermore, executive function should be associated with those memory processes thought to be frontally mediated such as encoding strategy and the use of organisation in the material to be remembered. This study attempted to examine these possibilities by incorporating memory and executive tests into the same study, with the addition of a newly devised executive function test which explores response initiation and suppression. It is hypothesised that my schizophrenic sample would display memory impairment similar to the pattern found in frontal-lobe amnesia, specific features of which would be associated with impairment of executive function.

## METHODOLOGY

### **Subjects**

Twenty five patients whose first language was English and who met DSM-III-R criteria for schizophrenia were recruited for this study over a period of 12 months from the Maudsley Hospital register. Their ages ranged between 25 and 50 years. Four were female. The mean duration of illness was 15.58 years. Only one patient was experiencing acute psychotic symptoms (hallucinations and delusions) at the time of testing. All but three patients (88%) were on maintenance neuroleptic medication and only three of this medicated group (14%) were also on anticholinergic medication. Subjects were excluded if they had significant systemic disease or head injuries that had rendered them unconscious. The same exclusion criteria were applied to controls. None of the subjects drank more than 21 units of alcohol per week. Each patient was matched as closely as possible with a healthy volunteer for age, sex, premorbid IQ, using the NART (Nelson 1982), years of education and parental social class using Goldthorpe and Hope's (1974) social grading of occupation scale (See table 1). All subjects gave informed consent. All the subjects in this study were also involved in a study of hippocampal abnormalities using magnetic resonance spectroscopy (Maier et al. 1995).



## Neuropsychological Assessment

The following neuropsychological test battery was administered to all subjects:

### Memory Tests

#### 1. Recognition Memory Test for Words (Warrington 1984).

This was administered using the standard procedure. The test consists of 50 stimulus words. Recognition memory was tested by presenting each word with a distracter. The subject was required to make a forced choice between them. The number of correctly recognised words was converted to an age-corrected scaled score.

#### 2. Recognition Memory Test for Faces (Warrington 1984).

The stimuli consists of 50 black and white photographs of unfamiliar faces. The method of testing was the same as for the Recognition Memory Test for Words.

#### 3. California Verbal Learning Test (Delis et al., 1987).

This test permits a detailed analysis of different aspects of verbal learning and memory. It provides measures of both recall and recognition of words over a number of trials. The subject was required to recall a list of 16 words (list A), which consisted of four words from each of four semantic categories, (i.e. fruits, clothing, tools, herbs and spices), over five trials. An interference list of 16 new words (list B) was then presented for one trial, immediately followed by both free

recall (short-delay free recall) and category-cued recall (short-delay cued recall) of list A. Following a 20 minute break, during which some of the executive function tests were administered, free and cued recall (long-delay free and cued recall) and recognition of the list A were assessed. Additional measures include intrusion errors, semantic and serial clustering strategies and serial position effects.

#### Tests of Executive function

##### 1. Verbal Fluency (Benton et al. 1983)

In this test the subject was required to say as many words as possible beginning with a given letter in 60 seconds (excluding numbers and proper nouns). For this study the letters F, A and S were used. The score, which was the sum of all acceptable words, was corrected for sex, age and education according to existing norms (Benton and Hamsher 1976).

##### 2. Wisconsin Card Sorting Test; WCST (Nelson 1976).

The subject was asked to sort 48 cards on the basis of three possible categories (colour, number and shape). The total number of errors, categories achieved and the number of perseverative errors made were recorded. In addition, the percentage of perseverative errors was calculated.



### 3. Hayling Sentence Completion Test ( Burgess & Shallice, 1996).

This is a response initiation and suppression test consisting of 2 stimulus conditions of 15 sentences each. In the first condition, (response initiation), 15 sentences were read to the subject with the last word omitted. The subject was required to give a word which plausibly completed the sentence. In the second condition (response suppression) the subject was asked to produce a word *unrelated* to each of 15 sentences. Two measures were scored: the sum of response latencies in condition 1, and an error score based on the quality of responses in condition 2 (a 'correct' completion response of a sentence received an error score of 3, a word semantically related to a word in the sentence received an error score of 1 and an unrelated word a score of 0).

#### PROCEDURE

The tests were administered in the following order: CVLT, Hayling Test, Modified Card Sorting Test, Verbal Fluency Test, Recognition Memory Test and NART. This order was necessary to ensure that no other memory tasks were administered during the 20 minute delayed recall interval of the CVLT to avoid interference.

### **Statistical analysis**

Differences between the groups were tested using analysis of variance with repeated measures. The exceptions to these were the use of independent 't' tests and the Mann-Whitney U Test. Correlational analysis was used to examine the interrelationship between measures. The statistical package SPSS v 6.1 for Windows (Norusis, 1992) was used for the analysis.

## **RESULTS**

### **Background variables**

There was no significant differences between the schizophrenic and control groups on any of the background variables, however schizophrenics were somewhat older than the controls and had fewer years of formal education (table 1). In addition, they had a higher parental social class rating as indicated by a lower numeric rank.

### **Memory functions**

#### **1. Verbal learning**

The means and standard deviations for both groups on trials 1 to 5 of the CVLT are provided in table 2. Significant main effect differences were found for trial and group but not for trial by group interaction, (table 3). This suggests that the



schizophrenic group recalled less material overall, but learned at the same rate as controls. Despite recalling less items, the schizophrenic group made more intrusion errors across trials 1-5 of list A (see table 2 ). However this did not reach significance ( $p > 0.10$ ).

## 2. Serial position

No significant differences were found between the groups on the primacy, middle region and recency measures of the CVLT ( $p > 0.05$ ). This indicates that the schizophrenic group's pattern of retrieval was normal, with the highest proportion of the list items being recalled from the beginning and end of the list.

## 3. Proactive interference

List B, the interference trial, was compared with list A trial 1 to assess whether there was an effect of proactive interference (i.e. list A learning leading to a build up of semantic associations which would interfere with the subsequent recall of list B). The means and standard deviations are provided in table 2. There was a significant main effect of trial with both groups recalling less of list B than list A. Although the patients recalled less overall, there was no significant group by trial interaction, (table 3). This indicates that the schizophrenic group had a normal vulnerability to proactive interference.

#### 4. Short-Delay Retention and Cueing

List A trial 5 was compared with the short delay free recall trial to measure short-delay retention of the learned material. There were significant main effects of trial, group and trial by group interaction (table 3). These data suggest that subjects recalled items significantly differently between the two conditions, the schizophrenic group recalled less items overall and that after a short delay, the amount of decline was significantly greater for the schizophrenic group. The impact of cueing as a method of improving recall was assessed by comparing the scores on the short-delay free recall trial with those of the short-delay cued recall trial. Analysis confirmed that both groups benefited from cueing and to the same degree.

#### 5. Long-Delay Retention and Cueing

Long-delay free recall performance was compared to short-delay free recall to measure whether the previously learned material was retained after 20 minutes delay, (table 3). Although the schizophrenic group continued to recall fewer items, neither group showed any significant further decline in recall performance. Subsequent cueing again led to a significant improvement in recall performance, and to the same degree in both groups.



## 6. Encoding strategies

Measures of semantic and serial encoding strategies were derived from the serial order of the subjects responses during recall in the initial 5 trials. The schizophrenic group used serial in preference to semantic processing, ( $t= 4.16$ ;  $p < 0.001$ ) whereas the control group used both strategies to almost the same degree, ( $t = .28$ ;  $p > 0.10$ ).

## 7. Recognition memory

There were no significant differences between the two groups in their ability to detect target items from distracter items, ( $t=.15$ ;  $P>0.10$ ) Similarly, no significant differences were observed for either the word, ( $t=. 06$ ;  $p>.10$ ) or face ( $t= .38$  ;  $p>.70$ ), versions of the Recognition Memory Test. These results suggest that there is a clear dissociation between free recall and recognition memory in our schizophrenic patients when compared to controls.

## Executive function

On the Verbal Fluency Test, the schizophrenic group performed significantly worse than controls (table 4) although the mean score was within established norms (Benton et al., 1983). The schizophrenic group also performed significantly worse on all measures of the WCST, with the exception of the overall number of errors. In addition, they were significantly worse on both measures of the Hayling Test.



## Correlational analysis

To examine the relationships between performance on executive function and memory tests, bivariate Spearman's rank order correlations were calculated (table 5). To reduce the number of variables in the analysis, the variables of the CVLT thought to reflect the performance of the schizophrenic group, based on the mean comparisons, were selected: list A trial 1, the sum of short-delay recall (list A trials 1-5), the sum of short and long delay recall, the sum of short and long delay cued recall, the semantic/serial scores and the total intrusion error scores. The word and face recognition scores from the RMT were also included. These were correlated with the Hayling response suppression errors and initiation latency, the total Verbal Fluency score and the 4 measures from the WCST, (categories, total errors, perseverative errors and percentage of perseverative errors. No significant correlations were found between any of the memory and executive function measures for the control group. For the schizophrenia group, List A trial 1 was positively associated with the WCST category scores and negatively associated with the WCST total errors, perseverative errors and the percentage of perseverative errors (i.e. the worse the memory, the fewer the number of categories and the more errors). Similarly, the sum of List A trials 1-5 (A total), was positively associated with the category scores and negatively associated with the total errors and perseverative errors. The sum of short and long-delay recall scores (A delay) was also positively



associated with the category scores, but not the other WCST measures. This was the same pattern for the total number of intrusions made. The number of correctly recognised faces from the RMT was positively associated with the total errors, perseverative errors and the percentage of perseverative of the WCST.

Correlational analysis was also carried out to check for an association between duration of illness and cognitive performance. No significant correlations ( $p > 0.05$ ) were found between duration of illness and any of the memory or executive function measures.

**Table 1. Background Variables**

<b>Subjects characteristics</b>	<b>Schizophrenics</b>	<b>Controls</b>
mean age	36.6 (8.40)	32.9 (5.66 )
years of formal education	13.98 (2.89)	14.11 (2.11)
premorbid IQ (NART)	116.60 (7.91)	116.68 (6.77)
Duration of illness (years)	15.58 (8.20)	NA
Father's level of occupation (0-36)	14.5	16.85



**Table 2. Memory performance on the CVLT**

mean and standard deviation (in parenthesis)

<b>Variables</b>	<b>Schizophrenics</b>	<b>Controls</b>
List A trial 1	5.08 (1.75)	6.80 (1.73)
List A trial 2	6.84 (2.44)	9.16 (2.19)
List A trial 3	8.32 (2.68)	10.36 (2.21)
List A trial 4	7.88 (3.28)	10.80 (2.06)
List A trial 5	8.44 (3.25)	11.36 (1.77)
List B	3.56 (1.95)	6.36 (2.05)
free recall intrusions	5.28 (3.81)	3.32 (3.95)
cued recall intrusions	4.24 (3.43)	3.64 (4.09)
total intrusions	9.52 (6.10)	6.96 (6.24)
short-delay free recall	7.48 (3.12)	10.20 (3.37)
short-delay cued recall	8.92 (2.44)	11.16 (3.35)
long-delay free recall	7.44 (3.30)	10.76 (2.84)
long-delay cued recall	8.24 (2.35)	11.16 (3.26)
semantic clustering score	1.24 (0.49)	1.91 (0.92)
serial clustering score	2.70 (1.50)	1.79 (1.31)
% primacy recall	52.25 (18.97)	64.99 (15.58)
% middle recall	34.00 (11.68)	41.32 (7.53)
% recency recall	72.94 (19.06)	60.20 (16.74)
recognition memory (hits)	13.28 (2.18)	13.76 (1.89)



Table 3. Analysis of variance for sections of the CVLT

Tests	F	(df)	p
Verbal learning (trials 1-5)			
Trial	45.23	4, 48	<0.001
Group	20.14	1, 48	<0.007
Trial x Group	1.26	4, 48	>0.50
Proactive interference (trials b vs. a1)			
Trial	12.24	1, 48	<0.009
Group	13.17	1, 48	<0.001
Trial x Group	2.49	1, 48	>0.36
Short-delay retention (a5 vs. SDFR)			
Trial	6.91	1, 48	<0.005
Group	14.84	1, 48	< 0.01
Trial x Group	8.56	1, 48	< 0.03
Short-delay cueing (SDFR vs. SDCR)			
Trial	21.72	1, 48	<0.001
Group	8.77	1, 48	<0.009
Trial x Group	0.87	1, 48	>0.62
Long-delay cueing (LDFR vs. LDCR)			
Trial	3.11	1, 48	>0.84
Group	16.55	1, 48	<0.001
Trial x Group	0.35	1, 48	>0.56
Long-delay retention (LDFR vs. SDFR)			
Trial	0.1	1, 48	>0.30
Group	8.02	1, 48	<0.001
Trial x Group	0.2	1, 48	>0.25
Encoding strategies (semantic vs. serial processing)			
Trial	6.31	1, 48	<0.01
Group	0.46	1, 48	>0.51
Trial x Group	8.62	1, 48	<0.004

Key: SDFR (short-delay free recall); SDCR (short-delay cued recall)

LDFR (long-delay free recall); LDCR (long-delay cued recall)



**Table 4. Executive function analysis**

means and standard deviations (in parenthesis)

Tests	Schizophrenics	Controls	p
Verbal Fluency Test	32.92 (7.55)	43.20 (15.85)	p < 0.005
Modified Card Sort Test			
Categories	4.72 (1.51)	5.52 (0.91)	p < 0.03
Errors	9.96 (7.88)	6.40 (6.44)	p > 0.87
Perseverative errors	2.84 (4.24)	0.84 (1.57)	p < 0.03
% perseverative errors	19.01 (18.31)	7.33 (12.91)	p < 0.02
Hayling Test			
error score (response suppression)	10.32 (5.62)	3.72 (3.34)	p < 0.001
latency (response initiation)	27.40 (31.21)	15.78 (11.89)	p < 0.001



**Table 5 Correlations of memory and executive function performance**

	WCST CAT	WCST ERRORS	WCST PE	WCST % PE	HAYLING SUPPRESSION	HAYLING INITIATION	TOTAL FLUENCY
LIST A TRIAL 1	$r = 0.66^{***}$	$r = -0.69^{***}$	$r = -0.51^{**}$	$r = -0.41^*$	$r = -0.17$	$r = 0.10$	$r = -0.002$
A TOTAL	$r = 0.61^{***}$	$r = -0.57^{**}$	$r = -0.46^*$	$r = -0.38$	$r = -0.33$	$r = 0.10$	$r = 0.10$
A CUE	$r = 0.37$	$r = -0.31$	$r = -0.31$	$r = -0.26$	$r = -0.26$	$r = -0.19$	$r = 0.14$
A DELAY	$r = 0.42^*$	$r = -0.36$	$r = -0.31$	$r = -0.33$	$r = -0.27$	$r = 0.061$	$r = 0.05$
SEMCR	$r = 0.10$	$r = -0.08$	$r = -0.32$	$r = -0.30$	$r = -0.08$	$r = 0.21$	$r = -0.30$
SERCR	$r = -0.15$	$r = 0.18$	$r = 0.22$	$r = 0.05$	$r = -0.17$	$r = -0.10$	$r = 0.002$
TOTAL I	$r = 0.40^*$	$r = -0.26$	$r = -0.20$	$r = -0.10$	$r = 0.18$	$r = 0.20$	$r = -0.32$
RMF	$r = -0.37$	$r = 0.42^*$	$r = 0.41$	$r = 0.43^*$	$r = 0.11$	$r = -0.18$	$r = 0.27$
RMW	$r = 0.15$	$r = -0.21$	$r = -0.20$	$r = -0.20$	$r = 0.09$	$r = 0.08$	$r = -0.28$

Key: WCST CAT = WCST total categories  
 WCST ERRORS = WCST total error score  
 WCST PE = WCST perseverative errors  
 WCST % PE = WCST % perseverative errors  
 A total = (sum of trials list A 1-5)  
 A cue = sum of short and long-delay cued recall trials  
 A delay = (sum of short and long-delay recall)  
 SEMCR = semantic score  
 SERCR = serial score  
 Total I = total intrusions

\*  $p < 0.05$  \*\*  $p < 0.01$  \*\*\*  $p < 0.001$



## DISCUSSION

The aim of this study was to examine the qualitative features of memory impairment in patients with schizophrenia, and to assess the relationship between memory and executive functions. Before discussing the meaning of the results, it must be pointed out that selection of patients and controls was determined by the needs of a parallel MRS study that required cooperation with a lengthy imaging protocol which resulted in the exclusion of some severely disturbed, actively psychotic patients. On the other hand, all schizophrenics fulfilled strict diagnostic criteria and were in my view representative of chronic schizophrenic populations in remission commonly included in neuropsychological studies. Moreover, the schizophrenic patients had a high level of premorbid ability estimated by the NART and were well matched to the controls for years of education and parental social class. This supports my belief that the findings cannot be interpreted as resulting from lower premorbid cognitive ability or educational attainment, thus representing genuine disease-related deficits.

To consider first the features of memory performance. Compared to controls, the schizophrenic group performed poorly on several aspects of verbal memory, particularly on immediate recall, with a increased rate of intrusion errors, and a reduced tendency to employ semantic encoding/retrieval strategies. In contrast, delayed recall (relative to immediate recall) and recognition abilities were preserved. The features of this pattern of memory impairment are similar to those found following lesions to the frontal cortex, and are unlike those



associated with lesions of the medial temporal/hippocampal structures. This supports my initial hypothesis that memory impairment maybe in part mediated by frontal lobe dysfunction.

Several features of the performance of the schizophrenic group on memory tasks deserve further comment. The results suggest that recognition memory may be better preserved than recall, both immediate and delayed. However, it may also be a reflection of the fact that recognition tasks may be intrinsically easier (Neale and Oltmans 1980). In addition, my patients showed relative sparing of verbal learning which proceeded at a normal rate and benefited from categorical cueing which is in agreement with McClain (1983). In agreement with previous studies (e.g. Paulsen et al 1995) the patients showed a preference for using serial encoding in preference to semantic encoding strategies, but this use of strategy was not found to be related to memory performance. This argues against the suggestion (e.g. McClain 1983) that poor recall in schizophrenia can be explained by a failure to use semantic encoding.

Turning to the performance on executive function tests, the patients performed uniformly worse than controls as reported in previous studies (Goldberg et al 1987; Shallice et al 1991; Morrison-Stewart et al 1992; Beatty et al. 1993; Seidman et al 1994). However the degree of impairment varied from task to task. Performance on the WCST and Verbal Fluency Test, even if significantly worse than the controls was within the prescribed norms and this may reflect the high premorbid ability of the patients in addition to the likely selective



vulnerability of executive tasks in schizophrenia. This probability is given further credence by the clear impairment of the schizophrenics on the test of response initiation and suppression (Hayling Test).

Having established a pattern of memory impairment consistent with frontal lobe involvement, together with an impairment on executive tests, the third stage of the present study was to assess the interrelationship between the two sets of data. In the schizophrenic group, associations were shown between aspects of memory and executive function as predicted, which were not present in the controls. The strongest correlations were between WCST measures and immediate recall on the CVLT: in particular, List A trial 1, and the sum of list A trials 1-5. Although causality cannot be assumed, these results offer some support for the hypothesis of a frontal contribution to the memory deficit of schizophrenia. However, the generality of this conclusion is reduced by a number of statistically (and practically) non-significant associations. First, WCST performance was unrelated to other aspects of memory also impaired in this sample, namely intrusion errors and the tendency to use serial rather than semantic ordered recall. Second, none of the memory measures showed any relationship to performance on either verbal fluency or to response suppression and initiation (Hayling Test). In line with this pattern of results, the scores of the executive tests were unrelated to each other. Thirdly, aspects of memory and executive function which appear conceptually related did not covary in this sample. For example, recall intrusion errors did not correlate with perseverative errors on the WCST, or to problems in response suppression.



What implications do the present results have for the functional-anatomical systems underlying memory and executive function in schizophrenia? A good starting point is to consider the cortical areas involved in performance of the WCST, the task most clearly associated with memory in this study. The traditional lesion approach established the WCST, and in particular the perseverative error measure, as an index of frontal function (e.g. Milner 1963). More recently, however, the study of patients with focal lesions has called into doubt both the sensitivity and specificity of the WCST in localising frontal lobe damage (e.g. Robinson et al., 1980, Anderson et al., 1991; van den Broek et al., 1993; Corcoran & Upton 1993). In the latter study patients with either hippocampal sclerosis or complex partial seizures with either temporal or frontal onset, were compared in the WCST, Verbal Fluency and Stroop tests. The greatest impairment on the WCST was shown by the hippocampal group with fewer categories sorted and more perseverative errors. The same group, however, was least affected on the other two tasks.

