SEMANTIC MEMORY DEFICIT IN SCHIZOPHRENIA

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by

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ABSTRACT

This study is designed to study the extent of semantic memory deficit in schizophrenia, its nature, and its correlates, in community-based schizophrenic patients using a semantic memory battery. The patients' performance was compared with that of matched controls. About six months later, the same cohort was tested again using the same battery. Patients' performance was analysed using the criteria proposed by Warrington and Shallice (1979), to decide whether this deficit conforms into an access or store type disorder. The criteria used where: consistency across time, level of attributes and the effect of cueing.

Typical parametric analysis showed significant impairment, on average, for this group of patients compared to controls on most tests of this battery. About a quarter or less of patients would perform below that of 5^{th} percentile of the controls group on different tests of the battery used. However, a more robust and atypical analysis strategy demonstrated that the significant impairment is limited to two tests (category fluency and naming to description). In addition, this impairment correlate with negative symptoms scores (on the SANS) but no significant correlation with positive symptoms scores (on the SAPS). Across time, improvement on SANS score correlated with improvement in some semantic memory tests scores (category fluency and naming to description). Further analysis showed patients performance followed the same pattern of controls. This would be interpreted as difficulty in access rather than degraded store on the criteria mentioned above. The strongest of evidence came from patients' performance on a cueing paradigm and inconsistency. These results are in support of earlier suggestion of an access semantic memory deficit in schizophrenia. The results could be related, in this cohort of patients, to being relatively young, with no significant symptomology, and living in the community.

DECLARATION

During the period in which this study was conducted I was working as a Clinical Lecturer at the University of Leicester and Honorary Specialist Registrar with Leicestershire Partnership NHS Trust. The idea and design of the study is my own work. However it was helped by discussions with my supervisor Professor Michael Reveley and my collaborator Dr Paula Moran who studied learning in the same sample of the study, which I am not covering in this thesis. Statistical advice was provided by Mr Nick Taub from the University of Leicester. I also benefited from the advice of Professor Keith Laws, from the University of Hertfordshire, especially on statistics.

I conducted all clinical assessments (using the SANS and SAPS) and obtained consent from patients to take part in the studies. I made the application to the Ethics Committee and was responsible for all communication associated with that. The psychological assessments, including Memory Tests, which I chose, were conducted by Research Assistants who worked in our department (Ms Jessica Watson, Louise Owen and Kate Martin) independently from the clinical assessment. Also clinician colleagues Dr Janet Bruce and Dr Steve Frost contributed to the study by allowing me access to their patients as well as conducting the HoNOS. Dr Darren Mackintosh contributed by independently collecting data on illness duration and age of onset of illness in the patients' sample.

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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1 INTRODUCTION

Memory is one of the most investigated and researched areas of cognitive functions. Several theories and models were proposed to explain it and understand the way it functions. It is fair to say that while there is a clear consensus on its importance, the way it functions is still an area of continuous debate. It has been divided into different types: one widely accepted division is short and long term memories. Short term memory relates to information that remains in consciousness after it has been perceived and forms part of the psychological present, while long term memory contains information about events that left consciousness and are therefore part of the psychological past (Eysenck and Keane 1995). Short term memory can be stored into long-term memory, and then retrieved to a varying degree of success depending on many factors. Long term memory comprises two types; Procedural and Declarative memory, and the latter can be subdivided into Episodic and Semantic memory (Parkin A J 1999).

The following paragraphs will focus on one type of long-term memory, which is semantic memory. The first part of this chapter will be a brief overview of the current views of the nature of semantic memory with particular reference to recent work and research in this field. It will be followed by a brief historical review of literature describing cognitive deficits in schizophrenia. This will lead into the subject of this dissertation, which is semantic memory in schizophrenia. In this part, previous reports of such a deficit will be reviewed. The final part of this chapter will be a literature review addressing the question whether semantic memory deficit in schizophrenia is an access or a store problem

1.1 Current views of the nature of semantic memory

In recent years, declarative long-term memory has been classified into context-specific memories personally experienced ("episodic memory") and impersonal non-context specific memories ("semantic memory") (Maguire & Mummery 1999). However, most people would refer to episodic memory as "memory" (e.g. I had Fish for lunch yesterday) and understand semantic memory as "knowledge" (e.g. a Fish is a water creature). Semantic memory, therefore, refers to information stored as concepts and the relationships between them. Semantic memory is plastic and dynamic and it creates an ongoing record of an individual's learning and experience.

The basic units of semantic information are concepts such as animals or furniture, or ideas or facts, which are generated in the course of exposure to the environment. These units comprise a series of exemplars grouped together into categories according to salient shared features: for instance chair, table and sofa can be categorized as furniture. The organisation of this information is conceptual rather than ordered in time, so categorisation provides the structure of semantic memory. In a highly complex environment like ours, categorisation helps us to adapt and cope with the complexity of our surrounding (Chen *et al* 1995).