A more direct approach is to examine the pattern of rCBF or metabolic activity in the brain of both healthy subjects and patients while performing the WCST. A consistent finding in the healthy subjects is an increase in rCBF or metabolism in prefrontal, and more specifically DLPFC, relative to rest or other control tasks (Marenco et al., 1993 Rezai et al., 1993; Catafau et al., 1994). This activation appears significantly reduced in schizophrenics, (Daniel et al., 1991; Berman et al., 1993; Catafau et al., 1994; Rubin et al., 1994). Further evidence from PET studies (e.g. Grasby et al.1994; Fletcher et al.1995) also suggests that the



DLPFC is normally activated during some memory tasks. The finding of a common substrate for these tasks adds support to my findings. An intriguing finding of this study is the lack of correlation in the schizophrenic group between the performance on the WCST and the verbal fluency task, in view of the fact that activation studies have suggested the involvement of the DLPFC in spontaneous word generation, (e.g. Frith et al. 1991). This suggest that both tasks may involve different functional but overlapping networks. Thus while DLPFC may be involved in each task, measures of performance on individual tasks may also depend upon other non-common structures.

The results require me to modify the initial premises of this study. The findings highlight the heterogeneity of the skills suberved under the term 'executive function' and suggest that some of these skills are probably suberved by independent subsystems, which are selectively vulnerable in schizophrenia. In addition, only a subset of executive functions relate to memory impairment. This is in keeping with the accumulating evidence that the brain abnormalities in schizophrenia although subtle, are widespread. The simultaneous investigation of overlapping aspects of cognition as attempted here, needs to be applied to patients selected according to the presence of specific symptoms to unravel the links between cognitive deficits and the clinical features of schizophrenia.



## CHAPTER 3

### Study 2: Confabulation

#### INTRODUCTION

As reviewed in chapter 2, Memory impairment out of proportion to other cognitive deficits has been demonstrated in schizophrenics of normal IQ and has on some occasions been found to be related to the severity and chronicity of the disease. The features of memory impairment sometimes include both short-term and delayed recall of verbal and non-verbal material, with relatively spared recognition abilities - a pattern analogous to frontal lobe memory impairment (Goldberg 1989). However, one striking feature about the memory impairments observed in schizophrenia, apart from the recall / recognition discrepancy is the *content* of the material recalled. The material is not just poorly recalled (e.g. reduced number of items or sentences), rather it is very disorganised and in some cases contains confabulated material. Indeed, although not investigated formally, some clinicians report this as a typical feature of schizophrenia.

Confabulation can be described as the production of incorrect information without the desire to deceive. It has been reported in a number of patients who have sustained brain damage from a range of sources. It has been observed in patients following an anterior communicating artery aneurysm (e.g. Kapur and Coughlan 1980; DeLuca et al 1993; Fischer et al 1995) in aphasia (Sandson et al 1986) and in Alzheimer's Disease (Kern et al 1992; Crisp, 1995). It has even been reported in unilateral spatial neglect, (e.g.



Chatterjee 1995). The observation of confabulation is not dependent on neuropathology, however, as it has been also demonstrated in normal subjects (e.g. Kopelman 1987; Burgess and Shallice 1996).

Confabulation is not a unitary disorder, but can take many forms and patterns. It can include actions and verbal statements and its content can range from minor anomalies through to highly implausible and bizarre stories. As a result of this variability, some authors, (e.g. Berlyne, 1972; Kopelman 1987) have felt the need to draw distinctions between two types of confabulation. The first type (provoked) is characterised by small distortions of real information or facts which are produced in direct response to questioning. This is contrasted with spontaneous confabulation where the content is considerably more bizarre or fantastic, which some patients act upon and which is produced without provocation. This type has been observed in some Korsakoff's patients (e.g. Kopelman 1987; Ujike et al 1989; Dalla-Barba et al 1990) and is believed by some to reflect frontal lobe pathology or frontal dysfunction.

It can be argued that the bizarre speech (formal thought disorder) of some schizophrenics resembles 'spontaneous' confabulation, in that it is often fantastic in content and often unprovoked. An additional similarity between schizophrenia and Korsakoff's syndrome is that they have been associated with a deficit in the ability to suppress inappropriate responses, (e.g. Shapiro et al 1981; Liddle et al 1991), which is believed to be a frontal lobe function (Perret 1974; Burgess & Shallice 1994, 1996). This is in keeping with other



studies which have also reported this problem in patients with various frontal lobe lesions (e.g. Kapur and Coughlan 1980).

These observations suggest that if confabulation is observed in schizophrenia, it would be related to both response suppression difficulties and formal thought disorder. The purpose of the present study was to show that confabulation occurs in schizophrenic patients. As a way of examining confabulation in a structured setting, story recall was investigated. It was hypothesised that confabulation in schizophrenia, if observed, would be associated with an inability to suppress inappropriate responses and thought disorder.

## METHODOLOGY

### **Subjects**

Twelve patients whose first language was English and who met DSM-III-R criteria for schizophrenia were recruited for this study over a period of 6 months from the Maudsley Hospital register. Patients were excluded if they had systemic disease or head injury that had rendered them unconscious, or drank more than 40 units of alcohol per week. The same exclusion criteria applied to both patients and controls. Ages ranged between 25 and 50 years. Each patient was matched for age, sex and premorbid IQ with either a healthy volunteer, (n=9) or an inpatient meeting DSM- III-R criteria for major depression (n=3) (See table 6). The inclusion of depressed patients was to control for factors other than psychosis, related to chronic psychiatric illness. All subjects gave informed consent.



## MATERIALS

### Experimental test of confabulation

To elicit confabulation in a structured setting, an experimental test involving memory for stories was constructed. Six short stories of one paragraph in length were derived from 'Aesop's fables', each of which had a specific moral associated with it. Elements in the original stories which were felt to be too childish for adult subjects were replaced without changing the theme of the story.

#### *Task instructions*

Each subject was told that a few short stories about different topics were going to be read to them and that they were to follow these stories from an exact copy provided. They were then informed that immediately following the end of each story, they would be required to repeat back as much of the story as they could and that this reproduction should be verbatim. Finally, subjects were told that following their recall of each story, they would be asked two questions.

These were:

- (1) Tell me in your own words what you think the point of this story is: what is it really about?
- (2) I am going to show you a list of morals. One of them is the correct one for the story you have tried to remember. Which one do you think it is?

These questions were aimed at establishing to what extent story recall is dependent on extracting 1. The gist, which is defined as the ability to provide the inner meaning or central point of a given story and 2. The moral of the



story, as an aid to adequate semantic processing. Subjects were presented with a list of 6 morals for each story and asked to choose the correct one. The other 5 moral choices were derived from other fables, but were unrelated to the story read to the patients. The stories were read out to the subjects at a normal reading pace whilst they read them from an identical copy. This procedure was used to aid comprehension of the text.

### Scoring of confabulation, gist and moral variables

Each story was subdivided on the basis of the different *ideas* it contained. The procedure for this was based on the story recall task from the Adult Memory and Information Processing Battery Test Manual (Coughlan and Hollows 1985). A correctly recalled idea was scored as 2, a partially recalled idea 1 and an idea not present in the story was coded c (confabulation). An example of a story divided into ideas is provided in appendix 1. An adequately provided gist was scored as 2, a vaguely related gist 1 and an incorrect answer 0. A moral was scored a correct 1, or incorrect 0.

## **Neuropsychological Assessment**

The following neuropsychological test battery was administered to all subjects:

### Memory Tests

1. Recognition Memory for Words (Warrington 1984).
2. Recognition Memory for Faces (Warrington 1984).
3. California Verbal Learning Test (Delis et al. 1987).



### Tests of executive function

1. Hayling Sentence Completion Test (Burgess & Shallice 1996).
2. The Verbal Associative Fluency Test (Benton et al 1983)
3. Modified Card Sorting Test (Nelson 1976).

### Tests of intellectual function

1. The National Adult Reading Test (Nelson 1982).
2. Ravens Progressive Matrices Advanced Set 1 (Raven 1958).

*The details of these tests are provided in chapter 2.*

### **Mental state**

Patients were interviewed using the Krawiecka scale to assess current symptomatology. This scale rates positive and negative symptoms and incoherence of speech, (thought disorder). Separate scores are obtained for each category. The range of ratings for all measures is 0-4, where 0 is absence of a symptom and 4 indicates a severe symptom.

### PROCEDURE

Following a interview using the Krawiecka scale, the tests were administered in the following order: CVLT, Hayling Test, Modified Card Sorting Test, Verbal Fluency Test, Recognition Memory Test, Raven's Progressive Matrices, NART and test of confabulation. This order was necessary to ensure that no other memory task was administered during the 20 minute delayed recall interval of the CVLT, to avoid interference.



## **Statistical analysis**

Differences between the groups were tested using independent t tests, and the Mann-Whitney U test, using one-tailed p values. The exception to this was the use of analysis of variance with repeated measures, for both story recall and the CVLT (trials 1-5). The Statistical Package for Social Scientists for Windows v 6.1 (Norusis, 1992) was used for the analysis.

## **RESULTS**

### **Background variables**

The control group was matched with the schizophrenia group on all background variables except for the Raven's Progressive Matrices, (table 6). The difference was significant at  $p < 0.01$ . No other significant differences were observed. The mean ratings for all symptoms on the Krawiecka scale are provided in table 7. All were in the low, but morbid range.

### **Memory**

The Performance on trials 1 to 5 of the CVLT (table 8) is a measure of verbal learning. A significant effect of trial was observed, ( $p < 0.001$ ) but no group main effect or trial by group interaction. Therefore, both groups are learning at the same rate. List b, the interference trial was recalled significantly less well by the schizophrenic group ( $p < 0.007$ ) as was free recall of list A after a long delay ( $p < 0.04$ ). A similar result was observed for cued recall after a long delay ( $p < 0.05$ ).



## Intrusion errors

Schizophrenic patients produced a large number of free recall intrusion errors compared to the controls (see table 8). This difference was found to be significant ( $p < 0.05$ ). There was no significant difference in the number of cued or total recall intrusion errors between the groups.

## Recognition Memory Test

No significant differences were observed for either the word or face versions of this test.

## Executive function

The schizophrenia group performed significantly worse than the controls on the Hayling Test errors ( $p < 0.01$ ) and on the Verbal Fluency Test ( $p < 0.003$ ), (table 8). No significant differences were found on the Modified Card Sort Test.

## Story recall

The performance of the groups are provided in table 9. Significant main effects of group ( $p < 0.005$ ) and story ( $p < 0.001$ ), were obtained as was an interaction between the two ( $p < 0.02$ ). The recall of the schizophrenic group was found to be worse on all the stories.



### **Moral identification**

The schizophrenic group correctly identified significantly fewer morals than the control group ( $p < 0.019$ , see table 9).

### **Gist identification**

No significant differences were found between the groups on the number of adequately provided gists.

### **Confabulation**

Appendices 2 and 3 provide the original text for stories 3 and 1 together with transcripts of confabulations elicited from patients *GH* and *JH* performing the story recall task. Points of particular interest are underlined for ease of evaluation. Each of the 12 schizophrenic subjects confabulated on at least one occasion (figure 1), however the variability within the schizophrenia group was quite large (mean 7.33, SD 7.51). It should be noted that only one control subject produced one confabulation on story 1. The difference between the two groups on the number of confabulations elicited was highly significant ( $P < 0.002$ ). To examine the possibility that confabulation may be a result of poor recall, we matched a selection of schizophrenic and control subjects on their total story recall performance, making 6 subjects in each group. The mean recall scores for these groups were 173.83 (SD 35.43) for the schizophrenia group and 158.83 (SD 30.40) for the control group. This difference was not found to be significant. The difference in the number of confabulations produced between the groups was significant,  $p < 0.005$ . Therefore the high rate of confabulation is not



explained by poor story recall performance. However schizophrenic patients with poor story recall produce more confabulations than the others. We also explored the possibility that confabulation may be related to poor intellectual function (Raven Progressive Matrices), or understanding the moral or gist of the stories. No significant relations were found between any of these variables and confabulation.

### **Confabulation, executive functioning and symptomatology**

To establish whether confabulation was related to executive functioning and symptomatology, I divided the schizophrenia group into high and low confabulators, using a median split based on the number of confabulations produced by each subject. A significant difference was found between the high and low confabulators on the Hayling error score ( $p < 0.05$ ). A significant difference was also found between the subgroups on the thought disorder rating ( $p < 0.04$ ). No other significant differences were observed. However, there was a trend for a difference on the free recall intrusion score, 6.00 (5.9) vs. 3.16 (3.65).

**Table 6 performance on the baseline tests**

<b>Group</b>	<b>number of subjects</b>	<b>mean age</b>	<b>IQ (NART)</b>	<b>Ravens Matrices</b>
schizophrenics	12	37.25	118.58	7.54*
controls	12	35.29	119.66	9.7

\* significant at  $P < 0.01$



**Table 7. Psychiatric mean symptomatology ratings on the Krawiecka scale**

<b>Symptom</b>	<b>mean rating</b>
Depression	1.9 (2.01)
Anxiety	2.98 (3.43)
Delusions	2.80 (2.99)
Hallucinations	2.41 (2.79)
Thought disorder	2.40 (2.69)
Poverty of speech	1.56 (3.11)
Flattened affect	2.85 (2.37)
Psychomotor retardation	2.41 (2.03)

note: standard deviations in parenthesis



**Table 8 Neuropsychological test performance**  
mean and standard deviations

<b>CVLT</b>	schizophrenics	controls
total recall from trials 1-5	38.66 (13.78)	45.63 (7.85)
list b (interference trial)	3.83 (1.94)	6.00 (1.48) **
long delay free recall	7.41 (4.60)	10.90 (2.91)
Free recall intrusions	4.58 (4.90)	2.09 (3.04)
<b>Recognition Memory Test</b>		
faces	40.58 (9.46)	46.90 (17.70)
words	48.00 (2.41)	49.22 (2.01)
<b>Hayling Test</b>		
total error score	11.91 (6.14)	5.54 (4.80) *
<b>Verbal Fluency Test (FAS)</b>		
total fluency score	31.58 (7.77)	46.00 (12.13)***
<b>Modified Card Sort Test</b>		
categories achieved	4.75 (1.81)	5.27 (1.19)
errors made	10.75 (9.11)	8.90 (6.28)
perseveration errors	2.41 (3.02)	1.27 (1.90)

\* p <0.01

\*\* p <0.007

\*\*\* p <0.003



**Table 9 Story recall performance**

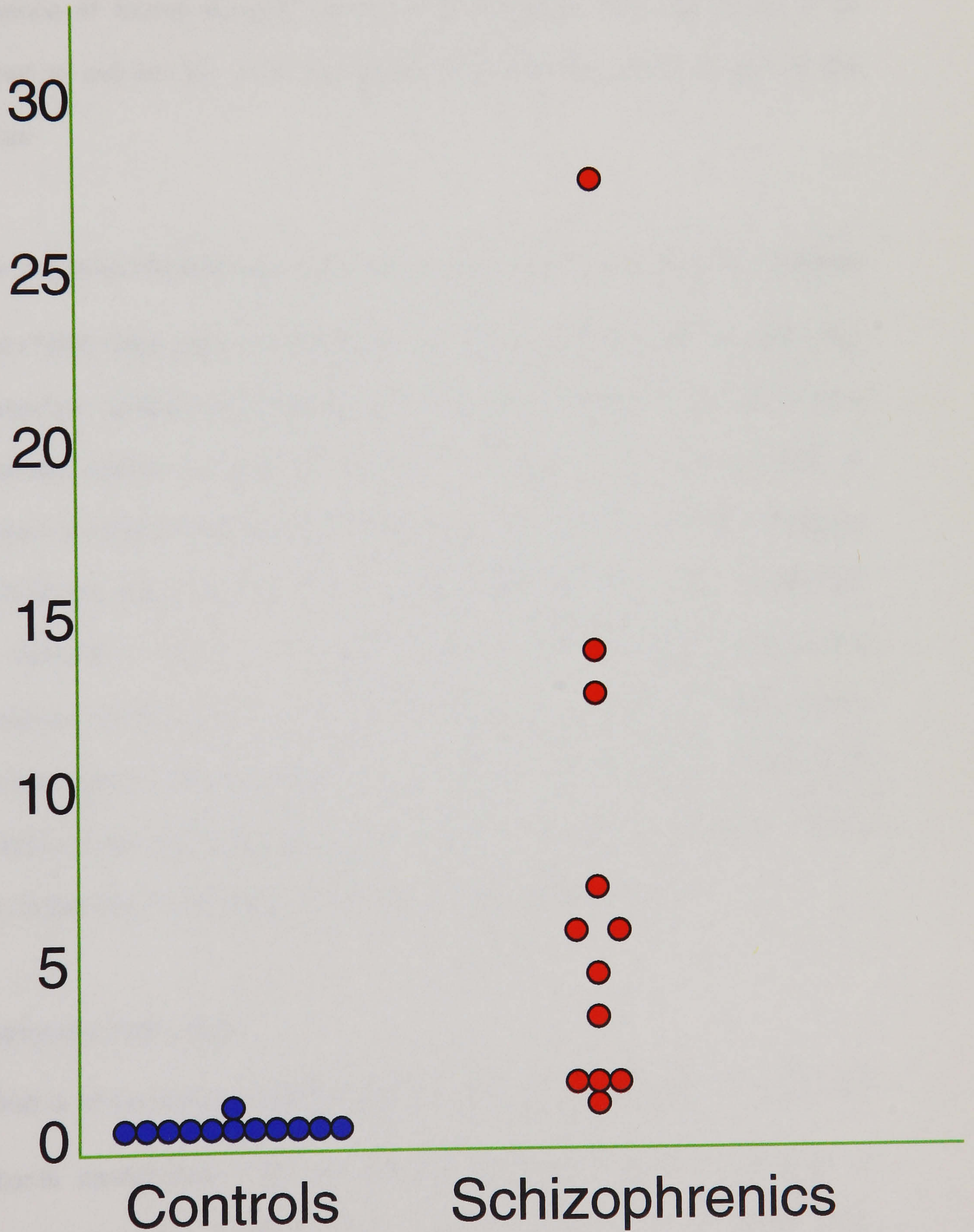
mean and standard deviation scores on story items

Items	schizophrenics	controls
no. of ideas recalled from 6 stories	112.66 (72.75)	185.83 (36.39)
no. correctly described gists	2.50 (2.39)	3.25 (2.22)
no. correctly identified morals	2.75 (1.13)	3.75 (.75)*
Total no. of confabulations made	7.33 (7.51)	0.08 (.028)**

\* sig. at  $p < 0.019$ \*\* sig. at  $p < 0.004$



### Total number of confabulations produced for each subject





## DISCUSSION

The results of this study demonstrate that schizophrenics can be induced to confabulate in a structured setting if asked to recall meaningful narratives. It appears that the confabulations elicited are related to difficulties in suppressing inappropriate responses (Hayling error score) and to the presence of formal thought disorder. Confabulation was not found to be related to current IQ, or to the ability to extract the moral or gist of the stories.

The cognitive impairments observed agree with previous reports. Goldberg et al (1989) have reported deficits in free recall of verbal material with intact recognition abilities and Liddle et al (1991) and Shallice et al (1991) have observed deficits on tests of executive function. On the other hand, in marked contrast to previous studies, (e.g. Weinberger et al 1986; Beatty et al 1993) the present study did not find the schizophrenics to be impaired on the Wisconsin Card Sort Test. It is not clear whether this is because the shortened version of the Card Sort Test was used, or simply because not all schizophrenics are impaired on this test. A comparison between both versions of the test by Nelson (1976), showing very similar results across the two, leads one to conclude that the latter may be more likely.

### Quality of confabulation

What is of particular interest in these observations is the way in which the patients confabulate. The schizophrenics appear to be reorganising or reconstructing the original story material resulting in new ideas. Their productions do not resemble the examples of confabulation reported by



Kopelman (1987) using Korsakoff and Alzheimer patients. In his study, when asked to recall stories, both groups of patients tended to produce irrelevant or unrelated material (intrusions) to varying degrees. It was predominately from this *new* material that the attempts at recall were constructed.

GH's version of *story 3* (appendix 2) is a particularly interesting example of the way in which the original material can be reconstructed to produce a very different series of events. Initially GH recalled that the man went on a swimming expedition in the middle of the ocean and then stops to pray, (for no apparent reason). The reference to swimming comes from the original story text, where because of being thrown into the sea, the *passengers* began to *swim* for their lives. GH then recalled that the man is hailed by people on a passing boat who suggest that he swim for himself rather than requesting help from god. The reference to people on a passing boat was constructed from the original story where the people are in fact fellow passengers on the *same boat* as the man.

JH's account of *story 1* (appendix 3) provides a very similar picture. What JH has done is to take words from the original text such as "beaten" and used them in a new way ("beat us") to link the references to quarrelling and sticks in the text. This reorganisation of the original material is, in varying degrees, a feature of all the accounts of stories given by the patients. This often resulted in rather bizarre versions of the stories.



### Confabulation and symptomatology

Thought disorder, but no other symptoms was found to be significantly related to confabulation in the schizophrenic patients. The two extracts discussed above could be seen as examples of thought disorder in that the accounts appear disorganised. However, the observation that even patients with little or no thought disorder also confabulated indicates that thought disorder may be a contributor to the severity of confabulation rather than its presence.

### Confabulation and executive function tasks

The association with the Hayling test suggests that the inability to withhold responses is related to confabulation in schizophrenia. This association has been reported in other studies using patients with frontal lobe involvement (e.g. Kapur et al 1980; Shapiro et al 1981). However, the lack of relationship between confabulation and any other executive function test suggests that schizophrenics do not need to be severely dysexecutive in Baddeley and Wilson's (1988) sense to confabulate. Indeed it could be argued that not all forms of confabulation have the same cognitive pathology and that response suppression difficulties may be a precursor for the type of confabulation demonstrated here. In any case, the relationship between confabulation and response suppression indicates that at least one aspect of 'frontal' or 'executive' dysfunction is implicated in this form of confabulation.



## Possible mechanisms for confabulation in schizophrenia

The results tentatively suggest that some *specific* aspect of comprehension impairment may be one of the mechanisms of confabulation in schizophrenia. For example, in *story 2* (appendix 1), the doctor who was called to treat the old woman's eyes, was *also* a thief, but almost all the patients failed to indicate that they understood this in their recall. This may be indicative of a specific comprehension difficulty. This possibility is further exemplified by the fact that none of the controls made this error despite the fact that their recall of this story was of varying accuracy. Patients tended to see this character as being two separate people. As a result, new ideas concerning the *two* people emerged. If specific comprehension difficulties are a contributing factor however, they may have been exacerbated by a problem of self monitoring. The patients never checked their accounts for the inclusion of irrelevant or over-inclusive material. The only comments they made related to whether they had remember enough. However it is worth noting that as the ability to extract the moral or gist of the stories was unrelated to confabulation, the *overall* lack of understanding of the stories does not result in confabulation. This is supported by the performance of the control group who also performed poorly on these measures but who nevertheless did not confabulate.

The fact that confabulation was still observed following a matching of control and schizophrenic subjects on story recall performance suggests that confabulation in schizophrenia could be seen as a disorder in itself rather than a consequence of memory deficit. Indeed, it could be argued that confabulation in schizophrenia may be a distinct behavioural symptom which



incorporates difficulties of response suppression and to a lesser extent thought disorder.

In summary, using a novel story recall technique the present study has demonstrated confabulation in schizophrenia in a structured setting. The confabulations elicited appear to be of a new type which is qualitatively different from the confabulations observed in Korsokoff's and amnesic patients. Confabulation appears to be related to an inability to suppress inappropriate responses and to a lesser extent formal thought disorder. It was not found to be related the degree of memory impairment, or the ability to understand the overall point of a story. These results suggest that confabulation in schizophrenia may be a specific behavioural sign for which tentative mechanisms are proposed, with the possibility of self monitoring and specific comprehension difficulties being involved.



## CHAPTER 4

### Study 3: Mechanisms of confabulation

#### INTRODUCTION

Confabulation is a newly described abnormality in schizophrenia. Its mechanisms, although hypothesised in chapter 3, are as yet unclear. Nevertheless, in other patient groups, a number of theories have been proposed. These include psychological defence mechanisms (Weinstein et al 1955), increased suggestibility, (Berlyne 1972), filling amnesiac gaps, (Barbizet 1963) and a disturbed sense of chronology (Van der Horst (1932). These have not been supported by empirical investigation. Among the neuropsychological mechanisms proposed, impaired self monitoring, a failure to inhibit incorrect responses and an inability to provide verbal self-corrections, have been the most strongly implicated and supported (Mercer et al 1977; Stuss et al 1978; Shapiro et al 1981). Deficits of this kind emphasise the role of executive or frontal dysfunction and have in some instances been seen as superimposed on amnesia (e.g. Stuss et al 1978; Baddeley and Wilson 1988). Moreover, the severity of the confabulation is seen as an index of the degree of frontal dysfunction. However, although it is perhaps more likely that confabulation will be observed when both executive and memory deficits are found to coexist, many dense amnesics do not confabulate. This suggests that memory problems are neither necessary nor sufficient to account for confabulation.



The apparent dissociations between memory, confabulation and executive function components probably reflects the type of confabulation observed. It can be argued that not all forms of confabulation have the same pattern of cognitive deficits. Indeed Burgess and Shallice (1994) have argued that a necessary precursor for 'fantastic' confabulation, (e.g. Berlyne 1972) may be a deficit in 'attentional control' whereas for the 'momentary' type it may be a problem located elsewhere. These arguments suggest that the specific mechanisms associated with a *particular* form of confabulation may be both overlapping with other forms, but may also contain unique features.

In chapter 3, I highlighted the contribution of difficulties with response suppression to confabulation in schizophrenia. This supports the findings of others (Kapur & Coughlan 1980; Shapiro et al 1981) with other types of patients. However, as also discussed in chapter 3, another possible mechanism for schizophrenic confabulation may be the failure of the patients to self-monitor or edit their reproductions. It was noted that patients never commented on their reproductions at any stage in marked contrast to the control subjects. There are at least two alternative hypotheses. Firstly, a working memory deficit may have prevented self-monitoring from occurring because patients may not have been able to 'hold on line' their narratives long enough to make corrections to them. In order to assess the relative contribution of these executive functions to confabulation, one would need to assess the ability of patients to provide self corrections in the absence of any memory load. Secondly, it is also possible that patients may be unable to distinguish between plausible and implausible material and therefore would provide less corrections than would be expected. The aim in this study was



to examine these hypotheses as a way of explaining narrative confabulation in schizophrenia.

## METHODOLOGY

### Patients

Three patients were selected from the twelve in study 2. All met DSM IV criteria for schizophrenia. Patients' J.H. and G.H were chosen because they were found to be high confabulators, whereas G.A. was chosen because he represented those patients who produced a moderate proportion of confabulations. Quantitative information on the patients' current medication was recorded. Their clinical symptomatology was assessed using the SANS and SAPS (Andreasen 1984). Brief case histories including presenting symptoms of the patients are provided below.

J.H. is a 36 year old man. His father is a retired principle scientific officer and his mother a former nurse. He succeeded in getting only one 'A' level after having passed 10 'O' levels 2 years previously. After leaving school, he worked at a local supermarket before going on to music college at the age of 21 to begin a degree course. He first became unwell during his first term at college when he began to experience auditory hallucinations. He returned home and his parents took him to see a psychiatrist. As it was felt that he did not require treatment at the time, he returned to college for the start of the new term. However, his behaviour deteriorated and he reported poor sleeping patterns, bizarre experiences and many ideas of reference. He believed that everything in the city was directed at him including the traffic and streetlights. He also described hearing voices talking to him and about him which were persecutory in nature. He had to leave college and was



reviewed by the psychiatrist who made a diagnosis of schizophrenia. He was later admitted to a psychiatric hospital for stabilisation on oral anti-psychotic medication and his acute psychotic symptoms resolved. There has been no recurrence of acute psychotic symptoms in recent years. He continues to live with his parents and maintains his music interest by playing in a jazz band.

G.H. is 45 year old man. His mother is a house wife and his father is a retired army officer, who travelled extensively around the world during G.H.'s first 12 years. He stayed at school until 19 years old and obtained 9 'O' levels. He left school in the middle of his 'A' levels and obtained a job but later resumed his 'A' levels at evening college. On the day of his exams, he walked out of the exam room and returned to his parents home. He was reported to be confused, thought disordered and expressed grandiose ideas. He was admitted to a psychiatric hospital for treatment although the diagnosis was unclear. He later had a number of unskilled jobs before enrolling in a course at University at the age of 20. This met with little success both academically and socially and he was forced to leave after a year. At this time he began to believe he was Jesus Christ, had ideas of reference and was thought disordered. He was readmitted to hospital and a diagnosis of schizophrenia was made. He has had numerous admissions to hospital in the past but has been well stabilised on anti-psychotic medication since 1983. He currently lives alone and attends a day centre run by the local psychiatric services.



G.A. is 34 years old. His father is a prominent solicitor in the city and his mother is a part-time domiciliary welfare officer. At school he obtained 9 'O' levels, 8 of which were at grade A. He also passed 5 'A' levels, 4 of which were at grade 'A', before going on to read Geology at Oxford. When he was 21, his parents reported that he was becoming markedly withdrawn. Following this, his work at University began to deteriorate and his tutor reported that he handed in an essay on geology with a cross drawn on it and the words "Christ will forgive me". During the following 6 months his condition deteriorated, although he was able to pass the first year exams. He was subsequently admitted to hospital as he was experiencing auditory hallucinations and had become increasingly preoccupied with religion. He was also thought disordered and noticeably socially withdrawn. A diagnosis of schizophrenia was made during this admission and he was commenced on anti-psychotic medication. He has had several admissions to hospital in the past but not in recent years. For the past few years, he has worked intermittently doing various basic administration duties as well as manual work, but is currently unemployed. He has been married for eight years and lives with his wife.

## MATERIALS

A battery of standard tests together with some experimental tasks was used. The battery was divided into four sections (1) Intellectual functioning, (2) memory, (3) executive function and (4) confabulation. In addition, 2 tests were employed to assess verbal working memory and plausibility/implausibility judgements.



All three patients were administered the National Adult Reading Test (NART) (Nelson, 1982) with revised scoring criteria to predict premorbid WAIS-R IQ, (Nelson and Willison 1991). The Raven's progressive Matrices advanced set 1 (Raven 1958) was used as a measure of current intellectual functioning (table 10). Current symptom profiles were assessed for each patient using the SANS and SAPS scales, (Andreasen 1984) and are provided in table 11.

The measures of 'frontal lobe' or 'executive function' used were the Hayling Test (Burgess & Shallice 1996), the Modified Card Sort Test (Nelson 1976), the Verbal Fluency Test (Benton 1983) and the Continuous Series Task (Gurd 1995) (table 13). Details of these tests are provided in chapter 2, with the exception of the Continuous Series Task, which is described below.

Memory was assessed by using the California Verbal Learning Test (CVLT); Delis et al (1987) and the Recognition Memory Test (Warrington 1984).  
*See chapter 2 for details of these tests.*

To isolate possible mechanisms of confabulation in narrative recall in schizophrenia, three tasks were employed. In the first task (sentence and story plausibility / implausibility) I used subjects' original narrative reproductions from our previous study. Each patient was provided with 6 narrative reproductions, 2 of these were their own, 1 each from 2 other patients and 1 each from 2 controls. All the patient reproductions contained confabulations and these formed the basis of the implausible sentences and



stories. The purpose of this task was to see if patients could distinguish between plausible and implausible sentences and stories and secondly, whether they judged their reproductions to be more plausible than other patients. Patients were of course blind as to the source of the stories. Performance on this task was analysed by calculating both the patients accuracy and the degree to which they demonstrated a bias to respond in a particular way.

In this respect, accuracy was defined as:

mean (% of plausible sentences judged plausible and % implausible sentences judged as implausible).

Bias was defined as:

mean (% plausible sentences judged as plausible and % of implausible sentences judged plausible).

The second task (fable story recall) required the patients to reproduce 2 new adapted fables verbatim as in the previous study, but also to listen to their reproductions via a recording afterwards. Details of the scoring procedure have been reported in chapter 3. With this task, it was possible to check if patients were still confabulating and whether they could offer any self-corrections on hearing their reproductions.

In the third task (simple story recall) patients were asked to recall 1 of the stories from the Adult Memory and Information Processing Battery, AMIPB (Coughlan and Hollows 1985). This was scored according to the published procedure. This story was chosen because it differed from the fables in that



it does not contain any behavioural inferences or morals ingrained in the text, but is instead a description of a series of events and is therefore considered as a simple story.

Two additional tasks were also used, the 'True/False Functional Sentences' Task (Botinni et al 1994) and the 'Continuous Series Task' (Gurd 1995). The True/False Functional Sentences Task consists of 20 sentences, some of which are not plausible, examples of these are provided in table 14. The subjects' task was to decide which were the plausible sentences from those which were not. The inclusion of this task allowed me to assess whether the patients could distinguish between plausible and implausible sentences which were not part of a narrative.

The Continuous Series Task (Gurd 1995) is a task of verbal working memory in which subjects were required to produce words in alternating series as quickly as possible. The task comprises of 3 parts administered in a fixed order. Firstly, the subject is presented with a pretask in which numbers, days of the week, months of the year and letters of the alphabet have to be repeatedly recited in turn, as quickly as possible within 20 seconds. Following this, the subject had to alternate between saying the days of the week beginning with Tuesday and numbers starting with the number 6. This was followed by a 3 and then a 4 category alternation, which adds the categories of months and letters of the alphabet. Thirty seconds was allowed for each section and a maximum of 21 alternations were recorded per section. Progression to subsequent sections was dependent on previous ones being completed with less than 20% of errors. All responses



were tape recorded and timed. This task also allowed me to examine self-monitoring in short-term memory without the possible confounding effects of semantic associations that are present in the narratives. To assess performance on this task, the number of items produced within each part of the task was recorded and converted to the mean number of items produced per second. The expected words per second was then calculated by obtaining the mean of the relevant pretasks, dividing the sum by 30. Finally, the mean number of words per second was subtracted from the expected words per second and the percentage difference was then calculated to obtain a shift cost. That is the extra time required when the subject has to shift between different sequences.

All tests and experimental tasks were administered prior to the assessment of symptoms, but the order of presentation of the battery sections was randomised. To assess the overall pattern of performance for individual patients over the range of tests, I converted the scores to percentiles, using the control data from chapter 3. I felt this to be appropriate as these subjects were matched on a number of background variables including age, and premorbid IQ. However for the 'Continuous Series' Task, I collected normative data from 20 controls of comparable age and premorbid IQ on the NART. An impairment index was then devised based on these normative data using the method of Shallice et al. (1991). I divided percentile ranges into 4 sections, assigning the degree of any impairment in the following way: 0= > 25th percentile; 1= 10-24th percentile; 2= 5-9th percentile and 3= < 5 percentile. On this basis, an intact index is 0 or 1 (>10th percentile) whereas an impaired index is a 2 or 3. It was not possible to calculate an impairment index for the experimental confabulation tasks presented here because only



one confabulation was produced from the control group in chapter 3. Therefore performance on these tasks will be described only.

In addition to these tasks, the narratives produced by the three patients in chapter 3 were analysed using a technique adapted from an article by Suh and Trabasso (1988). According to the authors, the meaning of a sentence in a narrative can be identified as setting, initiating event, goal, action, outcome, or reaction. These elements collectively make up the definition of an 'episode'. The definition of an episode structure requires that each goal will be linked directly to its initiating event or events and that each outcome be linked directly to the goal it fulfils (or fails to fulfil). The purpose of this analysis was to identify possible trends in confabulatory responses which may be associated with particular elements in the stories. To do this, each idea in the fables was independently rated by two coders on the basis of which element category each idea was thought to represent. The inter rater agreement coefficient using Kappa for this exercise was 0.83.

## RESULTS

All 3 patients had a long established history of schizophrenia and were receiving oral anti-psychotic medication at the time of assessment. They had low scores on the SANS and SAPS as shown in Table 11. The dosage of anti-psychotic medication has been converted to chlorpromazine equivalents (BNF) to simplify presentation and is also shown in Table 11. The doses are considered to be within the accepted range for chronic schizophrenic patients on maintenance medication.



The overall performance on neuropsychological tests and experimental tasks are as follows:

#### Patient J.H.

J.H.'s was impaired on 3 of the 4 'executive' or 'frontal' tasks, in particular his performance on the response suppression component of the Hayling Test and the 'continuous series' task was very poor (table 13). He was also impaired on 1/2 memory tests and especially on the list learning, long delay free recall and free recall intrusion measures of the CVLT (see table 12). His performance on recognition memory was intact. Taken collectively, J.H.'s performance is somewhat analogous to patients with frontal lobe lesions. J.H.'s ability to distinguish between plausible and implausible material was variable. He performed at chance level in detecting plausible fable stories and was a little better at identifying plausible sentences (table 14). Nevertheless, he performed well within established norms at identifying the literal sentences from the 'Functional Sentences' task. However J.H. was found to have a strong bias to say that the fable stories and to a lesser degree the fable sentences were plausible, (table 14). No bias was observed for the literal sentences, however. His recall of the 2 stories from the 'fable story recall' task produced 6 confabulated ideas from a possible 16 (38%), (table 15). Only 2 of these ideas were corrected following playback of the recording. On the 'simple story recall' task, 22% of the ideas recalled were confabulatory.



### Patient G.H.

G.H.'s performance was in many respects similar to that J.H. but a little worse. He was impaired on 3/4 'executive' or 'frontal tests' but the degree of impairment was more severe. Similarly, he was impaired on 1/2 memory tests and showed the same degree of impairment on list learning but not on intrusion errors. G.H. also showed normal recognition memory performance. His ability to distinguish between plausible/implausible fable stories and sentences was a little better than J.H.'s (table 14), but he performed less well on the literal sentences. Nevertheless his performance on the literal sentences was also within established norms. Like J.H., G.H. demonstrated a bias to say that both the fable stories and sentences were plausible but to a lesser degree. No bias was observed for the literal sentences. G.H.'s performance on the 'fable story recall' task produced 1 more confabulation than J.H. but he provided twice as many self corrections. His recall on the 'simple story recall task' was better than J.H.'s and he produced only 8% of confabulatory responses.

### Patient G.A.

G.A.'s overall performance was quite different to both J.H. and G.H.'s. Firstly he was only impaired on 2/4 tests of 'executive' or frontal function and showed no impairment on any of the memory tests. His accuracy in identifying plausible fable stories was better than J.H. and G.H., whereas his performance on the fable sentences was comparable. His detection of literal sentences was perfect. Unlike J.H. and G.H., G.A. demonstrated a bias to say that the fable stories were implausible, but like the others tended to report the fable sentences as plausible (table 14). Again, similar to J.H. and G.H., no bias was observed for the literal sentences. On the 'fable story



recall' task, G.A. produced half as many confabulations as J.H. and G.H. and like J.H. offered 2 self corrections. The number of ideas recalled on the 'story recall task' was less than both J.H. and G.H, but no confabulations were observed.

#### Specific post-hoc analysis

The use of strategies whilst performing part B of the Hayling Test was investigated using existing categories of strategy derived from Burgess & Shallice (1996). All three patients failed to use any of the widely used strategies, but rather produced unrelated words on occasion in the absence of a particular strategy.

The analysis of the patients' story reproductions from study 2 chapter 3, showed no particular pattern with respect to confabulations being produced on particular elements. All three patients showed different patterns of performance.

**Table 10 Premorbid IQ and current intellectual functioning**

Patient	NART	Raven Matrices
J.H.	119	100
G.H.	119	104
G.A.	123	104



**Table 11 current symptomatology for the 3 patients rated on the SANS and SAPS scales**

SANS	J.H.	G.H.	G.A.
Affective flattening	1	2	0
Alogia	2	1	0
Avolition	1	3	1
Anhedonia	0	3	2
Attention	0	0	0
SAPS			
Hallucinations	0	0	0
Delusions	1	0	1
Bizarre behaviour	0	1	0
Thought disorder	0	2	2
Chlorpromazine mg per day	500	300	800

The symptoms range from 0 (absence of a symptom) to 5 (severity of a symptom).

**Table 12 Memory test performance using the impairment index**

Test	J.H.	G.H.	G.A.
CVLT			
total of trials 1-5	3	3	0
Short delay free recall	1	2	0
short delay cued recall	1	2	0
long delay free recall	3	1	0
long delay cued recall	1	1	0
free recall intrusions	2	0	0
cued recall intrusions	0	0	0
Recognition Memory Test			
words	0	0	0
faces	0	0	0



**Table 13 Executive test performance using the impairment index**

Tests	J.H.	G.H.	G.A.
Planning (Modified Card Sort Test)			
categories	0	3	0
errors	0	3	0
% perseverative errors	2	2	0
Response initiation			
Hayling Test-latency	0	3	3
Verbal Fluency Test	0	1	0
Response suppression			
Hayling errors	3	2	2
Response monitoring			
Continuous Series Task	3	2	2

**Table 14 Patients performance at detecting plausibility**

Patients	J.H.	G.H.	G.A.
Accuracy (50%=chance)			
stories (fables)	50%	63%	75%
sentences (fables)	66%	88%	66%
sentences (literal)	90%	80%	100%
Bias to say plausible (50% = no bias)			
stories (fables)	100%	88%	25%
sentences (fables)	84%	63%	51%
sentences (literal)	50%	50%	50%
Literal sentences-examples			
The old man has a branch for a walking stick (p)			
The musician used his instruments as shoes (i)			

(p) = plausible; (i) = implausible



**Table 15 Percentage of confabulations produced**

Patients	J.H.	G.H.	G.A.
Fables: previous study	44%	32%	7%
Fables: present study	38%	39%	15%
Simple narrative	22%	8%	0.0%

## DISCUSSION

The three case studies presented here suggest a complex mechanism for the basis of confabulation. Taken collectively, the results reveal no consistent problems of memory, planning or response initiation. However all three patients performed poorly on tasks of response suppression and monitoring, despite having a normal overall IQ. The difference in the pattern of neuropsychological performance between both J.H. and G.H. and G.A., is that G.A. was unimpaired on the memory tests and planning. The pattern of performance of J.H. and G.H. in particular, resembles studies of patients with frontal lesions (Baddeley & Wilson 1988) and also resembles the neuropsychological profiles reported in some studies of other types of confabulating patients (Stuss et al 1987; Kapur and Coughlan 1980; Baddeley and Wilson 1986). In contrast, G.A.'s profile serves to highlight my original contentions that being severely dysexecutive and/or having a memory deficit are not necessary for confabulation in schizophrenia. What does appear to be necessary, is an impairment in response suppression and response monitoring. Problems with response suppression have been previously associated with confabulation (e.g. Stuss et al 1978; Shapiro et al. 1981) and therefore suggests that confabulation in schizophrenia has a



common mechanism with confabulation seen in other populations. In keeping with Shapiro et al's (1981) findings, the *severity* of the neuropsychological impairment seems to determine the severity of the confabulation. This is supported by the observations of J.H. and G.H.'s neuropsychological and confabulation profiles.