Through exposure to the environment, semantic information is obtained via input from different perceptual modalities, e.g. auditory or visual. This input is encoded into a comprehendible language, which the mind can store. One widely held view is that the input from different modalities is stored in a unitary semantic system in which all information, regardless of the modality of access or acquisition, is stored together

(Caramazza *et al* 1990). In contrast, an alternative theory proposes that information is stored on a modality-specific basis with separate but interconnected stores of knowledge (McCarthy and Warrington 1988). However, Hodges *et al* (1992) concluded that the cumbersome and circuitous nature of the explanation provided by the latter theory greatly reduced its plausibility. This is supported by the finding that there is a striking item-to-item correspondence of errors both within and across modalities in the semantic memory of patients with Alzheimer's disease. Hodges *et al* argued that a loss of an item from a common semantic store for all modalities is more parsimonious and therefore more convincing as an explanation than simultaneous loss of that item from a number of separate stores.

To retrieve information there are two processes, recall and recognition. According to the two processes theory, recall involves a search or retrieval process, which is followed by a decision or recognition process based on the apparent appropriateness of the retrieved information, while recognition involves only the second of these processes. This theory considered one of the most influential attempts to account for the superiority of recognition to recall (Eysenck and Keane 1995). Language is one medium for the contact between environment, learning, and semantic memory. It facilitates encoding of information as well as illustrates retrieval of semantic memory. Non-verbal behaviour is another means of communicating and expressing semantic memory, for e.g. keeping inflammable substances away from heat indicates that we are using our prior learning and information in our behaviour to avoid harmful outcomes. The retrieval of semantic information is vital to our interaction with the surrounding environment. Obviously any impairment in the semantic memory will affect day-to-day activities in a negative way.

Because of the complexity of the structure of the memory system, and the processes (encoding, storage, and retrieval) operating within that structure, there is no single comprehensive test for semantic memory. The limitation is obvious in the case of an aphasic, who will fail on a verbal memory test when asked to name for instance a bicycle. However, he might have no problem recognising that it's a vehicle and might even know how to write the word bicycle (obviously this is limited by how much the person knew about bicycles). Therefore, to be able to assess semantic memory a battery of tests is needed to cover different perceptual pathways, memory structure, and memory processes (especially the two modes of retrieval).

The field of semantic memory has received considerable psychological interest since Tulving drew attention to the conceptual distinction between semantic and episodic memory (Tulving 1983). The difference is striking in the case of veridicality; while it's a personal belief in episodic memory (e.g. I had "egg" this morning), it is social agreement in semantic memory (same e.g. I call it "egg" because there is social consensus that it should be called so). In addition, the source of episodic memory is sensation and experience, while it's more of a learning and comprehension in semantic memory. Tulving (1983) argued that they should be regarded as functionally distinct cognitive systems, but also were highly interdependent and interacted with one another virtually all the time. An example is that information has to be acquired by episodic memory and then stored as semantic memory (e.g. one has to be told what is an "egg", after that one might not remember when he was told that but will know what an "Egg" is). Similarly, semantic information should enhance episodic memory recall (same e.g. if one thinks of an egg, it would be easier to remember when one had last seen one).

Since Tulving's distinction, the theoretical as well as the experimental investigation of semantic memory has developed. At a theoretical level, the concept now includes not only memory for meaning of words, but also facts, concepts, and abstract categorizations. At an experimental level, researchers into the neuropsychology of semantic memory (experimental investigation of abnormal function in patients with neurological disorders) have used a model proposed by Warrington and Shallice (1979), which suggests there are two patterns of semantic memory impairment: firstly, degraded stores type disorder, and secondly, impaired accesses type disorder. This model proposed that degraded store disorder, in which knowledge is lost, characterised by:

a) High consistency with the same items lost across time; subjects would fail to name or identify same items across time and different tests.

b) Ineffectiveness of priming and cueing techniques to aid retrieval; providing cues or priming would have no effect, as the information does not exist.

c) Less familiar/frequent items are lost first; more frequent items presumably have a larger representation, which make them last to be affected.

d) Subordinate, or attribute information is especially affected; in the hierarchy of semantic information, the subordinate information would be

especially affected as it represents the deepest level of information processing and smallest represented. While superordinate information will be the least and last to be affected, as it represents the first piece of information processed and the strongest represented.

In cases of impaired access disorder, representation exists but the retrieval process is compromised and this disorder is characterised by:

a) Inconsistent pattern of performance across different testing times; subjects would be inconsistent in identifying the same item across time and tasks.

b) Improved performance with cueing and priming: as the problem is in accessing, cues would be very useful in enhancing performance.

c) Item familiarity/frequency effects are less apparent; as the representation exists for both familiar and less familiar items, there is less apparent difference between accessing frequent and non-frequent items than in store disorder.

d) Subordinate attribute knowledge is likely to be less affected; after obtaining the superordinate information, obtaining subordinate information should be not as much problem as it is in store disorder, because the representation would be still intact.

The validity of this distinction has been occasionally disputed (e.g. Rapp and Caramaza, 1993); however, these two patterns of semantic memory impairment in neurological disorders have achieved wide acceptance in the literature. For instance, when Hodges *et al* (1992) studied the semantic memory deficit in Alzheimer's disease, they found Alzheimer's disease to be a degraded store type disorder, consistent with the above-mentioned criteria.