What then of the specific mechanisms concerned with narrative recall? Taking both the measures of discrimination and bias into account, all three patients were poor at distinguishing between plausible and implausible sentences and stories. Although both J.H. and G.H. performance was above chance for discrimination, this was compounded by their bias to report that all stimuli were plausible. G.A. on the other hand had a tendency to report the fable stories as implausible. Performance on this task has implications for the stages of the confabulation process. The fact that the patients have difficulty in distinguishing between plausible and implausible stories and therefore are essentially reporting that their implausible stories are on the whole 'all right', suggests that the stories are perhaps represented abnormally at the input or encoding stage. Moreover, the elements of this representation, judging from the form of confabulation are perhaps disorganised and reconstructed even *before* they are retrieved. If correct, this would be different from existing theories of confabulation (e.g. Moscovitch 1989; Burgess and Shallice 1996), which place the problem at the output or retrieval stage. Indeed, Moscovitch has explained confabulation by arguing that it is a deficit in the strategic retrieval process. This is based on observations of confabulators who perform free recall tasks badly, but who nevertheless perform well on tests of recognition (a finding which is largely analogous to the present study).



Performance on the 'fable recall' task provides credence to my proposition of an encoding as well as retrieval problem because even when presented with a recording of their confabulated reproductions, the patients rarely corrected themselves. They deemed much of their reproduction to be plausible, confirming suggestions that they cannot detect plausibility whether the stories are their own or others. This demonstrates that self correction or prospective monitoring is not sufficient to overcome this problem. This was in spite of the possible confounding effects of memory load being lifted. With sentences from the fables however, J.H. and G.H. do slightly better, while with 'literal' sentences, all three patients have no problem. It is conceivable that their acceptance of the somewhat bizarre hypotheses which make up the confabulations, is a disorder in itself, perhaps directly related to the delusions which are the hallmark of psychosis.

The degree to which this abnormal representation is present in schizophrenia is I believe indicated by the number of self corrections provided on the 'fable story recall' task; the more self corrections provided, the less the abnormality. In this respect, G.A. was able to provide twice as many self corrections as either J.H. or G.H. and therefore has less of a problem at the encoding or input stage. In J.H. and G.H. it seems that they cannot recognise and reject even the most major implausible responses, whereas the less severe G.A. fails in rejecting only the more minor discrepancies. However, the patients' varying ability to provide self corrections on *hearing* their reproductions rather than during recall suggests that the output or retrieval stages are also faulty. The processes argued to be required at this stage, namely verification or self-monitoring (Moscovitch



1989) do not appear to be available to them during actual retrieval. This was demonstrated by their poor performance on the 'Continuous Series Task'. These processes are collectively referred to as the 'editor' (e.g. Burgess and Shallice 1996 ) and may perhaps only be available to the patients when working memory is not required.

Recall on the 'simple story recall task' compared with the 'fable recall task' suggests that what is in the story, or the way the elements are combined to produce a narrative is critical to the amount or even the presence of confabulation in schizophrenia. For example, the patients' problem with response suppression and response monitoring applies considerably more to fables than to other narrative stories, particularly for G.A. as he did not produce any confabulations on the story task. What is it about fables that produces confabulation? One possibility is that inferences have to be made in the fables from one 'element' or 'episode' (Suh and Trabasso 1988) to another and that these must be encoded at the input stage and then verified at the output level. However, from the analysis of the fables, no *particular* element seems to be more susceptible than others to producing confabulation. Nevertheless, this process places large executive demands on the faulty system of the patients and is perhaps responsible for provoking the production of confabulations. Inferences of this sort are not required in narratives such as the one used in this study from the AMIPB, in that the story only describes a sequence of events.



To a degree, these results go some way in highlighting the mechanisms of confabulation in schizophrenia. What is at present unclear, however, is whether patients with schizophrenia confabulate in other domains, in particular on autobiographical questioning and whether the mechanisms identified in this study relate to all types of confabulation observed. These questions will be addressed in the following chapter.



## CHAPTER 5

### Study 4: Autobiographical memory and confabulation

#### INTRODUCTION

'Autobiographical memory' can be described as the trace or store of personal facts, episodes and experiences from one's past. The information that is linked to an episode within autobiographical memory is thought to be hierarchically organised (Della Sala et al. 1993) and is further believed to be integrated into more than one semantic file (e.g. Neisser 1986; Barsalou 1988). By contrast, the term 'autobiographical recollection' is used to denote the general mechanism or process which comes into play when one is required to 'effortfully' retrieve information from remote autobiographical memories. Not surprisingly, this element is believed to be of vital importance in autobiographical retrieval, since this is not thought to be a automatic process (Baddeley 1982).

According to Hasher & Zacks (1979) retrieval of autobiographical 'traces' is a particularly demanding and elaborative process. Della Sala et al. (1993) have argued that retrieval from autobiographical memory involves three stages. The first stage is characterised by the activity of *planning* the answer to a specific autobiographical question. The second involves the *verification* of the remote traces that may surface, by cross checking these with the subjects 'general knowledge of the world'. In addition, plausibility judgements need to be made as do judgements as to the likelihood of the event having



ever occurred. Lastly, the memory has to be consciously converted into an *organised* verbal account of past experiences. Taken collectively, these cognitive processes are believed to be subserved by the 'supervisory attentional system' (Norman & Shallice 1980). This makes it likely that patients with frontal lobe damage and/or dysfunction will perform poorly when subjected to this type of task. In addition, it has been argued that confabulations too would be more probable under such conditions (Moscovitch 1989). In practice, these hypothesis have been confirmed by a number of authors (e.g. Kapur Coughlan 1980; Sala et al 1993; Baddeley & Wilson 1988). However, it should noted that confabulation has been observed in response to autobiographical questioning in the absence of frontal damage or dysfunction (e.g. Dalla-Barba et al 1990).

In chapter 4, a number of mechanisms for schizophrenia confabulation in response to narrative reproduction were highlighted. Many of these have been discussed here as also being involved in autobiographical retrieval in other patients. In view of this, one can perhaps speculate that the patients studied in chapter 4 may also confabulate when asked to recall autobiographical events, since they have deficits in the skills which seem to be involved in both sorts of task. The following study set out to test this hypothesis.

## METHODOLOGY

### **Subjects**

Four chronic schizophrenic patients were selected for this study on the basis that they fulfilled DSM IV criteria for schizophrenia and that they were known



confabulators from chapter 3. Three of these patients, (J.H., G.H. and G.A) have already been studied in detail in study 3, chapter 4 and therefore only brief details of their case histories will be provided here. The case history of Patient B.J. (who was one of the schizophrenia group in study 2) will be described in more detail.

### **Patients**

J.H. is a 36 year old man who first presented with psychotic symptoms at 18 years of age. During this period he had embarked on a degree course in music but during his first term, he began to feel generally unwell, which included experiencing auditory hallucinations. During the following term, his health deteriorated further to include poor sleeping patterns, bizarre experiences and many ideas of reference. He was subsequently diagnosed as having a schizophrenic illness at 21 years of age.

G.H. is 45 years old. He is the son of a retired army officer. He did well academically despite a disruption during his A levels years when he was forced to leave school in the middle of his 'A' levels because of his father's travelling commitments. He resumed A level study at evening college. However during this period at age 19, he began to experience psychotic symptoms including grandiose ideas and thought disorder, which preceded his first psychiatric admission. He later went on to University, but his health deteriorated and he subsequently left the course. A diagnosis of schizophrenia was made when he was 21 years of age.

G.A. is 34 years old. Like G.H. he also did well academically and went on to read Geology at Oxford, when aged 21, he was reported to becoming



markedly withdrawn. Other symptoms were experienced during the following six months, although he was able to pass the first year exams. However, he subsequently had his first psychiatric admission due to increasing auditory hallucinations, religious ideation and formal thought disorder. During this admission, he was diagnosed with schizophrenia.

B.J. was first seen by me in 1994. He is a 37 year old man who emigrated to England from Nigeria when he was 10 years old. His father is a civil servant and his mother is a housewife. He is the eldest of 6 sons. B.J. left school without any formal qualifications, but later qualified as a carpenter and joiner. One evening during a church service when he was 23, he began to experience visual hallucinations in the form of images, flashing lights and red and white flags. Some weeks later he described some passivity experience where he believed forces were holding the buses back, preventing him from boarding them and getting home. Later at a friend's house he felt comments were being made about him on the television. Subsequently, his condition deteriorated to include auditory hallucinations and social withdrawal. At this time he was admitted to a psychiatric hospital where he was also observed to display bizarre limb movements. A diagnosis of acute schizophrenia was made during this admission. He was discharged two months later, but was subsequently admitted later that year following a police arrest for being in possession of a knife in a betting shop and behaving in a threatening manner toward a bookie. This followed a letter he had written to the bookie at a betting office, which stated how he was owed £20,000. He was reported to have been felt cheated of his money and was just trying to stand up for himself against "hooligans in ties". He was readmitted and given a diagnosis of paranoid schizophrenia. B.J. has been readmitted to hospital on a number



of subsequent occasions, the last time being in 1994. Although his condition has been improved with antipsychotic medication, he is currently not taking any. Presently he is unemployed and lives with his parents in London.

## MATERIALS

### Confabulation

An autobiographical memory questionnaire based on the Autobiographical memory Interview (AMI; Kopelman et al 1990), was constructed and was largely based on information available in patients' case notes. It was felt that this information would be more easily verifiable than the kind of information currently sought in existing questionnaires of this kind. Further verification was sought where appropriate from patients' relatives. The questionnaire contained 11 questions probing three different information sources: family (3), personal (3) and recent events (2), which were based on three time periods: remote (childhood), adolescence/early adulthood (early adult life) and recent (recent life). In addition, three questions, one for each time period asked for information relating to meaningful events or incidents, e.g. "Tell me about an incident during childhood which has particular meaning for you?". These were aimed at establishing the patients' ability to provide a cohesive account of incidents from the past.

### Scoring

I adapted the criteria of Mercer et al (1977) for scoring responses to autobiographical memory questions, by omitting the "wrong" criteria as it is difficult to distinguish between a wrong and confabulatory response, (Mercer et al 1977; Della Barba 1990). In view of this, answers were scored as



“correct”, “I don’t know” or “confabulation”. Confabulatory responses were subdivided using the procedure of Della Barba et al (1990). The subdivisions were: wrong responses, invented responses and bizarre responses. A wrong response involved recalling an event in the wrong temporal context. Invented responses occurred where patients recalled events which demonstrated a substantial discrepancy from what actually happened and a bizarre response was when an answer was highly peculiar (e.g. “At what age did you go to University?” “ When I was 10”. When in fact it was at 18 years of age).

### **Symptom assessment**

Current symptoms, (within the last month) were assessed with the Scale for Positive Symptoms (SAPS) and the Scale for Negative Symptoms (SANS) (Andreasen 1984). In addition, current medication status was recorded and converted to chlorpromazine equivalents (table 16).

The following tests were administered to the patients. Details of these can be found in chapters 2 and 4.

### **Premorbid IQ and Intellectual functioning (table 17)**

1. National Adult Reading Test (NART) (Nelson, 1982)
2. The Raven’s progressive Matrices advanced set 1 (Raven 1958)

### **Executive function (table 18)**

1. Modified Card Sorting Test (Nelson 1976).
2. Hayling Test (Burgess & Shallice, 1996).
3. Continuous Series Task (Gurd 1995)



## Memory (table 19)

1. Recognition Memory Test (Warrington 1984).
2. California Verbal Learning Test (Delis et al., 1987).
3. Verbal Fluency (Benton et al 1983).

## PROCEDURE

Each patient was interviewed with the autobiographical questionnaire, which was tape recorded and then transcribed. This was followed by the assessment of symptoms and then testing using the afore mentioned neuropsychological tests.

## RESULTS

The neuropsychological profiles of the J.H., G.H. and G.A. have been presented in detail in my previous study, therefore only a brief summary will be provided here, together with more detailed information on their autobiographical recollection and instances of confabulation.

J.H.'s symptoms ratings were predominately in the low range, with some items receiving an asymptomatic score (table 16). With respect to neuropsychological assessment, J.H. was found to be impaired on 3/4 'executive' or 'frontal' tasks, in particular on tasks of response suppression and response monitoring, (table 18) He was also impaired on tests of free recall but not on recognition memory (table 19). His recall on the autobiographical memory questionnaire for questions relating to his family history was largely intact (table 20), but for personal history questions, half of his responses were confabulatory. When questioned on recent issues, he



correctly recalled two thirds of events, but the remaining responses were confabulatory. Overall, two thirds of his confabulations were provoked by personal type questions, which produced confabulations in both the 'invented' and 'bizarre' categories (table 21). Examples from both these categories are provided in table 22.

G.H. was more symptomatic than J.H. particularly for negative symptoms. However, overall his profile was in the low to moderate range. Cognitively like J.H., G.H. was also impaired on 3/4 'executive' or 'frontal tests' but the degree of impairment was greater. He was impaired on 1/2 memory tests and showed the same pattern of impairment as J.H. G.H. also performed best on family orientated questions on the autobiographical questionnaire, although unlike J.H., produced some confabulations here too. The percentage of correctly recalled personal and recent events was exactly the same as J.H., as was the percentage of confabulations produced for these type of questions. G.H. like J.H. produced confabulations of the invented type but the majority of his confabulations fell into the bizarre category, (see tables 21 and 23).

Like J.H. and G.H. G.A.'s symptoms were in the low range, equally distributed between positive and negative. However, his cognitive performance was considerably less impaired than both J.H. and G.H.'s. On test of 'executive' or 'frontal function' he was only impaired on 2/4 tests and the memory tests he was found to be completely intact. G.A.'s performance on the autobiographical questionnaire was also markedly better than J.H. and G.H. His answers to questions concerning family and recent history were without error, but like J.H. and G.H. he produced confabulatory



answers to questions concerning personal events (table 20). All these responses were of the invented category. Examples of these are provided in table 24.

B.J. was completely asymptomatic for negative symptoms and was assessed to have a low overall positive symptom rating. However, his rating for formal thought disorder was within the 'marked' range. On tests of memory, he was impaired on most measures apart from free recall intrusions and recognition memory. He also performed poorly on all tests of executive function, in particular on tasks of response initiation, (table 18). Performance on the autobiographical memory questionnaire was noticeably poorer than the other three patients studied here. Only 50% of both the family and personal events information was correct, with the remainder being confabulations. No answers to recent events questions were correct. Like G.H. B.J.'s confabulated in all three categories, although to a greater degree. The quality of these confabulations like G.A.'s, were equally distributed between the invented and bizarre categories.



**Table 16 Symptoms for the 4 patients rated for current symptomatology on the SANS and SAPS**

<b>SANS</b>	<b>J.H.</b>	<b>G.H.</b>	<b>G.A.</b>	<b>B.J.</b>
Affective flattening	1	2	0	0
Alogia	2	1	0	0
Avolition	1	3	1	0
Anhedonia	0	3	2	0
Attention	0	0	0	0
<b>SAPS</b>				
Hallucinations	0	0	0	2
Delusions	1	0	1	1
Bizarre behaviour	0	1	0	0
Thought disorder	0	2	2	4
Chlorpromazine mg per day	500	300	800	0

The symptoms range from 0 (absence of a symptom) to 5 (severity of a symptom).

**Table 17 Current intellectual functioning and premorbid IQ**

<b>Patient</b>	<b>NART</b>	<b>Raven Matrices</b>
J.H.	119	100
G.H.	119	104
G.A.	123	104
B.J.	100	90



**Table 18 Performance on tests of executive function using the impairment index**

Tests	J.H.	G.H.	G.A.	B.J.
Planning (Modified Card Sort Test)				
categories	0	3	0	3
errors	0	3	0	1
% perseverative errors	2	2	0	0
Response initiation				
Hayling Test-latency	0	3	3	3
Verbal Fluency Test	0	1	0	2
Response suppression				
Hayling errors	3	2	2	1
Response monitoring				
Continuous Series Task	3	2	2	2

**Table 19 Performance on tests of memory using the impairment index**

Test	J.H.	G.H.	G.A.	B.J.
CVLT				
total of trials 1-5	3	3	0	3
Short delay free recall	1	2	0	2
short delay cued recall	1	2	0	2
long delay free recall	3	1	0	2
long delay cued recall	1	1	0	2
free recall intrusions	2	0	0	0
cued recall intrusions	0	0	0	2
Recognition Memory Test				
words	0	0	0	0
faces	0	0	0	0



**Table 20 Patients performance on the Autobiographical Memory questionnaire**

Patients	Correct			I don't know			Confabulation		
	Family	Personal	Recent	Family	Personal	Recent	Family	Personal	Recent
J.H	80%	50%	66%	20%	0.0%	0.0%	0.0%	50%	33%
G.H.	75%	50%	66%	0.0%	0.0%	0.0%	25%	50%	33%
G.A.	100%	66%	100%	0.0%	0.0%	0.0%	0.0%	33%	0.0%
B.J.	50%	50%	0.0%	0.0%	0.0%	33%	50%	50%	66%

**Table 21 Percentage of confabulatory responses produced in each category**

Patients	Wrong			Invented			Bizarre		
	Family	Personal	Recent	Family	Personal	Recent	Family	Personal	Recent
J.H	0.0%	0.0%	33%	0.0%	50%	0.0%	0.0%	0.0%	17%
G.H.	0.0%	0.0%	0.0%	0.0%	25%	0.0%	25%	25%	25%
G.A.	0.0%	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%
B.J.	0.0%	0.0%	0.0%	0.0%	25%	25%	25%	25%	0.0%



**Table 22 Excerpts of confabulations from J.H. to questions from the autobiographical questionnaire**

<p>“Tell me about the exams you sat at school. What exams did you pass?”</p>	<p>“Yes I did a lot of ‘O’ levels. I got 15 ‘O’ levels. “ I did four early... four before I should have done and seven while I was sixteen and another four after I was sixteen.”</p>	<p>‘Invented’</p>
<p>“Tell me about an incident that happened at home or at work during the last year”.</p>	<p>“ I joined a little Jazz band who plays Charlie Parker music and I performed live in a pub and I thoroughly enjoyed it. I was playing bass guitar and the band played well and I got a round of applause..... ”</p>	<p>‘Wrong’</p>
<p>“Describe your Journey to this hospital today”.</p>	<p>“Oh, well... there was somebody else in the carriage (train). I suffer from stress as you know and tension, so I asked my sister to sit next to me so I could not see the person sitting in the carriage”</p>	<p>‘Bizarre’</p>



**Table 23 Excerpts of confabulations from G.H. to questions from the autobiographical memory questionnaire**

<p>“What subjects did you study at school or college? What exams did you pass?”</p>	<p><i>“I did very well. I um.... became a RAF marksman, a glider pilot, a staff officer in the RAF training core and got a Duke of Edinburgh’s award all within about eighteen months”.</i></p>	<p>‘Invented’</p>
<p>“Can you describe an incident that happened at home or at work during the last year”?</p>	<p><i>“My present neighbour who replaced the one that has just left, am....had labour pains and she turned to me to call an ambulance. She was stark naked in the hallway, eight months pregnant. She turned to me because she had no one to turn to”.</i></p>	<p>‘Bizarre’</p>
<p>Tell me about an event or incident during childhood which has particular meaning for you</p>	<p><i>“Yes! It first happened in Egypt. My sister fell six storeys in a block of flats, on the banisters on the stairway where I was playing with her up and down the banisters. She survived a brain operation and completely recovered from it. I kind of felt she was almost reborn.. her spirit”.</i></p>	<p>‘Bizarre’</p>



**Table 24 Excerpts of confabulations from G.A. to questions from the autobiographical memory questionnaire**

<p>“Can you tell me about an event that happened around the time that you first began to feel unwell? How did this effect the way you were feeling?”</p>	<p>“There was concern about my relationships with a couple of young nurses on the ward when I was there. I suppose I wanted to have a relationship with one of them and.....one of them was interested in other men at the time and the other one after our physical encounter said I was not the right man for her”.</p>	<p>‘Invented’</p>
<p>“Describe some other event during your 20’s that is memorable for you”?</p>	<p>“Yes.....in my second term at Oxford, I believe someone tried to poison me at one of the more formal dinners. I felt quite ill for a few days afterwards”</p>	<p>‘Invented’</p>



**Table 25 Excerpts of confabulations from B.J. to questions from the autobiographical memory questionnaire**

<p>“What work did your parents do for a living?”</p>	<p>“My father was a ship builder, steel merchant and a pipe installer and civil servant”</p>	<p>‘Invented’</p>
<p>“Tell me about an incident that happened at home or at work during the last year”.</p>	<p>“About six, five or four months or so ago, I tried to act against hooligans by thinking about it and then sending my ideas to the primenster...but it depends on the economic situation”.</p>	<p>‘Bizarre’</p>



## Discussion

The purpose of this study was to establish whether patients with schizophrenia confabulate in domains other than with narrative material. The observations of these four cases demonstrate that they do. By asking patients to recall personal information from three different time frames and categories, confabulations were produced by all patients to varying degrees. The production of confabulation in response to autobiographical questioning is in keeping with studies of other types of patients, (e.g. Dalla-Barba, Cipolotti et al 1990; Baddeley and Wilson 1988; Kopelman et al 1995). In line with the findings in chapter 4 memory impairment, at least as measured by standardised neuropsychological tests, is not necessary to produce confabulation in response to autobiographical questioning. By contrast, the observed deficits on tests of executive function for all patients, in particular problems with response suppression and response monitoring, serves to support the contention that these deficits are central to schizophrenic confabulation produced by autobiographical questioning as well as with narrative material. However, in order to support this, one would need to find patients without these executive deficits who also do not confabulate.