This distinction has both theoretical and clinical implications. It can be used to gain a better understanding of the cognitive deficit in mental disorders, which can be compared with more fully characterised disorders of the central nervous system. A degraded store type disorder will imply loss of the representation, which means that interventions will be, to a large extent, damage limitation. And the best one can hope for is to prevent further loss of the representation. While in access type disorder the representation is intact, and interventions should target enhancing the access to the representation. Therefore, knowing the type of the disorder would be very useful in planning interventions in the rehabilitation of those patients to enable them to function at their optimal level. This can only be achieved after appreciating the nature and pattern of the cognitive deficit, which should form a vital part of any clinical assessment.

1.2 Cognitive deficits in Schizophrenia

In schizophrenia, it is well accepted that cognitive dysfunction is part of the clinical picture. Studies testing first-episode and antipsychotic-naïve patients have confirmed that cognitive deficit is a feature of schizophrenia, which is often present early in the

course of the illness (Sharma 1999). These important observations are not new, as difficulties with memory were reported as early as the beginning of the 20th century. However, there was no consensus on the nature of the deficit. Kraepelin (1913) noticed that ".. Memory, acquired knowledge and expertness remain sometimes fairly well preserved, sometimes they undergo considerable loss". Bleuler (1911) wrote, "… at times these patients forget and other times they know the same fact according to the circumstances involved. The actual amount of knowledge remains preserved, but it is not always available or it is employed in the wrong way". These controversial but important observations were under researched until recently.

The nature of the cognitive deficit gains importance as the pathogenetic mechanism of schizophrenia is far from clear. Woods (1998), in a review of published data on schizophrenia and relevant clinical and experimental studies of neurodevelopment and its disorders, argued for schizophrenia as a progressive neurodevelopmental disorder: there is moderate support for the prenatal developmental abnormalities and strong evidence against a classic neurodegenerative pathogenesis according to neuropathological studies. Therefore understanding the type of deficit and its stability will influence any hypothesis that attempts to explain the pathogenesis of schizophrenia. This is not to suggest that performance on neuropsychological tests will provide all the necessary answers. However, in the absence of clear consistent neurological findings, any similarity in its profile of cognitive impairment with that of other neurological disorders will, hopefully, improve our knowledge about schizophrenia.

On a different note, predicting outcome has been an area of extreme difficulty for both clinicians and researchers. Green (1996), in a review of studies that evaluated neurocognitive measures as predictors and correlates of functional outcome for schizophrenia, concluded: deficiencies in the areas of verbal memory and vigilance may prevent patients from attaining optimal adaptation and hence act as "neurocognitive rate-limiting factors". These factors are becoming more and more important with the move towards community care and the emphasis on quality of life. The last two decade witnessed the introduction of new medications (e.g. atypical antipsychotics) together with psychological interventions (e.g. Cognitive Remediation) aiming at improving cognitive function, in addition to treating other clinical symptoms. Obviously, a better knowledge of the nature of the deficit is essential for achieving that target. Hence, the field of cognitive functions in schizophrenia attracts attention and continues to be an area of active research as well as clinical interest.

1.3 Semantic memory deficit in Schizophrenia

The findings of Clare *et al* (1993), that semantic memory impairment is disproportionate to overall intellectual impairment in schizophrenia was supported by the finding of McKay *et al* (1996) that the level of impairment was approaching that's seen in a group of mild to moderate Alzheimer's disease patients. The first study used several cognitive tests for episodic and semantic memory in two samples, of schizophrenics and controls matched for age, sex, and estimated pre-morbid IQ. In the latter study, group analysis and a more detailed examination of two single cases suggested that semantic memory impairment represents a disproportionate and possibly specific neuropsychological deficit in schizophrenia.

An interesting finding was reported by Duffy & O'Carroll (1994) who, in comparing a group of schizophrenic patients with patients suffering from alcoholic Korsakoff's syndrome, found that although demonstrating superior episodic memory functioning, the schizophrenic sample were found to perform more poorly than the Alcoholic Korsakoff Syndrome sample on a test of semantic memory. This double-dissociation makes it difficult to consider the deficit as a part of general intellectual decline. Furthermore, the possibility of general intellectual decline would be an unlikely explanation, "...because cross-sectional studies have demonstrated that with schizophrenia, IQ is often only about one standard deviation below average" (McGurk 1999). These findings cannot be ignored if one wants to understand the cognitive deficit associated with this disabling disorder. Therefore, it is accepted that semantic memory deficits are a robust findings for Schizophrenia (Condray 2005).

There are psycho physiological evidences to support the observation of semantic memory deficit in schizophrenia. N400 component of the scalp-recorded event-related brain potential (ERP) was used extensively to study semantic memory in patients with schizophrenia compared to healthy controls. It provides an electrophysiological index of semantic memory activation that occurs prior to an overt behavioural response. The N400 regularly occurs within a time window of 250-500 ms post-stimulus onset and based on studies using intracranial recordings, reflects activity from multiple brain areas, including inferotemporal cortex, superior temporal sulcus, medial temporal lobe, hippocampus, and ventrolateral prefrontal cortex. N400 is viewed as a reflection of the ease with which access of long-term semantic memory occurs, with increase in N400 amplitude suggesting increased difficulty during semantic memory access (see Kutas and Fedemeier 2000). It was noticed that access of long-term semantic memory is

facilitated by previous learning experience and meaning in healthy individuals. Words that follow semantically associated words (apple – orange) are recognised more accurately and quickly than words that appear after un-associated words (apple- violin). This phenomenon is called semantic priming effect and clearly reflected in N400. The pattern typically observed for healthy individuals involves an enhanced N400 amplitude to semantically unrelated words compared to the N400 amplitude elicited to semantically related words (N400 unrelated>N400 related words). In contrast, the general findings for schizophrenia show a similar or equivalent N400 to semantically related and unrelated words (Condray 2005).

At a clinical level, and arising from attempts to account for the symptomatology of schizophrenia, suggestions have been made that abnormality of semantic memory may be relevant (McKenna *et al* 1994). These suggestions stem from the theory that schizophrenics have an abnormality of knowledge about the world (David and Cutting 1994). As the concept of knowledge is synonymous with semantic memory, what we have in schizophrenia has to be an impairment of semantic memory. Goldberg *et al* (1998), amongst others (Tamlyn *et al* 1992 and Mortimer *et al* 1995), suggested that it might be the case especially in thought disorder. Further evidence came from recent work on category fluency test in patients with schizophrenia (Sumiyoshi *et al* 2005) which suggested that semantic memory disorganisation may contribute to the symptoms of alogia in schizophrenia. In their study, Paulsen *et al* (1996) found that patients with non-paranoid subtypes displayed greater disorganization in their semantic memory than patients with paranoid subtype. These suggestions remind us of Cameron's (1939) observation when he wrote of "an inability to maintain the boundaries of the problem and to restrict their operations within its limits" describing

patients performance when they were asked to sort objects into groups. In spite of being considered part of the history of psychiatry rather than any significant value currently, the concept of over inclusiveness seems to have touched on a certain aspects of semantic memory that involved in abstract categorisation and concept formation.

1.4 Semantic memory deficit in Schizophrenia: access or store problem?

Following its development and application in Alzheimer's disease, the access/store dichotomy model has received research attention in schizophrenia. McKenna *et al* (1994) concluded that the application of neuropsychological methods suggests that impairment in schizophrenia is one of access to the semantic store. This study used a single case study design in a sample of four patients and the results were preliminary. In addition the conclusion was based on analysis of the results of one subtest (picture naming from the Hodges semantic memory battery). Hence, debate around the nature and characteristics of this deficit remains unresolved as it has been suggested that the semantic memory deficit in schizophrenia reflects degradation or loss of the representations, difficulty accessing intact representations and even semantic disorganization (Paulsen *et al* 1996; Vinogradov *et al* 2003).

1.4.1 Literature Review

One of the earliest accounts to study semantic memory in schizophrenia was by Koh and co-workers (Koh 1978). They studied the performance of young patients with schizophrenia in comparison with non-schizophrenia patients and healthy controls, on a

sorting task of items into groups with shared common features. The conclusion was that the impairment was minor and a reflection of the organising processes acting during the task. However, a later study by Tamlyn *et al* (1992) found marked deficit in semantic memory in schizophrenia. This study used the "Silly Sentences" Test of Collins and Quillian (1969) to a sample of sixty schizophrenic patients encompassing all grades of severity. In this test the subjects has to state whether each of fifty spoken sentences are true or false as quickly as they can. Further work in the field of semantic memory in schizophrenia was soon to follow aiming to identify the pattern of the deficit.

In a review of semantic memory and schizophrenia, influenced by the techniques and disciplines of cognitive neuropsychology, McKenna *et al* (1994) aimed to answer four important questions,

1 Is semantic memory impaired in schizophrenia?

2 Is the semantic memory impairment disproportionate to overall intellectual impairment?

3 Does semantic memory impairment in schizophrenia conforms to a recognised neuropsychological pattern?

4 Is there anomalous semantic memory function in schizophrenia?

They concluded that not all patients with schizophrenia show evidence of any neuropsychological impairment. When they do, however, there is good evidence that

semantic memory is affected along with other domains of function. They went on to suggest that the impairment is one of access to the semantic store. They acknowledged that ".it would be premature to claim that the positive and negative symptoms of schizophrenia might be explicable in terms of abnormal semantic memory; nevertheless, the idea of fundamental disorder of knowledge has considerable theoretical precedent and arguably not a little experimental support".

Following that review, studies reported rather inconsistent findings. For example Allen *et al*. (1993), and Joyce *et al*. (1996), conformed by suggesting that the difficulty is in accessing of representations rather than some disorder of the representation themselves. The two studies used category fluency test, comparing the performance of schizophrenics with controls. In the test used subjects were asked to generate as many items as possible from a certain category (e.g. animals) within one minute. While the first study looked at consistency across time (on five occasions), the second study looked at the effect of cueing on performance. However, the use of fluency task as the only measure for semantic memory raises questions regarding its specificity to semantic memory. This is because, in addition to semantic memory problems, additional and separate limitations may also inhibit fluency (Laws *et al* 1998). Bozikas *et al* 2005 also concluded that "disproportionately impaired category fluency test may be primarily due to organization and not to inefficient access to and retrieval from semantic store".