The relationship between deficits in response monitoring and response suppression and autobiographical confabulation is perhaps not surprising since autobiographical recollection is a novel task requiring a multi-componential sequence of steps which includes checking and coordinating through inhibition and selection of responses (Della Sala et al. 1993). These in particular would be necessary for the second step of



recollection, namely verification (the first being to plan the tasks), where intact response monitoring and response suppression would allow for the verification of the remote trace that eventually surfaces. However, as these abilities do not form a supraordinate function, one can speculate that autobiographical recollection and executive function, as measured by the tests used here, call on a number of widely overlapping aspects of attentional control. This is said to be linked to the prefrontal cortex (e.g. Baddeley 1990; Shallice 1988; Shallice et al 1989), and therefore the findings reported here serve to support the role played by *certain* 'executive' functions, or aspects of the prefrontal network to autobiographical confabulation in schizophrenia.

Qualitatively, the four patients uniformly responded most correctly for questions concerning their family. It is unclear as to why this may be, but it is unlikely to be because the questions were aimed at establishing the correct recollection of facts, rather than a collection or description of events, since both fact and descriptive questions were included within each of the three categories, although to a lesser degree for family questions. It is perhaps more likely that the time frame is a contributor, since the family questions were all prior to the onset of their illness whereas those on personal or recent issues were either close to or after the first signs of schizophrenia. Indeed, poor recall or memory loss for a period of acute psychosis is reported by many patients. Nevertheless, there was a strong tendency for all three patients to either recall information correctly or to confabulate, with very few 'I don't know' responses.



The majority of the confabulatory responses were produced in response to questions of a personal nature. In line with my previous argument, this may in part be because many of the incidents occurred around the onset of the patients' psychosis. However, it is also possible that, since more of the personal questions asked for *descriptions* of events, this may have increased the likelihood of confabulations being produced. It is more difficult to arrange a series of related events into a coherent sequence. This would be akin both to the difficulty in reproducing the fables in chapter 3 and to the presence of formal thought disorder, observed to varying degrees in three of the patients. However, while this interpretation may go some way to accounting for confabulations which are 'wrong' or 'invented', it is unlikely to explain the 'bizarre' confabulations produced by J.H., G.H., and B.J., since these were highly implausible and not just disorganised. It is more likely that the mechanisms said to be related to 'spontaneous' confabulation, such as those associated with frontal dysfunction or frontal pathology (e.g. Kopelman 1987), are major determinants here, since spontaneous confabulations are by their very nature bizarre and these patients were poor on executive tasks.

What part do the patients' own delusion systems play in autobiographical confabulations? Both G.H. and B.J. produced confabulations which contained aspects which are central to their personal delusional beliefs. For example, G.H.'s was reported to have a number of religious delusions prior to his second admission at twenty years of age (see chapter 4). This subject matter was observed in both his narrative confabulations (appendix 2) as well in the incident with his sister reported here (table 23), where he makes reference to his sister being 'reborn' following a confabulated accident. What



is perhaps interesting to note is that G.H. does not require a religious 'prompt' to produce religious type confabulations. Indeed, although the original fable story (appendix 2) had a reference to God in it, the autobiographical question which provoked the bizarre confabulation had no such prompt. It seems then that G.H. on occasions, spontaneously uses aspects of his religious beliefs for inclusion in some confabulations.

In contrast to G.H., B.J.'s delusional system, although not evident in chapter 3 with narrative material, is clearly apparent during autobiographical questioning. B.J.'s ideas about hooliganism and capital mentioned earlier are clearly apparent here and serve to shape a 'bizarre' confabulation provoked by a 'recent' autobiographical question (table 25). Like G.H. it is unclear as to why B.J.'s delusional ideas are incorporated into his confabulations, but this observation serves to highlight a possible relationship between delusions and confabulations. However, it should be pointed out that G.H. and B.J. were assessed as only questionably deluded, as was J.H. who did not incorporate deluded ideas into his confabulations. Taken collectively, 'active' or 'current' delusions appear to have no *direct* role in autobiographical confabulation, whereas delusional systems perhaps serve as a model or framework on which certain patients base their confabulations.

In summary, the findings reported here demonstrate that patients with schizophrenia produce confabulations when subjected to autobiographical questioning. Although the 'frontal' problems are not solely responsible for this abnormality, this study has shown that the processes that are largely subserved by the prefrontal areas, namely executive functions, make a



selective contribution to the production of autobiographical confabulation in schizophrenia. In particular, deficits in response suppression and response monitoring appear to be related to the verification process required during this task. Observations from two of the patients demonstrates that personal delusional systems may play a part in the confabulations for some patients by providing a framework within which to construct a personal experience. Adequate autobiographical memory involves a complex process of piecing together autobiographical accounts of events and experiences constructed from conscious mental images. It is perhaps this complexity which maximises prefrontal involvement or executive function and is therefore largely responsible for the production of autobiographical confabulation in schizophrenia.



## CHAPTER 6

### **Study 5: Brain activity associated with response initiation and suppression in normal volunteers**

#### INTRODUCTION

Throughout this thesis, each study has shown that schizophrenia patients have a profound deficit in response suppression and to a lesser degree response initiation as measured by the Hayling Test (Burgess & Shallice 1996). Although this deficit was not found to be related to the frontal memory pattern observed in chapter 2, it was found to be associated with confabulation, elicited by both narrative material and autobiographical questioning.

Deficits in response suppression have previously been reported in schizophrenia (e.g. Shallice et al 1991; Liddle et al 1992; David 1993; Nopoulos et al 1994; Schreiber et al 1995) using various forms of the Stroop Test. In the study of Shallice et al. of five cases, 4 of these were reported to be impaired on the standard colour naming test. David, used a lateralised version of the stroop task, which was presented via a tachistoscopic. Although no main effects were observed, the schizophrenia group was found to be impaired independently on the incongruent and congruent trials when compared with normal controls, depressives and manic patients.



Anatomically, the evidence linking response suppression and response initiation to the frontal lobes stems from clinical studies which have reported patients with frontal lesions to have deficits on tasks calling on these abilities (Benton 1968; Luria 1970; Miller 1984). These studies all reported that patients with left frontal lesions produced far fewer words on the Verbal Fluency Test (VFT) than patients with lesions elsewhere in the brain. Problems of this sort can be described as problems with response initiation. However this interpretation is by no means certain as Perret (1974) has argued that the VFT calls on similar cognitive processing demands as the Stroop task despite their differing formats (VFT requiring the generation of words within a specific category whereas the Stroop Test requires inhibition of competing responses). Perret's study of 118 patients with circumscribed lesions showed that patients with left frontal lesions were impaired on word fluency as well as a modified version of the Stroop Test. More importantly, however, he found correlations of performance on the two tests to be highest in the left frontal group. Perret explained this finding by arguing that when patients perform a word search according to an initial letter, they are being asked to "suppress the habit of using words according to meaning". In fluency tasks subjects are asked to generate words (or whatever) in a particular category. Such a task necessarily has two components; activating words within the category and suppressing words outside the category. As Perret points out, generating words by an initial letter requires the suppression of the stronger semantic associations. However, even when generating words in a semantic category, some semantic associations may have to be suppressed. For example, the word HORSE may activate the word CART, but this word would not be appropriate for the category of living



things. This analysis emphasises the close relationship between initiation and suppression in fluency tasks.

Some studies have shown that when suppression skills are tapped more specifically, patients with frontal lesions are impaired. Drewe (1975) found that patients with frontal lesions were impaired on a 'go, no-go' task where the subject is required to withhold responses to 1 or 2 stimuli. However she found no difference between left and right frontal lesion patients. Verfaillie & Heilman (1987) in a case study of 2 patients with differing medial frontal lesions observed that, in a task where they had to respond with the opposite hand to the one touched, the patient with the left frontal lesion performed normally whereas the right frontal patient did not. This was also the case during a response preparation task where the patient with the left frontal lesion, like the controls, benefited from preparatory information whereas the right frontal patient did not.

Some of the functional implications of these lesion studies have been supported and extended with the advent of functional imaging. For example the studies of both Pardo et al (1990) and Bench et al (1993) using positron emission tomography (PET) with normal subjects observed that frontal regions, in particular the anterior cingulate, were activated during performance of the Stroop Test. Similarly, Frith et al. (1991) using a verbal fluency task observed regional activation including both the anterior cingulate and left dorsal lateral prefrontal cortex (DLPFC), with a reciprocal deactivation of activity in the



superior temporal gyrus when compared with a control task involving word repetition.

It is possible that both initiation and suppression are related skills, subserved by similar but overlapping subsystems and functional regions. The problem of comparing these cognitive skills is that the usual tests which examine them, (e.g. verbal fluency, Stroop tasks) differ widely in their characteristics. However, the Hayling Test (Burgess and Shallice (1996), which was first described in chapter 2, examines initiation and suppression with minimal changes in the characteristics of the task (see chapter 2 for details). Both parts of the test are performed poorly by patients with frontal lesions (both left and right), but not by patients with lesions elsewhere (Burgess and Shallice, 1996). As reported in chapters 2-5, it is now established that schizophrenic patients also perform poorly on this test.

Posner and Snyder (1975) have suggested that there are two distinct processes underlying retrieval of items from long-term memory and there is much experimental work supporting this position in relation to single word processing (e.g. Neely 1976). The two processes are 'spreading activation' which is automatically elicited by stimuli and strategic, conscious attention, similar to Norman and Shallice's supervisory attentional system (Norman & Shallice 1980; Shallice 1988), which can be facilitatory or inhibitory. The production of a response in the various tasks I have discussed will depend on both these processes. In the first part of the Hayling test appropriate words are



likely to be retrieved through the automatic association process caused by the presentation of the sentence and there is relatively little need for strategic processes. However, in the second part of the test where an inappropriate word has to be found, there will be a major role for strategic processes.

In addition to verbal fluency, a number of word generation tasks have been studied with PET (e.g. Wise et al 1991; Raichle et al; 1994; Warburton et al 1996), which involve similar processes to the Hayling task. For example in the Warburton et al. study the subject was required to produce verbs for given nouns (e.g. cake-eat). However, although the results have differed from study to study due largely to design factors, there is some convergence for activations of frontal regions, although there are differences over the precise locations. Involvement of the left temporal lobe has also been demonstrated, where both increases and decreases in rCBF have been observed. The precise role of this region is however unclear and seems to depend on the nature of the task. In the Warburton et al study (1996), they identified this region (in particular the posterior part of the left temporal lobe) as being involved in the lexical and semantic components of analysis needed to perform this task. It therefore seems reasonable to suppose that any task that makes similar demands will also produce activation of this region.

If Perret's (1974) suggestion that both the Stroop and verbal fluency tests have similar processing demands are correct, there should be some convergence of regions of activation in the Hayling Test with those observed in previous



functional imaging studies where the verbal fluency and Stroop tests have been used, as it encompasses the features of both. In particular, activation of the anterior cingulate should be observed on both parts of the test due to its proposed role in tasks calling on the supervisory attentional system (Shallice 1988), as should the left temporal region since word retrieval is required in this task.

Studying the abnormal mechanisms of response suppression anatomically in schizophrenia whilst quite obviously valuable to this thesis, would have its limitations in that they would show only the consequences of the breakdown of the system or process- it would still be speculation as to what the processes were *before* they were damaged or disrupted. Alternatively I could have compared impaired schizophrenic patients on this task with another schizophrenic group who can perform the task adequately, but it is possible that the intact group may perform the task in a different way from normal subjects. For these reasons, the current study was carried out using normal volunteers.

## METHODS

### **Subjects**

Six normal male volunteers were recruited for this study. Ages ranged between 19 to 36 years. All were right handed as assessed by the Annett handedness questionnaire (Annett 1970) and none had any significant medical or psychiatric history. All gave informed consent. The procedure for administering radioactivity was approved by the local ethics committee and approval to administer



radioisotope was granted by the Administration of Radioactive Substances Advisory Committee (ARSAC) U.K.

### Activation task

The main task used was an extended version of the Hayling Test. This modification was necessary to make the test suitable for the PET activation procedure. Using the method of Burgess and Shallice (1996) additional sentences were selected from those given by Bloom and Fischler (1980), which were found to produce a high probability of one particular response. The additional sentences were randomly assigned to either part A (initiation) or part B (suppression) of the Hayling Test. In addition, two control conditions were also included into the design. The materials were displayed on a computer screen supported 30cm from the volunteers face. The 4 conditions were as follows:

#### Response initiation

Subjects were instructed to provide an appropriate word to complete a sentence from which the last word was missing. (e.g. 'The captain wanted to stay with the sinking *SHIP*').

#### Response suppression

Subjects were required to provide a word which made no sense in the context of the sentence from which the last word was missing (e.g. 'Most cats see very well at *BANANA*').



The same instructions were used as in the Burgess and Shallice (1996) study.

#### Reading

Subjects were required to read out the last word of a sentence.

#### Rest

Subjects lay with their eyes closed during the prescribed period.

In conditions 1-3, sentences were presented at a rate of 1 every 6 seconds (6 sentences per scan). Each of the four conditions were performed 3 times during the session and were counterbalanced between subjects to control for order effects. Because of technical problems, 2 subjects only received 8 scans each, therefore each of the 3 conditions were repeated twice only for these two subjects.

#### Scanning procedure

Regional cerebral blood flow (rCBF) were obtained using a CTI model 953B-PET scanner (CTI Inc, Knoxville, USA) with collimating septa retracted. Subjects received a twenty second intra-venous bolus of  $H_2^{15}O$  at a concentration of 55 mBq ml<sup>-1</sup> and a flow rate of 10ml min<sup>-1</sup> through a forearm cannula. Twelve dynamic PET scans were collected for 4 subjects and 8 for two subjects, each over a period of 2.5 minutes, beginning 0.5 minutes before the delivery of the bolus. The integrated radioactivity counts accumulated over the



acquisition period was used as an index of rCBF. Subjects were scanned in a quiet, darkened room. There was a 10 minute gap between each scan.

### **Data analysis**

The data were analysed with statistical parametric mapping, using software from the Wellcome Department of Cognitive Neurology, London implemented in Matlab (Mathworks inc. Sherborn MA, USA). Statistical parametric maps are spatially extended statistical processes that are used to characterise regionally specific effects in imaging data. Statistical parametric mapping combines the general linear model to create the statistical map of SPM and the theory of Gaussian fields to make statistical inferences about regional effects, (Friston et al. 1991; Worsley et al. 1992; Friston et al. 1994).

### **Spatial realignment and normalisation**

The scans from each subject were realigned using the first as a reference. The six parameters of this rigid body transformation were estimated using a least squares approach (Friston et al. 1995a). This approach is based on an approximate linear relationship between the images and their partial derivatives with respect to parameters of the transformation. Following realignment, all images were transformed into a standard space (Talairach and Tournoux 1988). This normalising spatial transformation matches each scan in a least squares sense to a reference or template image that already conforms to a standard space. The procedure involves a 12 parameter affine (linear) and quadratic (non linear) 3-dimensional transformations. This is followed by a 2-dimensional



piece-wise (transverse slices) non linear matching, using a set of basis functions that allow for normalisation at a finer anatomical scale (Friston et al. 1995a). Again the parameters were estimated using standard least squares after linearising the problem. As a final pre-processing step, the images were smoothed using an 16mm FWHM isotropic Gaussian kernel.

### **Statistical analysis**

After specifying the appropriate design matrix, the condition, subject and covariant effects were estimated according to the general linear model at each and every voxel (see Friston et al. 1995a). The design matrix included global activity as a confounding covariate and this analysis can therefore be regarded as an ANCOVA (Friston et al. 1990). To test hypotheses about regionally specific conditions or covariate effects, the estimates were compared using linear compounds or contrasts. The resulting set of voxel values for each contrast constitute a statistical parametric map of the t statistic  $SPM\{t\}$ .

### **Statistical inference**

The  $SPM\{t\}$  were transformed to the unit normal distribution  $SPM\{Z\}$  and thresholded at 3.09 or  $p = 0.001$  uncorrected. The resulting foci were then characterised in terms of spatial extent ( $k$ ) and peak height ( $u$ ). The significance of each region was estimated using distributional approximations from the theory of Gaussian fields. This characterisation is in terms of the probability that a region of the observed number of voxels (or bigger) could have occurred by chance ( $P_{nmax} > k$ ), or that the peak height observed (or higher) could have



occurred by chance ( $P_{Z_{max}} > \alpha$ ) over the entire volume analysed (i.e. a corrected p-value).

## RESULTS

All experimental conditions were firstly compared to the rest condition, (see table 25). Both parts of the Hayling Test showed significant activation of the occipital cortex, left frontal operculum and the inferior frontal gyrus, (DLPFC). Significant activation was also seen in the left middle temporal gyrus during part A of the Hayling Test and in the precentral gyrus during part B. Relative to the reading condition, Part A produced activation in the left frontal operculum, left inferior frontal gyrus, the middle temporal gyrus and the right anterior cingulate gyrus (table 25 and figure 2). Part B of the Hayling Test compared with reading showed significant activations in the left frontal operculum, left inferior frontal gyrus and the right anterior cingulate gyrus, with no significant activation of the middle temporal gyrus (table 26 and figure 3). When parts A and B of the Hayling Test were compared, (initiation minus suppression) significant activations were observed in the middle temporal and left inferior frontal gyri (Brodmann's area 44/6) during part A (table 27 and figure 4). There were no regions where activation was greater in part B of the Hayling Test than in part A.

It should be noted that the limited field of view (10cm) of our scanner model did not allow us to look at certain structures, notably the cerebellum.