Spitzer (1999) reviewed his work and others of the priming effect in schizophrenia. To his surprise, there were several studies reporting increased semantic priming effect in thought-disordered schizophrenic patients. However, the non-thought-disordered schizophrenic patients showed the same priming effect as normal subjects on using the

same lexical-decision task. In the framework of network models of semantic memory, these results were interpreted as further evidence for an increase in activation and speed of the spreading of associational activation in thought-disordered schizophrenic patients. The fact that schizophrenic patients perform, on the priming issue, similar to controls (or even better performance in thought-disordered patients!) can be considered further evidence in support of the access disorder theory.

One potential issue concerning many of these studies is their reliance upon the use of a single criterion to determine the nature of the deficit: for example consistency (Allen *et al* 1993); priming (Spitzer *et al* 1993); or cueing (Joyce *et al* 1996). Others have relied upon group designs (e.g. Allen *et al* 1993; Joyce *et al* 1996; Spitzer *et al* 1993; Vinogradov *et al* 1992) that may hide a multitude of individual patterns of performance. Laws, McKenna, & Kondel (1998) argued that reliance upon single criterion can be misleading because patients may show the converse profile on a different criterion: for example, a patient with poor naming may show consistency across time or modality (suggesting that access is fine) yet benefit from cueing (suggesting that access is compromised); and similarly group analyses will obscure potentially important individual differences (see also Storms *et al* 2003 a, b for a discussion).

Laws *et al* (1998), using the same proposed model but different neuropsychological test (face naming test), found heterogeneous performance pattern pointing to access disorders in some patients and store disorder in others. They found that the difference between the two patterns of performance strongly correlate with quantitative differences in patient deficit-severity. The notion of deficit severity was suggested as an

explanation, rather any qualitative difference affecting the pattern. Earlier, a study by Mortimer *et al* (1995) of acute patients described a general deficit of access but identified an additional store deficit in a small number of the more severely ill patients. The first study used four criteria but a single test, while the second used a cross sectional method (looking at the performance at one point in time); therefore the generalisability of their conclusions might also be limited.

Laws *et al* 2000, in a study using Graded Naming Test, found the majority of chronic schizophrenic sample (twenty two) showing storage disorder pattern while access disorders alone occurred in a small minority. This pattern was emerging according to two of the above-mentioned criteria (consistency and word frequency). They found the sample performance was disproportionate to their intellectual level, according to the National Adult Reading Test (NART) IQ (Nelson 1982), and comparable in degree and type to the naming problems found in neurological patients with left hemisphere lesions. Further evidence in support of the storage deficit theory came from a study of Rossell & David 2006, when they used three criteria (consistency, frequency and priming) in multiple semantic processing tasks in schizophrenia. However, Al-Uzri *et al* 2004 suggested that the deficit is one of access type having used also three criteria (consistency, frequency, and cueing). It also identified naming to description test as one of the best discriminators, amongst semantic memory tests, between patients and controls. This study used a semantic memory battery but the sample was rather small (n=12), hence it is difficult to generalise its conclusions.

It is obvious that while there is little or no doubt on the existence of a semantic memory deficit in schizophrenia, the debate around the nature of the deficit is yet to settle.

Therefore, there was a need for a study provides the required answers on the nature of semantic memory in schizophrenia by avoiding the limitation of the reviewed previous studies. The study should include a battery of tests, an adequate and representative sample, and tests across time.

2 THE STUDY

This was a study of semantic memory in a cohort of patients suffering from schizophrenia. All patients' performances were compared with that of healthy controls. In addition, the study examined the correlates of semantic memory with clinical and demographic variables. A subset of patients was tested twice to be able to study performance across time.

Three of the four criteria mentioned-above were used to determine if the impairment, if any, is one of access or store. They were found to be strong discriminators between the two types of the impairment. In addition, according to Shallice (1988), whether item frequency is a satisfactory criterion for differentiating the two types of impairment remains an unresolved issue. Therefore, this criterion was not used in this study.

2.1 AIMS

This study is structured to answer two questions:

1- Is there a semantic memory deficit in this sample of patients with schizophrenia?

2- What is the type of semantic memory deficit in schizophrenia (According to Warrington and Shallice criteria), and its correlates?

2.2 HYPOTHESES

I. There is a semantic memory deficit in patients suffering from schizophrenia.

II. The deficit is likely to be an access type disorder in this cohort of patients.

2.3 METHOD

2.3.1 Subjects

Although this is not an exactly epidemiological study in its strict definition, every effort was made to make sure that the sample collected was as representative as possible of patients with schizophrenia Therefore, every patient with a possible diagnosis of schizophrenia was identified from psychiatric records in one area of approximately 100,000 people in South Leicestershire. This included examining old records of all psychiatric patients in the area to make sure no potential patient was missed. Their diagnosis was confirmed using ICD-10 criteria (WHO 1992). The area can be described as a suburban British residential area with a majority of middle/working class population. The two consultants responsible for the area have a policy of not discharging schizophrenic patients from their care even if they need minimal psychiatric input. The only exceptions were those who suffer from a severe and incapacitating form of schizophrenia that necessitated a referral to rehabilitation psychiatry. Those patients usually move out of the area into long-term care units or sheltered accommodation.

Patients excluded were those with organic brain disease, head injuries, co-morbidity, and whose first language was not English. None of the participants had ECT in the year prior to taking part in the study. Patients with age greater than 60 years were also excluded as Kelly *et al* (2000) suggested that older people (over 60 years of age) with schizophrenia show a poorer cognitive performance than younger patients. The

patients' performance on the memory tests was compared with that of controls (n=71). The controls live in the same city and were recruited by adverts in the local hospital, university and supermarkets. They had no history of mental illness, and share the same exclusion criteria with patients.

One hundred and ninety patients were identified of whom 133 were potentially eligible. Of those not eligible, two did not fulfil strict diagnostic criteria for schizophrenia, one died before testing, five had a diagnosis of substance misuse, eight had a history of organic brain disease/head injury, thirty were over age 60 years, and for eleven English was not their first language. Of the 133 eligible patients, 60 declined to take part, leaving a total of 73 (55%) patients who were eligible and volunteered to take part in the study (Figure 1). All patients who took part in the study were stable and living in the community except one who was an inpatient at the time of the study.

The known socio-demographic and clinical characteristics of patients who participated in the study were compared with those who did not take part (table 1). Those characteristics included; age, gender, years in education, accommodation, employment status, medication prescribed, age of onset, length of inpatient stay and illness duration. There were no significant differences between the two groups except for years in education where the participants in the study had more years in education. The participants were slightly older, on average, at the age of onset but this difference did not reach significance.

Table 1

Comparison between Patients who Participated and those Refused to take part in the study.

	Participants (N=73)	Refused (N=60)		
	Mean (S.D)	Mean (S.D)	t	p
Age (yrs)	39.4 (11.7)	40.3 (9.6)	-.50	N.S
Age illness onset (yrs)	27.2 (7.9)	25.7 (7.3)	1.7	N.S
Illness duration (wks)	669 (545.6)	752.9 (427.5)	-.94	N.S
Inpatient stays (wks)	185.7 (322.7)	217 (208.3)	-.61	N.S
Education (yrs)	13.6 (2.7)	12.23 (2.5)	2.96	.004
	Participants	Refused	X^2	p
Gender M:F	42:31	35:25	0.01	N.S
Accommodation*	17:18:27:10:1	21:11:18:7:3	4.21	N.S
Employment**			10.03	N.S
Anticholinergics Yes:No	27:46	22:37	0.25	N.S
Antipsychotic treatment***	37:24:8:4	29:22:6:2	0.09	N.S

* Accommodation = independent: with partner: with parents: supported: residential.

** Employment = Standard Occupational Classification 2000 as numbered in Table 1

***Antipsychotic treatment = atypical: typical: mixed: antipsychotic free

As shown in Table 2, the participating patients were 31 females and 42 males, and the controls were 33 females and 38 males. There was a small but statistically significant difference in age (t=2.48, df= 142, p=0.014) and NART (t=-2.49, df= 132, p=0.014) between patients and controls. These differences were not clinically significant.

Table 2

Comparison between Patients and Controls demographics

	Patients (N = 73)	Controls (N = 71)	Inferential Test statistics	p
Gender M:F	42.31	38.33		N.S
Age(yrs),mean (S.D)	39.4(11.7)	34.4 (12.4)	2.48	0.014
NART, mean (S.D)	112.7 (6.6)	115.5 (6.4)	-2.49	0.014

2.3.2 Measures

The semantic memory battery (appendix 1) used was developed by John Hodges to test people with neurological disorders (Alzheimer, Huntington, and stroke patients). This battery has the ability to test the semantic memory in different modalities (verbal and visual) using the same items, so it was possible to look for consistency across tests as well as across time. In addition it has the ability to test processing of information and stimuli from different modalities to provide answers, both verbally and non-verbally. This battery was used on at least one occasion to test semantic memory in schizophrenia.

The patients were tested on five tests of Hodges Semantic Memory Battery, on two occasions. There was a period of six to eight months between the two interviews. This battery of tests, three of which (picture naming, picture sorting, and word-picture matching) are employing one consistent set of stimulus items, and designed to assess input to and output from central representational knowledge about the same group of items by a different sensory modality. Each test contains the same 48 items chosen to represent 3 categories of animals (land animals, sea creatures and birds; n=24) and 3

categories of man-made items (household items, vehicles and musical instruments; n= 24) the items were matched on the basis of prototypicality within each category. That is to say, for each semantic category, exemplars were chosen to represent the range from highly prototypical (e.g. desk, guitar, lion), to atypical (e.g. rocking chair, French horn, racoon). The items were chosen from the corpus of line drawings by Snodgrass and Vanderwart's black and white line drawings. The five tests used were:

1. Category fluency: subjects were asked to generate as many items as they can from the category of animals in one minute.