**Table 26 Comparisons of activation with rest**

Comparison	Z score	Region	Brodmann's area	Talairach coordinates (mm)		
				x	y	z
Initiation vs Rest	5.65	Occipital cortex	17/18	-2	-98	-8
	5.07	Left frontal operculum/ inferior frontal gyrus	45	-34	18	4
	4.98	left middle temporal gyrus	21/22	-46	-42	4
Suppression vs Rest	6.2	Occipital cortex	17/18	-4	-100	-12
	4.98	Left frontal operculum/ inferior frontal gyrus	45	-36	24	8
	3.75	Precentral gyrus	6	-36	-6	36
Reading vs Rest	5.28	Occipital cortex	17/18	-24	96	-8



**Table 27 Comparisons of activation with reading**

Comparison	Z score	Region	Brodmann's area	Talairach coordinates		
				x	y	z
Initiation vs Reading	5.15	Left frontal operculum / inferior frontal gyrus	45	-32	14	4
				-54	20	4
	4.25	Left middle temporal gyrus	21/22	-44	-42	4
	4.06	Right anterior cingulate cortex	32	2	26	32
Suppression vs Reading	4.71	Left frontal operculum / inferior frontal gyrus	45	-36	24	8
				6	20	40
	3.53	Right anterior cingulate gyrus	32	6	20	40

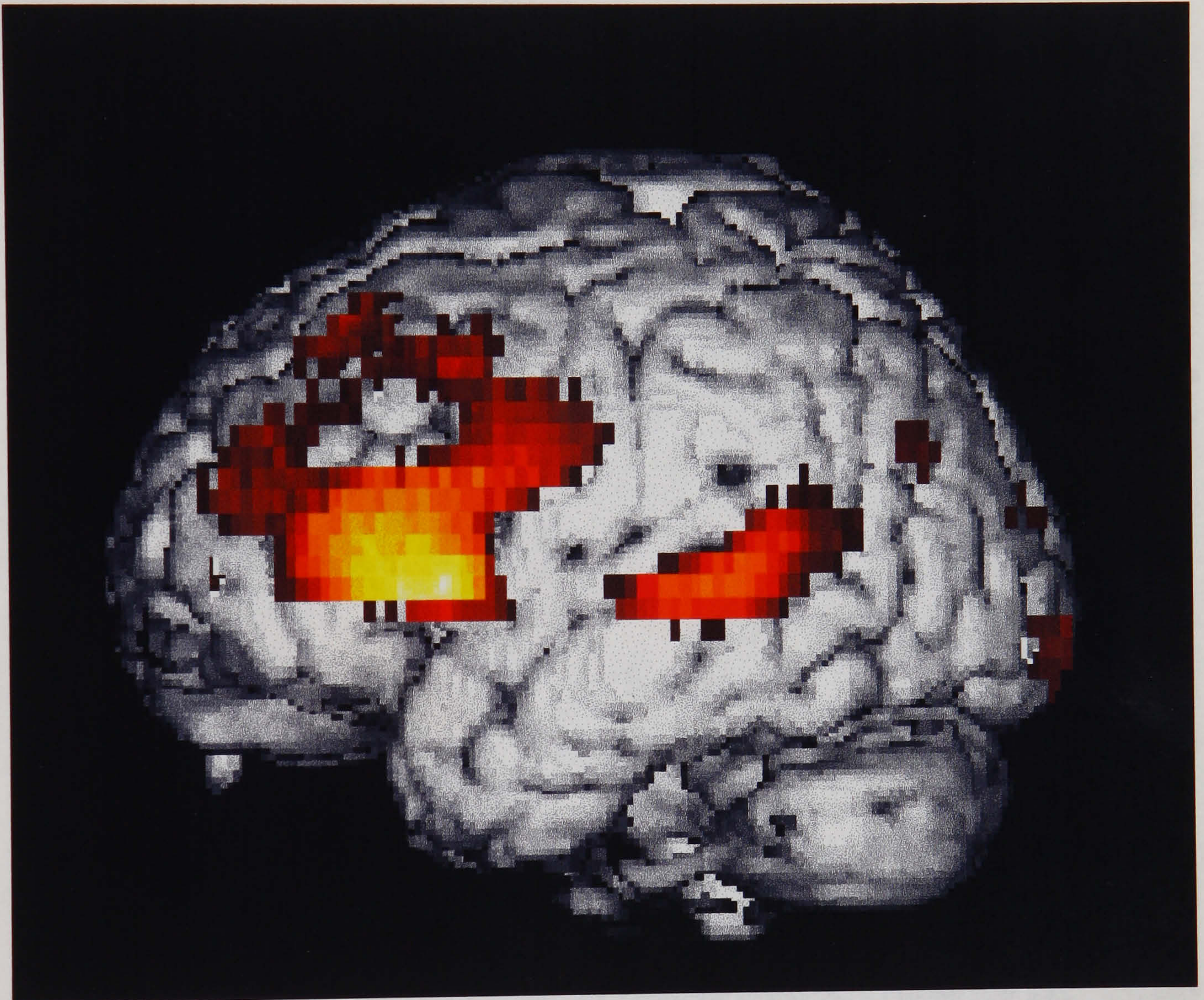


**Table 28 Comparison of regions of interest between parts  
A and B of the Hayling Test**

Comparison	Z score	Region	Brodmann's area	Talairach coordinates		
				x	y	z
Initiation vs. suppression	3.62	Left inferior frontal region	44/6	-54	2	4
	2.97	Left middle temporal gyrus	21/22	-48	-44	4

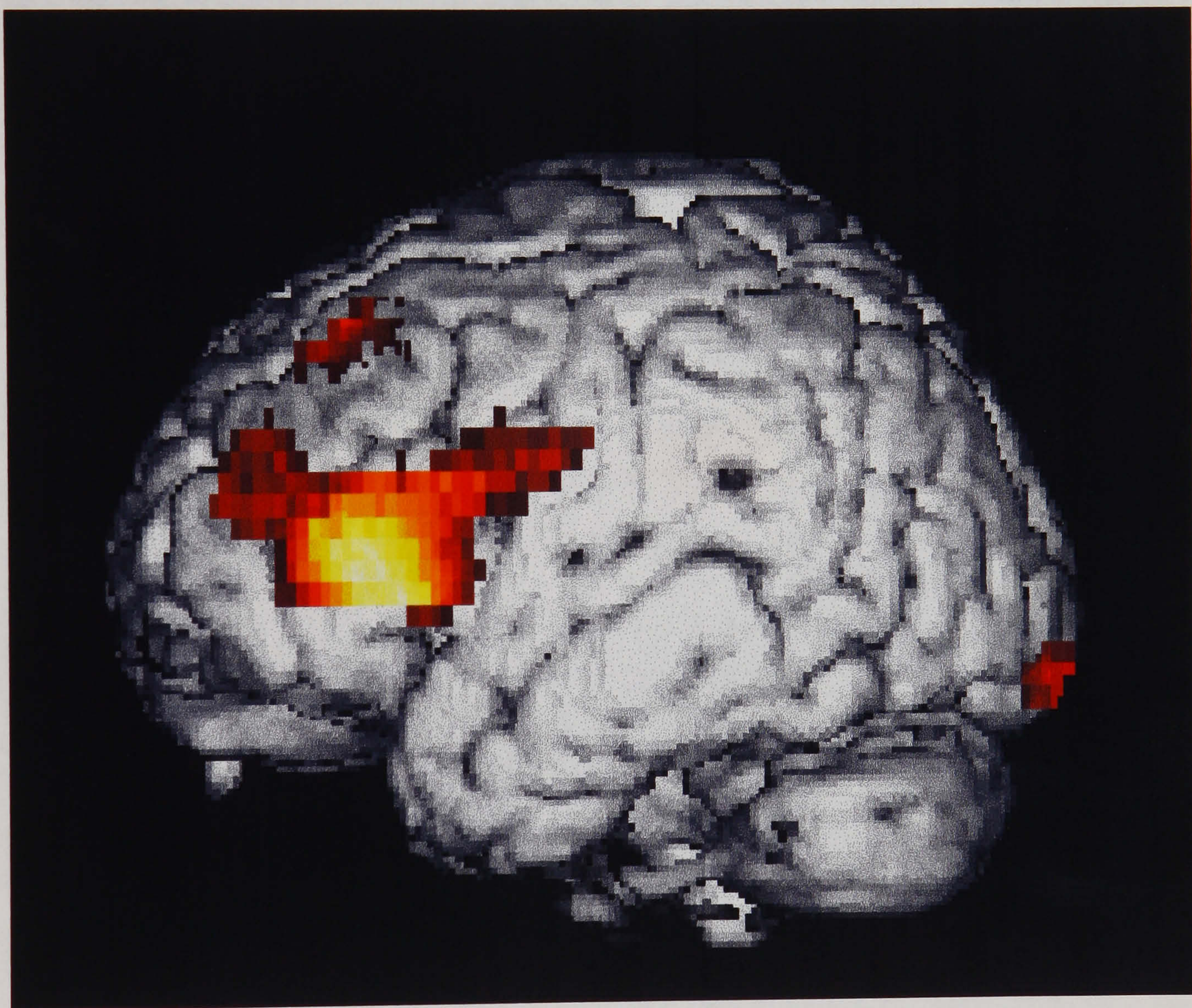


**SPM projection superimposed on to a T1 weighted normalised MRI brain scan. Areas of significantly increased activity during response initiation compared to reading are shown**



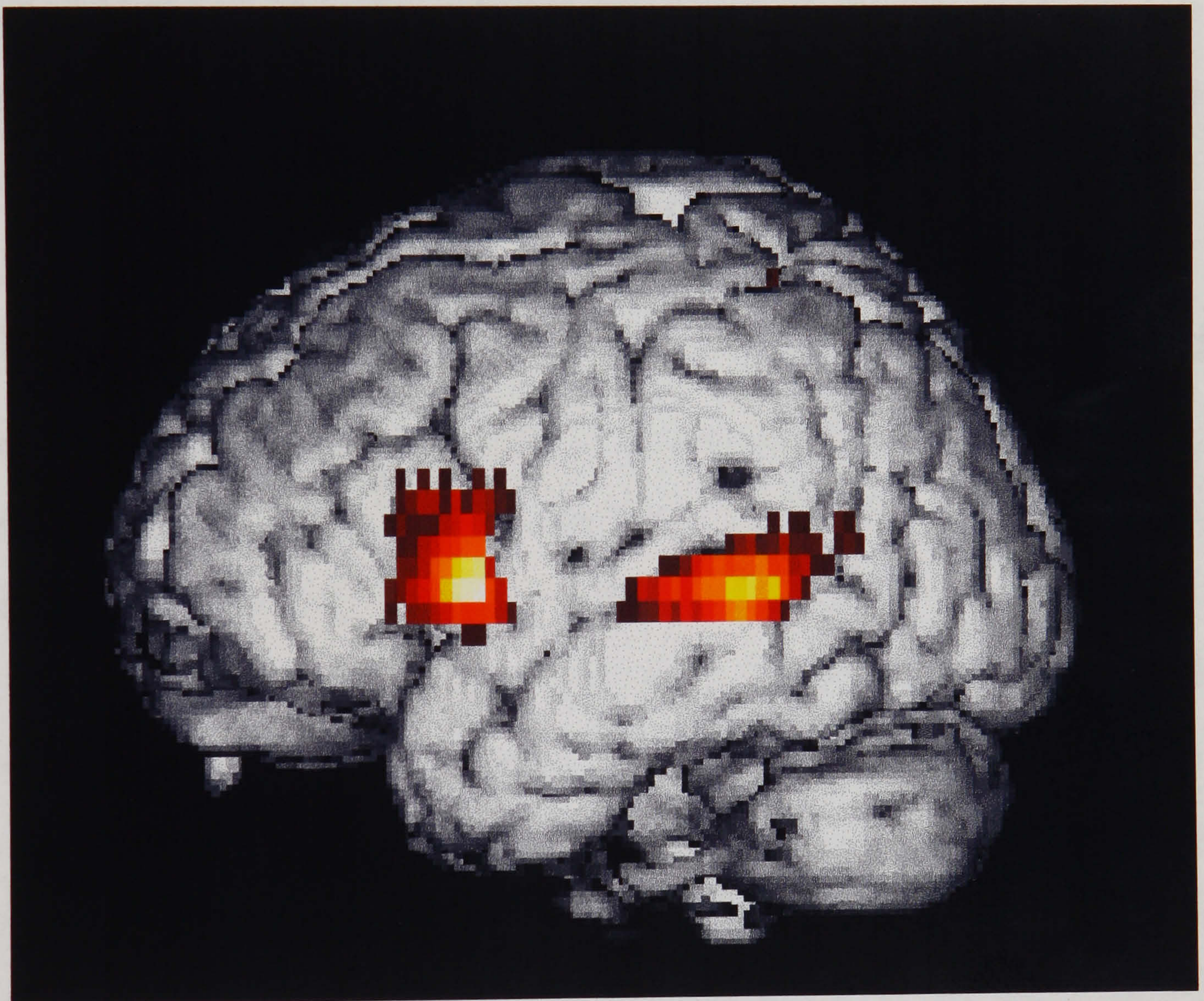


**SPM projection superimposed on to a T1 weighted normalised MRI brain scan. Areas of significantly increased activity during response suppression compared to reading are shown**





**SPM projection superimposed on to a T1 weighted normalised MRI brain scan. Areas of significantly increased activity during response initiation compared to response suppression are shown**





## DISCUSSION

The results of this study show that when compared with a control reading task, both forms of the Hayling Test are associated with activation in 3 areas, the left frontal operculum and inferior frontal gyrus and the right anterior cingulate. The difference in activation patterns between parts A and B of the Hayling Test (initiation and suppression) were restricted to the increase in activity in the middle temporal gyrus and the left inferior frontal gyrus (Brodmann's area 44/6) during response initiation. Activation in the middle temporal gyrus during response suppression was not found to be significantly above rest or reading.

The identification of these regions in a task that requires response initiation and suppression, in particular the frontal and anterior cingulate areas, supports my initial hypothesis and is in keeping with Burgess and Shallice's findings (1996), as well as those which have used other 'executive function' or 'frontal lobe' tests, which call on the same skills as the Hayling Test, (Perret 1994, Drewe 1975; Pardo et al 1990; Bench et al 1993). However, my findings are most analogous to those PET studies on normal subjects where tasks of word retrieval have been investigated (Frith et al 1991; Wise et al 1991; Raichle et al 1994; Warburton et al 1996). In particular the experiment of Warburton et al. on verb retrieval in which subjects had to think of appropriate verbs to given concrete nouns, is similar to the Hayling Test both cognitively and also with respect to its functional anatomy. For example, the activations of the frontal operculum and inferior frontal gyrus in left prefrontal sites and the right anterior cingulate and the left middle temporal gyrus are in very similar locations.



With the exception of the occipital cortex, no other significant activations were observed when the reading condition was compared to rest. This could be due to the length of the time the stimuli was displayed. For example, previous studies (e.g. Price et al (1994) have reported that when verbal stimuli are presented for more than 150ms there is less activity in language areas compared to words presented for shorter durations. Price et al. (1994) suggests that this is because activity is reduced once the words have been sufficiently processed. During the reading condition of this study the sentences were presented for far longer than necessary to perform the relatively easy task of scanning the sentence and reading out the last word. For these reasons the activity produced in the temporal and frontal cortices may not have been significantly different from rest using the chosen statistical threshold. By comparison, even though the same exposure duration was used for both parts of the Hayling Test, these tasks make considerably greater demands on the system and require the subject to process the sentences for a longer period of time.

Surprisingly, neither initiation nor suppression produced any anterior cingulate activation when compared to rest, but did when compared to reading. Anterior cingulate activity in the rest condition was intermediate between the reading condition and the two experimental conditions and did not differ significantly from either. We suggest that during the rest condition, because instructed not to do anything, subjects were actively suppressing mental activity and were constantly monitoring themselves. In contrast during the reading condition, their



attention was sufficiently focused but less active than during rest. This argues against the use of a rest condition in PET studies because although subjects may not be engaged in an experimental task, they may be nevertheless processing information to a degree approaching or exceeding an actual task.

What are the specific contributions of the regions activated during performance of the Hayling test? The lateral prefrontal cortex (LPFC) has been implicated in a variety of task engaging executive components or processes. The inferior frontal gyrus which was found to be activated, forms part of the ventrolateral prefrontal cortex. Recent work has concentrated on a dissociation between dorsolateral and ventrolateral prefrontal function (e.g. Petrides 1994), with the former being associated (in memory at least) with complex high-level planning and the latter with executive decision.

Both Paulesu et al. (1993) and Warburton et al. (1996) have also associated activation of the LPFC, in particular the inferior frontal gyrus with word retrieval processes. The precise role of the left inferior frontal gyrus in the Hayling Task is at present unclear. However, it is reasonable to propose that this region is required for both intrinsic word generation, as well as for finding an appropriate word searching strategy in the absence of any external cue as to how this is to be done.



The significance of right anterior cingulate activation during both parts of the test is consistent with the notion of the medial frontal regions being involved in the control of attention and response selection (Luria 1970; Pardo 1990; George et al 1994; Devinsky et al 1995), features that are paramount to the adequate performance of this test. However, it is possible that activation of this area may signify its equal importance with the LPFC as an executive function region in this test. For example, Burgess and Shallice (1996) reported no difference in performance between right and left frontal patients on the Hayling Test, which in the light of the present findings suggests that damage or dysfunction to medial frontal (e.g. anterior cingulate), may be sufficient to impair a patient's performance during either parts of the test. What then is the role of the anterior cingulate in the Hayling Test? Although this region is said to be heterogeneous in function (Bench et al 1993), it appears that the response selection functions of the anterior cingulate may be part of a broader contribution to cognitively demanding information processing, which comes into play in tasks in which a strong habitual response must be overcome (as in part B of the Hayling Test) or when it contains novel sequences of actions (part A). These functions are said to be subserved by the supervisory attentional system (21). In view of this, it is possible that the anterior cingulate has a primary role in the supervisory attentional system.

One interesting finding in this study was the increase in cortical activity when subjects were required to provide an appropriate word compared to when they had to suppress one. The observed increases in blood flow in the left middle



temporal gyrus and Brodmann's area 44/6 in part A are at first surprising given that verbal suppression (part B) is a much more difficult task to perform. Left superior temporal regions are said to play a major role in the representation of words (Wernicke 1874), a role that would be paramount on part A of the Hayling Test. However, Frith et al. (1991) using a Verbal Fluency Test, proposed that reduced activity in this area might reflect the inhibition of words which are automatically activated, but not appropriate in the given context. This idea is I believe given further credence with respect to the pattern of activation in part B of the Hayling Test, since it is a *puer* test of suppressing inappropriate responses. Moreover, Friston et al. (1991) have suggested that the rejection of inappropriate words may be more successful when the overall activity of a network within which words are represented was reduced. What is difficult to account for is the greater frontal activity in Hayling A compared to Hayling B. Suppression is not only subjectively a more effortful task, but is also associated with longer reaction times. Perhaps a high level of sustained frontal activity is associated with both the tasks.

What are the implications from this study for the finding of response suppression and initiation deficits in schizophrenia and their relationship to confabulation? The results from these normal subjects demonstrates that response suppression and response initiation are indeed mediated by the frontal lobes. More specifically however, like other executive process, a particular 'system' is evident here which involves a reciprocal relationship between frontal and temporal regions. It is reasonable to propose that, in schizophrenia, this relationship is compromised particularly during response



suppression. One possible consequence for confabulation is that the frontal regions are failing to deactivate or suppress inappropriately retrieved or inaccurate memory traces. In this respect, the most likely dysfunctional region would be the anterior cingulate since its role is one of *response selection* (Devinsky et al 1995), as opposed to word production which is more under the control of the inferior frontal gyrus and frontal operculum. However to explore this, one would need to repeat this study with a group of schizophrenic patients.



## CHAPTER 7

### CONCLUSIONS

The aim of four of the studies was to characterise the nature of executive dysfunction in memory within schizophrenia. Chapter 1 highlighted the heterogeneous contribution of executive functions to memory by providing evidence that executive dysfunction per se is not related to the finding of memory impairment. What appears to be the case is that only a subset of executive components contribute to the observed frontal memory pattern. As it was only the Wisconsin Card Sort Test which related to memory performance, the components to be singled out are perhaps planning and set shifting. However, some caution is needed in this interpretation. Although this task is generally seen as a major indicator of frontal lobe dysfunction, the interpretation of 'poor performance' is problematic. The complexity of this test is such that it almost certainly involves a number of cognitive processes and may also be directly sensitive to memory deficits.

One possible contender is working memory, as this is required both during immediate memory (the list learning component of the CVLT) and the card sort task. Moreover, this skill is called upon less during the other executive tests employed here and may thus partially account for the fact that, although the schizophrenic patients performed these other executive tasks more poorly, this performance was not related to the memory deficits observed. However, to support the contention for a working memory deficit being responsible for the relationship between immediate memory and executive deficits, one would need to carry out tests of immediate memory in



conjunction with a version of the card sort test which allows for a disentangling or fractionation of the various components of the task. This is clearly an approach future studies could adopt.

Having established a pattern of memory deficit consistent with frontal lobe dysfunction together with coexisting executive deficits, chapter 3 set out to investigate whether patients with schizophrenia, like some frontally impaired patients also confabulate. This study saw the first demonstration of confabulation in schizophrenia within a structured setting. By attempting to recall fable stories, an entire group of schizophrenic patients produced confabulations which were essentially rearrangements of the stories ideas into new ones. This was not observed in the control group, where only one confabulation was produced which was of a entirely different order. Perhaps surprisingly, confabulation in the schizophrenia group was not found to be related to memory performance on the standard tests, although some of the highest confabulators were also the most impaired on the memory tests. As in chapter 2, executive dysfunction played a key role in this abnormality and like chapter 2, the contribution was again specific. On this occasion, difficulties with response suppression was found to be the major executive component relating to confabulation. This observation supported the initial hypothesis as did the observed relationship between confabulation and thought disorder. Indeed, the confabulations produced resembled thought disorder to a remarkable degree in both form and content, which begs the question as to whether the methodology employed here is really a technique for producing thought disorder which is not picked up with traditional psychiatric assessment tools. Nevertheless, with respect to response suppression, it was not clear from this study whether this meant that



confabulation was simply due to the inability to reject inappropriate material (assuming one knows what is inappropriate), or whether this deficit serves to exaggerate an already existing underlying problem. The results from chapter 4 supported the latter hypothesis. By studying single cases rather than groups, I was able to establish that problems with response monitoring in addition to response suppression were adding to a more basic deficit in the ability to make plausibility judgements. All four patients had difficulty to varying degrees in detecting plausible story material, even the most implausible accounts of stories, suggesting that information is perhaps represented abnormally during encoding. This study served to highlight the contribution of a deficit in making plausibility judgements in addition to impairments in response suppression and response monitoring to the confabulatory process. Since all of these executive skills are required at different stages during the verification process, this study further served to demonstrate that the mechanisms of confabulation in schizophrenia involve a collection of executive components, each having a specific role in the confabulatory process.