2. Picture naming: subjects were asked to name all of the 48 line drawings without cueing on the first interview. On the second interview a cueing paradigm was used. Firstly semantic information about the item was given and if failed, secondly subjects were given the first letter of the name of the item.

3. Picture sorting: this task was designed to test superordinate and subordinate knowledge about the test items, which could be expressed by the subject non-verbally. A matching –to-sample sorting technique was employed at three levels in the hierarchy of semantic knowledge,

    a. Level one: living versus man-made.

b. Level two: in living domain (land animal versus bird versus water creatures) and in the non-living domain (house hold items versus vehicles versus musical instrument).

c. Level three: this was limited to the twelve land animals for which knowledge was tested in certain area (native to Britain versus foreign) and the twelve household items for which knowledge was similarly tested in a parallel area (electrical versus non-electrical).

Subjects were first asked to sort the same 48 cards used in the naming test into one pile for those items, which are living, and another for those that are man-made. Then subjects were given the 24 living items and asked to sort them into the appropriate category (land animal versus bird versus water creature) followed by the 24 man-made items, which were to be sorted into one of 3 possible categories (household item versus vehicles versus musical instrument). Finally subjects were given the pictures of the same 12 land animals given before, and they were asked to sort them according to their different binary attributes (native to Britain versus foreign). Followed by the 12 household items which they were similarly asked to sort according to different attributes (electrical versus non-electrical). Cards bearing a written indication of the sort criteria (e.g. living and man-made, etc.) were displayed in front of the subject during each task.

4. Word- picture matching (category comprehension test), subjects are presented with picture arrays consisting of six items from the same category (e.g. land animals) and asked to point to the items named by the

examiner .The subjects viewed the same 48 items used in the previous two tests. The test sequence is consistent across subjects and is arranged so that one from a different category follows each item.

5. Naming to description, on this test the subjects were given a description of 24 different living and man-made items and were asked to give the name of the item .18 of these 24 items were present amongst the 48 items used in the previous 3 tests. In the second interview a cueing paradigm was used which consist of the first letter of the name of the item only.

Subjects were also assessed on the following measures:-

A The Rivermead Behavioural Memory Test (RBMT) (Wilson *et al*, 1989), which is a test of everyday memory with good ecological validity, is made up of 12 measures that are each aimed at testing one aspect of everyday memory:

(1) Remembering a name (2) Remembering a hidden belonging (3) Remembering an appointment (4) Picture recognition (5) Immediate recall of a newspaper article (6) Delayed recall of a newspaper article (7) Face recognition (8) Remembering a new route- immediate (9) Remembering a new route-delayed (10) Delivering a message (11) Orientation questions (12) Knowing the date.

The RBMT has a screening score (0-12), and it is not very demanding in terms of effort or time (takes 25-30 minutes to administer). It has been used before in schizophrenia studies (e.g. McKenna *et al* 1990, Kelly *et al* 2000);

B The National Adult Reading Test (NART) which is an estimate measure of pre-morbid intelligence (Nelson, 1982). It has been widely used in the psychiatric literature, and in particular schizophrenia studies (e.g. Gilvarry *et al*, 2001);

C The Schedule for Assessment of Positive Symptoms (SAPS) and The Schedule for Assessment of Negative Symptoms Scale (SANS), which was given to patients only. It is widely used scale for symptom ratings in schizophrenia (Andreason and Olsen 1982);

D Health of the Nation Outcome Scale (HoNOS), which is used for assessment of psychiatric patients' current community functioning (Wing *et al*, 1998);

E Demographic dates for all subjects were documented, including occupation group using the office for national statistics classification (Table 3);

Table 3 **Standard Occupational Classification 2000 (From the Office for National Statistics)**	
Number	Occupational Group
1	Managers and Senior Officials
2	Professional Occupations
3	Associate Professional and Technical Occupations
4	Administrative and Secretarial Occupations
5	Skilled Trades Occupations
6	Personal Service Occupations
7	Sales and Customer Service Occupations
8	Process, Plant and Machine Operatives
9	Elementary Occupations
10	Unemployed

In addition, duration of illness and age of onset for the patients were documented through information provided by the patient and verified against medical records including first documentation by General Practitioners. Duration of illness was defined as the period between time of first psychotic symptoms reported and the time of current assessment. Age of Onset was defined as the age when first psychotic symptoms were reported.

A psychologist administered the cognitive assessments independently from the clinical assessment. The patient's answers were recorded and they were not given the right answers at any stage or test. The responsible consultants (JB and SF), assessed the patients' level of community functioning using the HoNOS, were blind to the cognitive assessment. Illness duration and age of onset was calculated independently (DM).

During the two interviews I rated the patients clinically using the SANS & SAPS. In addition I obtained detailed history from the patients and their medical notes. A brief version of the history was documented which included level of education, medication and current social circumstances.

Ethical committee approval was obtained prior to approaching patients. The patients identified with the help of the responsible consultant, who informed the patients about the study. Patients were given information sheet and were encouraged to ask questions about the study. They were advised to discus the study with their General Practitioner and family. After giving verbal consent they were asked to sign consent form prior to testing.