What is apparent from this study is that the ability to suppress and monitor responses and to make plausibility judgements only appear to breakdown when the patients are presented with complex stories, since little confabulation was produced with simple narratives. Moreover, these processes are also not at fault with single *unconnected* sentences as in the true/false functional sentences task, as all patients performed very well. Taken collectively, this suggests that confabulation in schizophrenia is dependent on the patient being asked to recall information which is made up of a *combination* of highly related elements which only when *put together*,



make sense. With increasing complexity (or related elements) comes more confabulation.

The study reported in chapter 5 expanded on these findings whilst at the same time attempted to answer the question of whether schizophrenics confabulate in other domains. With other patients autobiographical questioning has been the tool of choice to produce and measure confabulation. It therefore seemed appropriate to adopt this method if a more direct comparison between confabulation in schizophrenia with that seen in other patients was to be made. The findings of this study, in line with those in chapter 3 and in particular chapter 4, highlighted response suppression and response monitoring as being crucial executive skills in confabulation. In this study however, it was the contribution of these processes to *autobiographical* confabulation that served to both extend the finding of confabulation in schizophrenia and support some of the important mechanisms found in other types of patients. In line with the study in chapter 4, the complexity of what was being asked by some questions contributed to the differences in the amount of confabulation produced between different types of questions. Questions which asked patients to recall 'events' produced more confabulations than those asking for 'facts', suggesting that the former is more complex task.

The mechanisms of confabulation reported in this study are indeed, not too dissimilar from 'frontal' patients. However, for two patients, the presence of 'delusional' systems in the form 'confabulatory frameworks' was certainly a contributory feature. Although this was not universal, this clearly highlights a possible link between delusions and confabulation. However, as was



documented in chapter 5, delusional ideas identified by psychiatric assessment, do not need to be present. Nevertheless, this link appears to be something which warrants further study.

Finally in contrast to chapters 1-5, chapter 6 saw the need for a move away from studying schizophrenic patients directly. This was felt necessary in order to understand the functional anatomical mechanisms for response suppression in normal subjects, to allow me to theorise as to the possible abnormal mechanisms in schizophrenia and, ultimately, some of the functional anatomy related in confabulation. Using a modified version of the Hayling Test with PET imaging, a number of left sided frontal regions were found to be involved, which worked together with the left middle temporal gyrus. What appears to be the case in normal functioning is that in response suppression, activity in this left temporal area needs to be kept to a minimum, or at least not significantly above rest to enable the system to successfully suppress automatic responses. Presumably the storage of these automatic responses lies in this region and, as discussed in chapter 6, there is much support for this notion. What may be going on in schizophrenia however is open to debate. Perhaps the most obvious hypothesis would be one of abnormal functional connectivity. Certainly this would fit in with some current theories (e.g. Friston & Frith 1995). However, it is also conceivable that the areas themselves may be dysfunctional. Certainly there is evidence for this too in the literature with respect to frontal and temporal areas. Despite these unanswered questions, one now has some knowledge as to some of the functional regions related to response suppression which in turn



so strongly related to schizophrenic confabulation. What is now required is a further study which isolates the *abnormal system* of confabulation.

Perhaps the logical progression from this thesis would be to uncover the functional anatomy of confabulation in schizophrenia for both narrative and autobiographical confabulation, and to see how this relates to the functional mechanisms of response suppression identified here. As clearly demonstrated in chapter 4, the type of story which patients are asked to recall (fable vs. simple stories) has a significant impact on whether confabulation is observed. With this in mind a first step would be to use PET to compare the regional activity produced between fable and simple story recall. Assuming that significant differences would be found, this study could be further expanded to study the effect of increasing complexity on the neurophysiology of narrative recall. Using PET to understand the neural mechanisms of autobiographical recall and ultimately autobiographical confabulation may produced some similar findings to studies which have investigated episodic memory (e.g. Shallice et al. 1994; Andreasen et al 1995c), since the recall of past experiences involves this specific system. These studies as well as many others have reported the involvement of the right prefrontal cortex in episodic memory retrieval. This is perhaps the most consistent finding in PET studies of cognition. In this light it would seem to reasonable to suggest the involvement of this region in autobiographical confabulation and it is something which perhaps future studies should investigate.



In conclusion, whilst this thesis has served to extend the finding of coexisting impairments in memory and executive function by examining more specifically what components of executive dysfunction relate to memory, it has perhaps opened up a can of worms with respect to confabulation. Although I have sort to understand its mechanisms by highlighting the fractional contribution of executive dysfunction, I cannot help but wonder what subsequent studies will report on this now newly established abnormality in schizophrenia.



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## APPENDIX 1

*Story 2* divided into ideas

An elderly woman / , who lived in a house / full of beautiful paintings and ornaments / , asked her doctor / to treat her sore eyes / . The doctor came / and put ointment / on her eyelids / , but while she sat / with her eyes closed / , he stole / one or two valuable possessions / . Each time he visited / , he took another item / , until the old woman's house was almost bare / . One day / he arrived to treat her / , but he found two policemen / waiting to arrest him / . "I'm not a thief!" / he said / . "I didn't say you were a thief," / said the old lady, / "but you are a bad doctor / . Before you cured my eyes / , I could see all my belongings / . Now I can't see any of them / ."

### Moral choices

A wise man learns from his mistakes

Selfishness brings it's own punishment

A thief will always be caught out

Greedy people end up with less

Be happy with what you've got

Treat others the way you like to be treated



## APPENDIX 2

Original story and confabulation transcript of story 3 by patient G.H.

### *story 3*

A rich man / took a valuable cargo / on a voyage / across dangerous seas /.  
 A storm soon blew up / and the ship went down / throwing the passengers /  
 into the sea /. They all began to swim / for their lives / except the rich man /  
 who raised his arms to heaven / and promised his god / all kinds of riches / if  
 he was saved /. The other passengers shouted / to the praying man,/ "Don't  
 leave it for god to save you /, swim for yourself."/

### **patient GH**

A rich man went on a swimming expedition\*/ and he stopped swimming in  
 the middle of the ocean\*/. In the middle of the ocean he decided that he  
 would pray to our lord god.....he would pray to god\*/, our lord....Jesus who  
 would\*/.....am.....Jesus our lord, who would accept his prayer\*/.....  
 answered prayer\*/. But he carried on praying as was his word\*/ and he was  
 hailed by people on a passing boat\*/ who said, "god won't help you, swim for  
 yourself."

*\* indicates a confabuted idea*



## APPENDIX 3

Original story and confabulation transcript of story 1 by patient J.H.

### *Story 1*

A farmer who's sons were always quarrelling tried to make them see how pointless their arguing was. But no matter what he said, they still bickered so he decided to show them what he meant. He took a bundle of sticks, handed it to them and told them to try and break it. They each tried but couldn't manage it. Then he untied the bundle and handed them the sticks one by one. This time they broke them easily. "Its the same with you my children," he said. " When you stay together you make a strong team, but if you break up and quarrel, you are easily beaten.

### **patient JH**

"A farmer who's sons were quarrelling tried to beat them. It's no use he said. If you beat us we will still quarrel You always do this , so they tried to tell him a story. Why do you always beat me, they said. You should know by now..... that its not usual. If....."



## APPENDIX 4

One of the autobiographical questionnaires used in chapter 5

Questions for: G.A.

### Family history

- Q1 What work did your parents do for a living ?
- Q2 Do you have any brothers or sisters? *prompt: ages / occupation*
- Q3 Where did you and your family live during you childhood? (*up to 14 years of age*)
- Q4 Tell me about an event or incident during childhood which has particular meaning for you?

### Personal history

- Q5 Tell me about the exams you sat at school / college. *Prompt: what exams did you pass?*
- Q6 What jobs did you do after leaving school / university?
- Q7 Can you tell me about an event that happened around the time that you first began to feel unwell? *Prompt: During school/ during a hobby. How did this effect the way you were feeling at the time?*
- Q8 Describe some other event during your 20's that is memorable for you ?

### Recent history

- Q9 Can you remember when it was that we met?
- Q10 Describe your journey to this hospital today? *Prompt: people you met.*
- Q11 Tell me about an incident that happened at home or at work during the last year?

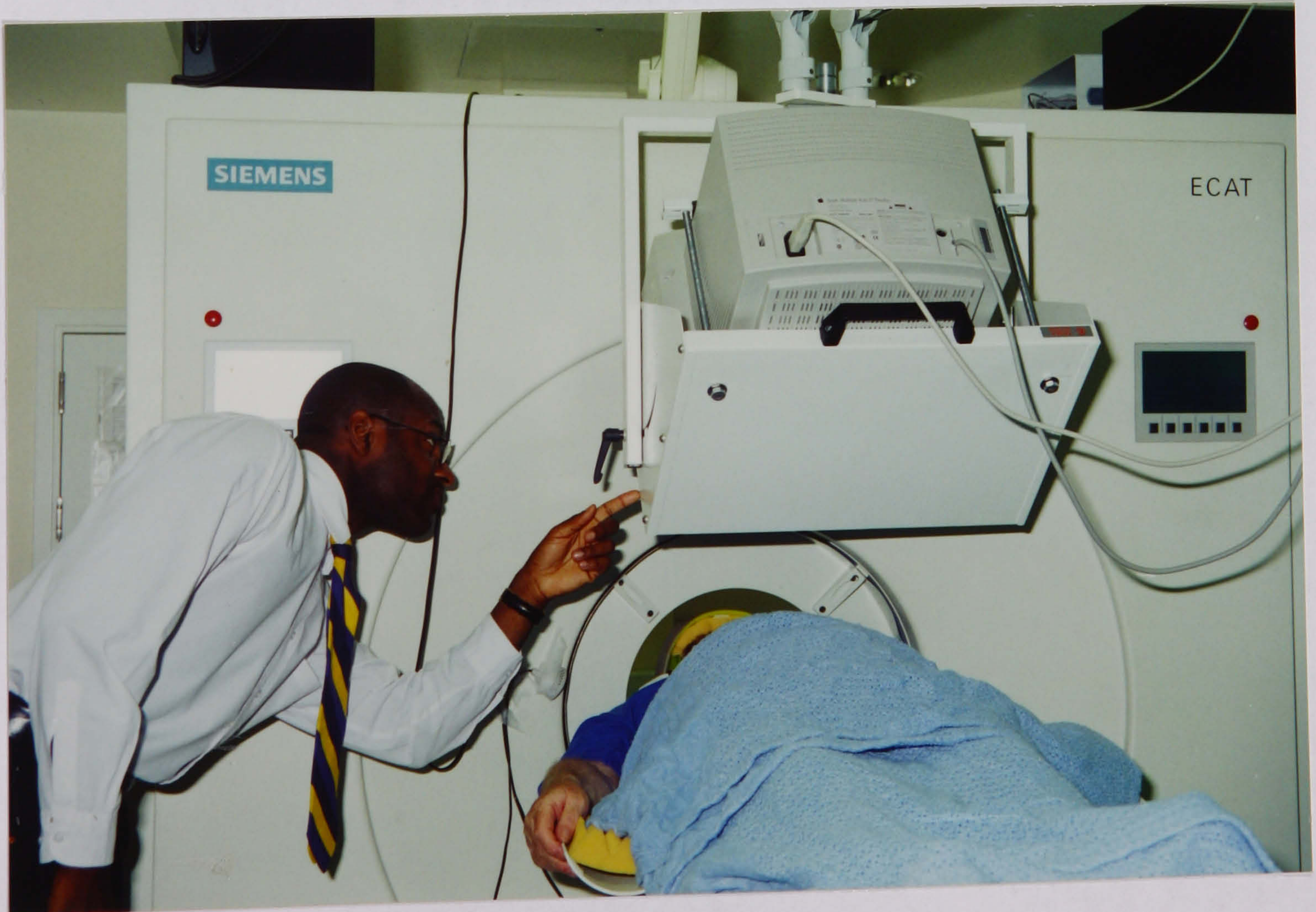
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Comments:



# APPENDIX 5

The author conducting a PET scan





## PUBLICATIONS FROM THIS THESIS

Nathaniel-James, D.A. and C.D. Frith (1996). Confabulation in schizophrenia: Evidence of a new form? *Psychological Medicine*, 26, 391-399.

Nathaniel-James, D.A., Brown, R. and Ron, M.A. (1996). Memory impairment in schizophrenia: Its relationship to executive function. In press *Schizophrenia Research*.

Nathaniel-James, D.A., Fletcher, P. and Frith, C.D. (1996). The functional anatomy of verbal initiation and suppression using the Hayling Test. In press *Neuropsychologia*.

Nathaniel-James, D.A., Foong, J. and Frith, C.D. (1996) The mechanisms of confabulation in schizophrenia. In press *Neurocase*.



**PRIZES WON FOR STUDIES FROM THIS THESIS**

British Neuropsychiatry Prize (1995)

International Congress on Schizophrenia Research Young Investigator  
Award (1995)

Biennial European Winter Workshop on Schizophrenia Young Scientist  
Award (1996)







# Confabulation in schizophrenia: evidence of a new form?

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**SYNOPSIS** This study is an attempt to demonstrate confabulation in schizophrenia. Twelve patients who met DSM-III-R criteria for schizophrenia were matched for age, sex and pre-morbid IQ with 12 volunteers, 9 of whom were normal healthy subjects, with the remainder being depressed patients. To elicit confabulation, subjects were asked to recall narratives. In addition, subjects were examined on a number of neuropsychological tests. Confabulation was defined as recall of information not present in the narrative. Variable amounts of confabulation were observed in all schizophrenics, while only one control subject confabulated. The content and structure of their productions differed from previously reported forms of confabulation in that schizophrenic patients spontaneously rearranged the original narratives to produce new ideas. The amount of confabulation was found to be related to difficulties in suppressing inappropriate responses (Hayling test) and formal thought disorder, but unrelated to understanding of the gist or moral of the narratives. Tentative mechanisms for the process of confabulation are proposed, based on specific difficulties with comprehension, response monitoring and response suppression.

## INTRODUCTION

Memory impairment that is out of proportion to other cognitive deficits has been demonstrated in schizophrenics of normal IQ (Caley *et al.* 1984; McKenna, 1990; Saykin *et al.* 1994) and has on some occasions been found to be related to the severity and chronicity of the disease. The features of memory impairment include both short-term and delayed recall of verbal and non-verbal material (Kolb & Wishaw, 1983) with relatively spared recognition abilities. This discrepancy between recall and recognition memory has been consistently reported (e.g. Bauman & Murray, 1968; Nachmani & Cohen, 1969; Goldberg *et al.* 1989), but may occur because recall tasks are more difficult than recognition tasks (e.g. Neale & Oltmanns, 1980).

Regardless of the problem posed by the failure to match difficulty level, this pattern appears to resemble frontal lobe memory impairment (Goldberg *et al.* 1989) and is in keeping with the

fact that schizophrenic patients have widely been reported to perform poorly on frontal lobe tests (Liddle & Morris, 1991; Shallice *et al.* 1991; Beatty *et al.* 1993). The material is not just poorly recalled (e.g. reduced number of items or sentences), rather it is very disorganized and in some cases contains confabulated material. Indeed, although not previously investigated formally, some clinicians report this as a typical feature of schizophrenia.

Confabulation has been defined as the 'falsification of memory occurring in clear consciousness in an organically derived amnesia' (Berlyne, 1972); 'An extreme form of lying, or deception' (Joseph, 1986) and 'An honest lying' (Moscovitch, 1989). This phenomenon is usually evident during questioning about recent and past events.

Confabulation is sometimes observed in Korsokoff's syndrome (e.g. Kopelman, 1987) and is believed by some to reflect frontal lobe pathology or frontal dysfunction when the type of confabulation elicited is spontaneous. This type of confabulation is referred to as 'fantastic' and is often grandiose and wide ranging (Berlyne, 1972). This is contrasted with 'mo-

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mentary' confabulation where the responses are fleeting and occur usually in response to direct questioning. It can be argued that the bizarre speech (formal thought disorder) of some schizophrenics resembles 'fantastic' confabulation, in that it is often fantastic in content and often unprovoked.

An additional similarity between schizophrenia and Korsakoff's syndrome is that they have been associated with a deficit in the ability to suppress inappropriate responses, (e.g. Shapiro *et al.* 1981; Liddle & Morris, 1991), which is believed to be a frontal lobe function (Perret, 1974; Burgess & Shallice, 1994). This is in keeping with other studies that have also reported this problem in patients with various frontal lobe lesions (e.g. Kapur & Coughlan, 1980).

These observations suggest that if confabulation is observed in schizophrenia, it would be related to both response suppression difficulties and formal thought disorder. The purpose of the present study was to show that confabulation occurs in schizophrenic patients. As a way of examining confabulation in a structured setting, story recall was investigated. It was hypothesized that confabulation in schizophrenia would be associated with an inability to suppress inappropriate responses and thought disorder.

## METHOD

### Subjects

Twelve patients whose first language was English and who met DSM-III-R criteria for schizophrenia were recruited for this study from the Maudsley Hospital register over a period of 6 months. Patients were excluded if they had systemic disease or head injury that had rendered them unconscious, or drank more than 40 units of alcohol per week. The same exclusion criteria applied to both patients and controls. Ages ranged between 25 and 50 years. Each patient was matched for age, sex and pre-morbid IQ with either a healthy volunteer ( $N = 9$ ) or an in-patient meeting DSM-III-R criteria for major depression ( $N = 3$ ) (see Table 1). The inclusion of depressed patients was in order to control for factors other than psychosis, related to chronic psychiatric illness. All subjects gave informed consent.

## Materials

### *Experimental test of confabulation*

To elicit confabulation in a structured setting, an experimental test involving memory for stories was constructed. Six short stories of one paragraph in length were derived from *Aesop's Fables*, each of which had a specific moral associated with it. Elements in the original stories that were felt to be too childish for adult subjects were replaced without changing the theme of the story.

*Task instructions* Each subject was told that a few short stories about different subjects were going to be read to them and that they were to follow these stories from an exact copy provided. They were then informed that immediately following the end of each story, they would be required to repeat back as much of the story as they could and that this reproduction should be verbatim. The stories were then read at a normal reading pace. Finally, subjects were told that following their recall of each story, they would be asked two questions. These were:

(1) Tell me in your own words what you think the point of this story is: what is it really about?

(2) I am going to show you a list of morals. One of them is the correct one for the story you have tried to remember. Which one do you think it is?

These questions were aimed at establishing to what extent story recall is dependent on extracting: (1) the gist, which is defined as the ability to provide the inner meaning or central point of a given story; and (2) the moral of the story, as an aid to adequate semantic processing.

The stories were read out to the subjects while they read them from an identical copy. This procedure was used to aid comprehension of the text. Subjects were presented with a list of six morals for each story and asked to choose the correct one. The other five moral choices were derived from other fables, but were unrelated to the story read to the patients.

*Scoring of confabulation, gist and moral variables* Each story was subdivided on the basis of the



different *ideas* it contained. The procedure for this was based on the story recall task from the Adult Memory and Information Processing Battery Test Manual (Coughlan & Hollows, 1985). A correctly recalled idea was scored as '2', a partially recalled idea '1' and an idea not present in the story was coded 'c' (confabulation). An example of a story divided into ideas is provided in Appendix 1. An adequately provided gist was scored as '2', a vaguely related gist '1' and an incorrect answer '0'. A moral was scored a correct '1', or incorrect '0'.

### Neuropsychological assessment

The following neuropsychological test battery was administered to all subjects.

#### *Memory tests*

1. *Recognition memory for words* (Warrington, 1984) This was administered using the standard procedure. The test consists of 50 stimulus words. Recognition memory was tested by presenting each word with a distractor. The subject is required to make a forced choice between them. The number of correctly recognized words was converted to an age-corrected scaled score.

2. *Recognition memory for faces* (Warrington, 1984) The stimuli consist of 50 black and white photographs of unfamiliar faces. The subject was asked to recognize them when each was paired with a distractor photograph drawn from a similar pool. The number of correctly recognized faces was converted to an age-corrected scaled score.

3. *California Verbal Learning Test* (Delis *et al.* 1987) This test measures both recall and recognition of words over a number of trials. The subject was required to recall a list of 16 words (four words from each of four semantic categories) over five trials. An interference list of 16 new words was then presented for one trial, immediately followed by both free and category-cued recall of the first list. Following a 20 min delay, free and cued recall and recognition of the first list were assessed.

#### *Tests of executive functioning*

1. *Hayling Sentence Completion Test* (Burgess & Shallice, 1996) This is a response suppression test consisting of two stimulus conditions of 15 sentences in each condition. In the first condition

(response initiation) the subject was read 15 sentences from which the last word was omitted and was required to give a word which reasonably completed the sentence. In the second condition (response suppression) the subject was asked to produce a word unrelated to each of the 15 sentences. Three measures were scored: the sum of response latencies in condition 1, the sum of response latencies in condition 2 and the quality of responses in condition 2. An actual completion response of a sentence received an error score of 3, a word semantically related to a word in the sentence received an error score of 1 and an unrelated word a score of 0.

2. *The Verbal Associative Fluency Test* (Benton *et al.* 1983) In this test the subject is required to say as many words as he can think of that begin with a given letter of the alphabet (excluding numbers and proper nouns). For this study the letters FAS were used. The score, which is the sum of all acceptable words provided in three one-minute trials is adjusted for sex, age and education using the standard adjustment formula (Benton *et al.* 1983).

3. *Modified Card Sorting Test* (Nelson, 1976) This is a shortened version of the Wisconsin Card Sorting Test. It consists of one set of stimulus cards and two sets of 24 response cards. The subject was asked to sort the cards on the basis of three possible categories (form, number and shape). The total number of errors, categories achieved and the number of preservation errors made was recorded as a measure of the ability to shift cognitive set.

#### *IQ tests*

1. *The National Adult Reading Test* (Nelson 1982) This was administered following the standard procedure of Nelson (1982) to obtain an estimate of pre-morbid intelligence.

2. *Raven's Progressive Matrices Advanced Set 1* (Raven, 1958) This test was used to assess reasoning in the visuospatial modality and provides an estimate of current intellectual functioning.

#### **Mental state**

Patients were interviewed using the Krawiecka scale (Krawiecka *et al.* 1977) to assess current symptomatology. This scale rates positive and negative symptoms and incoherence of speech (thought disorder). Separate scores are obtained



for each category. The range of ratings for all measures is 0–4, where '0' is absence of a symptom and '4' indicates a severe symptom.

### Procedure

Following an interview using the Krawiecka scale, the tests were administered in the following order: CVLT, Hayling Test, Modified Card Sorting Test, Verbal Fluency Test, Recognition Memory Test, Raven's Progressive Matrices, NART and test of confabulation. This order was necessary to ensure that no other memory task was administered during the 20 min delayed recall interval of the CVLT, to avoid interference.

### Statistical analysis

Differences between the groups were tested using independent *t* tests, and the Mann–Whitney *U* test, using one-tailed *P* values. The exception to this was the use of analysis of variance with repeated measures (MANOVA) for both story recall and the CVLT (trials 1–5). The *Statistical Package for Social Scientists for Windows v. 6.0* (Norusis, 1992) was used for the analysis.

## RESULTS

### Background variables

The control group was matched with the schizophrenia group on all background variables except for the Raven's Progressive Matrices (Table 1). The difference was significant at  $P < 0.01$ . No other significant differences were observed.

The mean ratings for all symptoms on the Krawiecka scale are provided in Table 2. All were in the low, but morbid range.

### Memory (CVLT)

The performance on trials 1 to 5 of the CVLT (Table 3) is a measure of verbal learning. A significant effect of trial was observed ( $P <$

Table 2. *Krawiecka scale: mean rating of symptoms*

Symptom	Mean rating (s.d.)
Depression	1.90 (2.01)
Anxiety	2.98 (3.43)
Delusions	2.80 (2.99)
Hallucinations	2.41 (2.79)
Thought disorder	2.40 (2.69)
Poverty of speech	1.56 (3.11)
Flattened affect	2.85 (2.37)
Psychomotor retardation	2.41 (2.03)

Table 3. *Neuropsychological test performance*

	Schizophrenics	Controls
	Mean (s.d.)	Mean (s.d.)
CVLT		
Total recall from trials 1–5	38.66 (13.78)	45.63 (7.85)
List B (interference trial)	3.83 (1.94)	6.00 (1.48)**
Long delay free recall	7.41 (4.60)	10.90 (2.91)*
Free recall intrusions	4.58 (4.90)	2.09 (3.04)*
Recognition Memory Test		
Faces	40.58 (9.46)	46.90 (17.70)
Words	48.00 (2.41)	49.22 (2.01)
Hayling test		
Total error score	11.91 (6.14)	5.54 (4.80)**
Verbal Fluency Test (FAS)		
Total fluency score	31.58 (7.77)	46.00 (12.13)**
Modified Card Sort Test		
Categories achieved	4.75 (1.81)	5.27 (1.19)
Errors made	10.75 (9.11)	8.90 (6.28)
Preservation errors	2.41 (3.02)	1.27 (1.90)

\*  $P < 0.05$ ; \*\*  $P < 0.01$ .

0.001) but no group main effect or trial by group interaction. Therefore, both groups are learning at the same rate.

List B, the interference trial was recalled significantly less well by the schizophrenic group ( $P < 0.007$ ) as was free recall of list A after a long delay ( $P < 0.04$ ). A similar result was observed for cued recall after a long delay ( $P < 0.05$ ).

### Intrusion errors

Schizophrenic patients produced a large number of free recall intrusion errors compared with the controls (see Table 3). This difference was found to be significant ( $P < 0.05$ ). There was no significant difference in the number of cued or total recall intrusion errors.

Table 1. *Performance on the baseline tests*

Group	Number of subjects	Mean age (years)	IQ (NART)	Raven's matrices
Schizophrenics	12	37.25	118.58	7.54*
Controls	12	35.29	119.66	9.7

\* Significant at  $P < 0.01$ .



**Recognition Memory Test**

No significant differences were observed for either the word, or face versions of this test.

**Executive functioning**

The schizophrenia group performed significantly worse than the controls on the Hayling Test errors ( $P < 0.01$ ) and on the Verbal Fluency Test ( $P < 0.003$ ) (Table 3). No significant differences were found on the Modified Card Sort Test.

**Story recall**

The performances of the groups are provided in Table 4. Significant main effects of group ( $P < 0.005$ ) and story ( $P < 0.001$ ), were obtained, as was an interaction between the two ( $P < 0.02$ ). The recall of the schizophrenic group was found to be worse on all the stories.

*Moral identification*

The schizophrenic group correctly identified significantly fewer morals than the control group ( $P < 0.019$ , see Table 4).

*Gist identification*

No significant differences were found between the groups on the number of adequately provided gists.

**Confabulation**

Appendices 2 and 3 provide the original text for stories 3 and 1 together with transcripts of confabulations elicited from patients G.H. and J.H. performing the story recall task. Points of

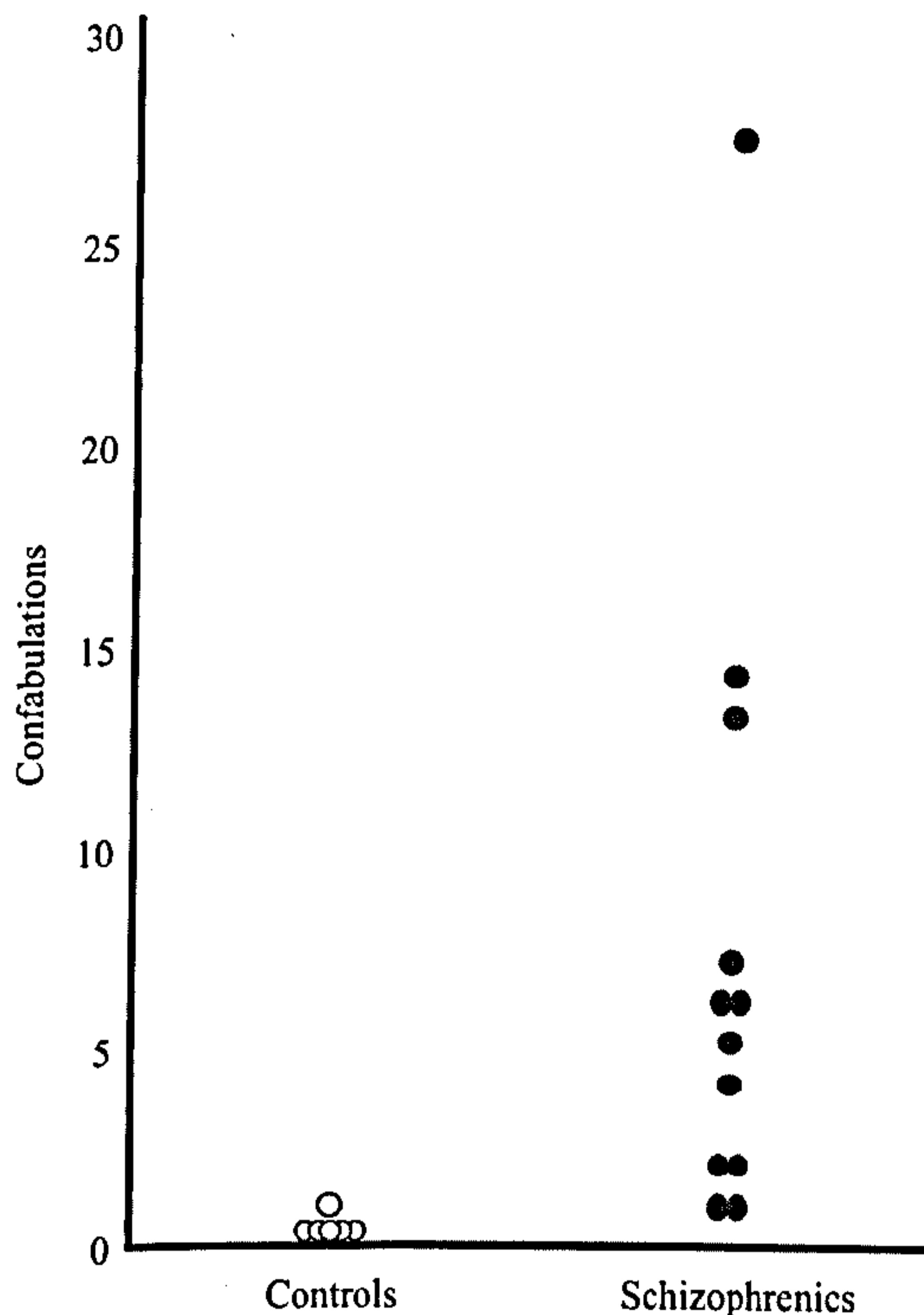


FIG. 1. Total number of confabulations elicited from each subject (O, controls; ●, schizophrenics).

Table 4. Story recall performance scores on story items

Items	Schizophrenics	Controls
	Mean (s.d.)	Mean (s.d.)
Ideas recalled from 6 stories (N)	112.66 (72.75)	185.83 (36.39)*
Correctly described gists (N)	2.50 (2.39)	3.25 (2.22)
Correctly identified morals (N)	2.75 (1.13)	3.75 (0.75)*
Total confabulations made (N)	7.33 (7.51)	0.08 (0.028)**

\* Significant at  $P < 0.02$ ; \*\* significant at  $P < 0.004$ .

particular interest are underlined for ease of evaluation. Each of the 12 schizophrenic subjects confabulated on at least one occasion (Fig. 1); however, the variability within the schizophrenia group was quite large (mean 7.33, s.d. = 7.51). It should be noted that only one control subject produced one confabulation on Story 1. The difference between the two groups on the number of confabulations elicited was highly significant ( $P < 0.002$ ). To examine the possibility that confabulation may be a result of poor recall, we matched a selection of schizophrenic and control subjects on their total story recall performance, making six subjects in each group. The mean recall scores for these groups were 173.83 (s.d. = 35.43) for the schizophrenia group and 158.83 (s.d. 30.40) for the control group. This difference was not found to be significant. The difference in the number of confabulations produced between these groups was significant ( $P < 0.005$ ). Therefore, the high rate of confabulation is not explained by poor story recall performance. However, schizophrenic patients with poor story recall produced more confabulations than the



others. We also explored the possibility that confabulation may be related to poor intellectual function (Raven's Progressive Matrices), or understanding the moral or gist of the stories. No significant relations were found between any of these variables and confabulation.

### Confabulation, executive functioning and symptomatology

To establish whether confabulation was related to executive functioning and symptomatology, we divided the schizophrenia group into high and low confabulators, using a median split based on the number of confabulations produced by each subject. We found a difference between the high and low confabulators on the Hayling error score ( $P < 0.05$ ). A significant difference was also found between the subgroups on the thought disorder rating ( $P < 0.04$ ). No other significant differences were observed. However, there was a trend for a difference on the free recall intrusion score 6.00 (5.9) v. 3.16 (3.65).

## DISCUSSION

The results of this study demonstrate that schizophrenics can be induced to confabulate in a structured setting if asked to recall meaningful narratives. It appears that the confabulations elicited are related to difficulties in suppressing inappropriate responses (Hayling error score) and to the presence of formal thought disorder. Confabulation was not found to be related to current IQ, or to the ability to extract the moral or gist of the stories.

The cognitive impairments observed in our study agree with previous reports. Goldberg *et al.* (1989) have reported deficits in free recall of verbal material with intact recognition abilities (Liddle & Morris, 1991) and Shallice *et al.* (1991) have observed deficits on tests of executive function. On the other hand, in marked contrast to previous studies (e.g. Beatty *et al.* 1993), the present study did not find the schizophrenics to be impaired on the Wisconsin Card Sort Test. It is not clear whether this is because the shortened version of the Card Sort Test was used, or simply because not all schizophrenics are impaired on this test. A comparison between both versions of the test by Nelson (1976) showing very similar results between the two, leads us to conclude that the latter may be more likely.

### Quality of confabulation

What is of particular interest in these observations is the way in which the patients confabulate. The schizophrenics appear to be reorganizing or reconstructing the original story material, thus resulting in new ideas. Their productions do not resemble the examples of confabulation reported by Kopelman (1987) using Korsakoff and Alzheimer patients. In his study, when asked to recall stories, both groups of patients tended to produce irrelevant or unrelated material (intrusions) to varying degrees. It was predominately from these intrusions that the attempts at recall were constructed.

G.H.'s version of *Story 3* (Appendix 2) is a particularly interesting example of the way in which the original material can be reconstructed to produce a very different series of events. Initially, G.H. recalled that the man went on a swimming expedition in the middle of the ocean and then stopped to pray (for no apparent reason). The reference to swimming comes from the original story text, where because of being thrown into the sea, the *passengers* began to *swim* for their lives. G.H. then recalled that the man was hailed by people *on a passing boat*, who suggested that he swim for himself rather than requesting help from god. The reference to people on a passing boat was constructed from the original story where the people are in fact fellow passengers on the *same boat* as the man.

J.H.'s account of *Story 1* (Appendix 3) provides a very similar picture. What J.H. has done is to take words from the original text such as 'beaten' and used them in a new way ('beat us') to link the references to quarrelling and sticks in the text. This reorganization of the original material is in varying degrees, a feature of all the accounts of stories given by our patients. This often resulted in rather bizarre versions of the stories.

### Confabulation and symptomatology

Thought disorder, but no other symptom was found to be significantly related to confabulation in the schizophrenic patients. The two extracts discussed above could be seen as examples of thought disorder in that the accounts appear disorganized. However, the observation that even patients with little or no thought disorder



also confabulated, indicates that thought disorder may be a contributor to the severity of confabulation rather than to its presence.

### Confabulation and executive function tasks

The association with the Hayling test suggests that the inability to withhold responses is related to confabulation in schizophrenia. This association has been reported in other studies using patients with frontal lobe involvement (e.g. Kapur & Coughlan, 1980; Shapiro *et al.* 1981). However, the lack of relationship between confabulation and any other executive function tests suggests that schizophrenics do not need to be severely dysexecutive in Baddeley & Wilson's (1988) sense to confabulate. Indeed, it could be argued that not all forms of confabulation have the same cognitive pathology, and that response suppression difficulties may be a precursor for the type of confabulation demonstrated here. In any case, the relationship between confabulation and response suppression indicates that one aspect of frontal lobe dysfunction is implicated in this form of confabulation.

### Possible mechanisms for confabulation in schizophrenia

Our results tentatively suggest that some *specific* aspect of comprehension impairment may be one of the mechanisms of confabulation in schizophrenia. For example, in *Story 2* (Appendix 1), the doctor who was called to treat the old woman's eyes, was *also* a thief), but almost all the patients failed to indicate in their recall that they understood this. This may be indicative of a specific comprehension difficulty. This possibility is further exemplified by the fact that none of the controls made this error despite the fact that their recall of this story was of varying accuracy. Patients tended to see this character as being two separate people. As a result, new ideas concerning the *two* people emerged. If specific comprehension difficulties are a contributing factor, however, they may have been exacerbated by a problem of self-monitoring. The patients never checked their accounts for the inclusion of irrelevant or over-inclusive material. The only comments they made related to whether they had remembered enough. However, it is worth noting that as the ability to extract the moral or gist of the stories was unrelated to confabulation, the *overall* lack

of understanding of the stories does not result in confabulation. This is supported by the performance of the control group, who also performed poorly on these measures, but, who nevertheless did not confabulate. The fact that confabulation was still observed following a matching of control and schizophrenic subjects on story recall performance suggests that confabulation in schizophrenia could be seen as a disorder in itself rather than a consequence of memory deficit. Indeed, it could be argued that confabulation in schizophrenia may be a distinct behavioural symptom, which incorporates difficulties of response suppression and thought disorder.

In summary, using a novel story recall technique the present study has demonstrated confabulation in schizophrenia in a structured setting. The confabulations elicited appear to be of a new type, which is qualitatively different from the confabulations observed in Korsakoff's and amnesic patients. Confabulation appears to be related to an inability to suppress inappropriate responses and, to a lesser extent, formal thought disorder. It was not found to be related to the degree of memory impairment, or the ability to understand the overall point of a story. These results suggest that confabulation in schizophrenia may be a specific behavioural sign for which tentative mechanisms are proposed, with the possibility of self-monitoring and specific comprehension difficulties being involved.

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## APPENDIX 1

### *Story 2* divided into ideas

An elderly woman / , who lived in a house / full of beautiful paintings and ornaments / , asked her doctor / to treat her sore eyes / . The doctor came / and put ointment / on her eyelids / , but while she sat / with her eyes closed / , he stole / one or two valuable possessions / . Each time he visited / , he took another item / , until the old woman's house was almost bare



/ . One day / he arrived to treat her / , but he found two policemen / waiting to arrest him / . 'I'm not a thief!' / he said / . 'I didn't say you were a thief,' / said the old lady, / 'but you are a bad doctor / . Before you cured my eyes / , I could see all my belongings / . Now I can't see any of them / .'

#### Moral choices

A wise man learns from his mistakes  
Selfishness brings it's own punishment  
A thief will always be caught out  
Greedy people end up with less  
Be happy with what you've got  
Treat others the way you like to be treated

## APPENDIX 2

Original story and confabulation transcript of *Story 3* by patient G.H.

### Story 3

A rich man / took a valuable cargo / on a voyage / across dangerous seas / . A storm soon blew up / and the ship went down / throwing the passengers / into the sea / . They all began to swim / for their lives / except the rich man / who raised his arms to heaven / and promised his god / all kinds of riches / if he was saved / . The other passengers shouted / to the praying man, / 'Don't leave it for god to save you / , swim for yourself.'

### Patient G.H.

A rich man / went on a swimming expedition\* / and he stopped swimming in the middle of the ocean\* / . In the middle of the ocean he decided that he would pray to our lord god ... he would pray to god\* / , our lord ... Jesus who would\* / ... am ... Jesus our lord, who would accept his prayer\* / , ... answered prayer\* / . But he carried on praying as was his word\* / and he was hailed by people on a passing boat\* / who said, 'god won't help you, swim for yourself.'

\* Indicates a confabulated idea.

## APPENDIX 3

Original story and confabulation transcript of *Story 1* by patient J.H.

### Story 1

A farmer whose sons were always quarrelling tried to make them see how pointless their arguing was. But no matter what he said, they still bickered. So he decided to show them what he meant. He took a bundle of sticks, handed it to them and told them to try and break it. They each tried but couldn't manage

it. Then he untied the bundle and handed them the sticks one by one. This time they broke them easily. 'It's the same with you my children' he said, 'When you stay together you make a strong team, but if you break up and quarrel, you are easily beaten.'

### Patient J.H.

'A farmer whose sons were quarrelling *tried to beat them. It's no use* he said. If you beat us we will still quarrel. You always do this, *so they tried to tell him a story*. Why do you always beat me, they said. You should know by now ... that it's not usual. If...'

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