2.3.3 Statistical analysis

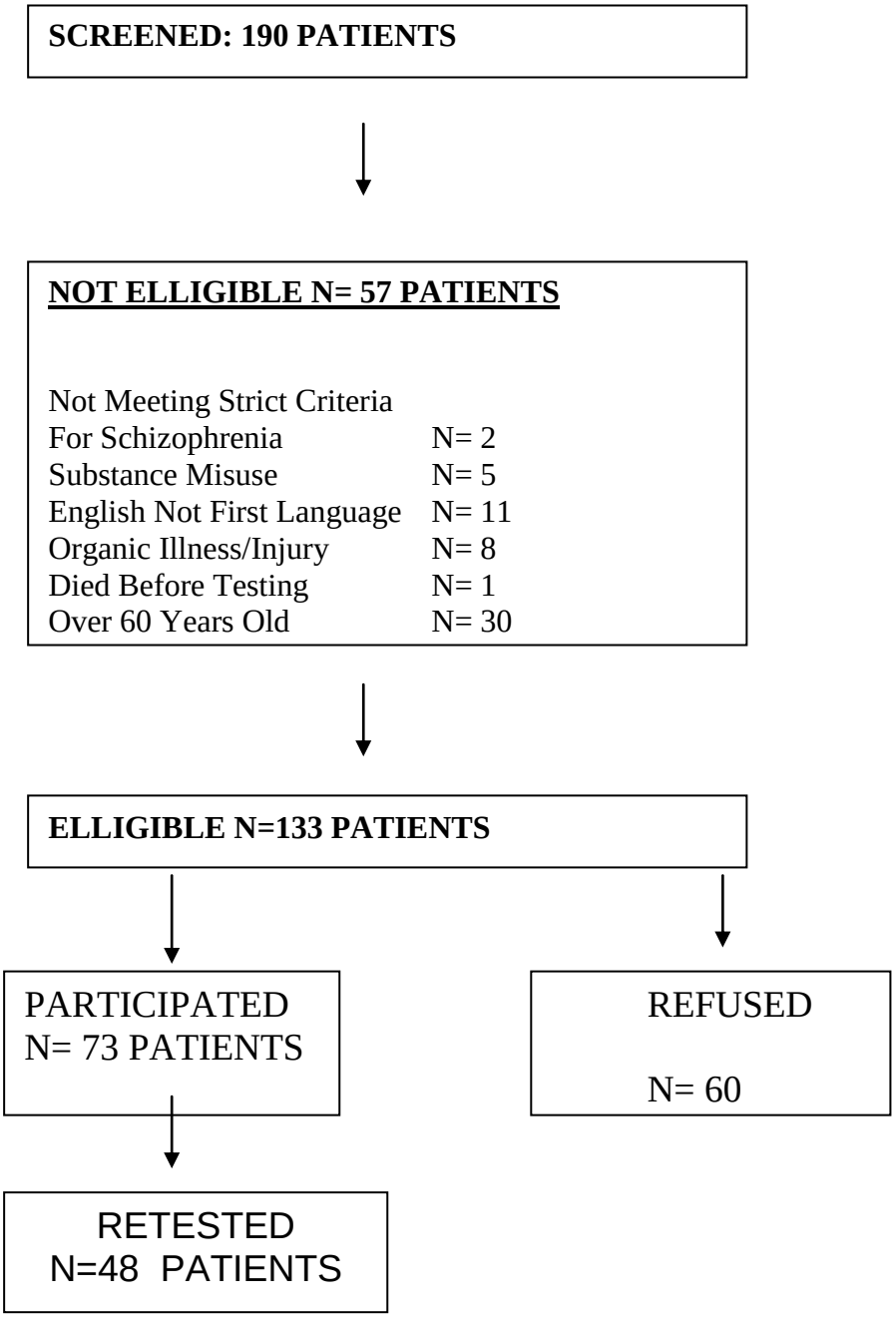
Sample size was calculated to achieve statistical power of 80% possibility of obtaining significant results at 5% when submitted for ethical committee approval. Differences between patients and controls were examined by *t*-test or Chi-square, as appropriate, for demographic variables; RBMT scores were examined by logistic regression; within groups differences were examined using ANOVA; correlations were examined using Pearson's *r* or Spearman's rho as appropriate. The Statistical Package for the Social Sciences (SPSS), was used to analyse the data.

3 RESULTS

Studies comparing the semantic memory performance of schizophrenic patients with controls often include normal control groups whose performance is at or near ceiling. Even after carrying-out nonlinear transformations of data, it may be inappropriate to use typical parametric analyses with the kind of data typically obtained in this category specific literature i.e. heavily skewed distributions, unequal variances across groups, and/or multiple zero errors for controls. Hence, it is important to explore atypical strategies of data analysis as well as typical parametric analysis to a) see what difference it would yield in outcome, and b) address different questions of this study (extent of the deficit and its correlation versus its nature). Therefore, initial typical parametric analysis was conducted to examine differences between patients and controls and patients performance according to the criteria for differentiating between access and store disorder. This was followed by atypical strategies of data analysis to examine in a robust way the correlation with different variables.

As per Figure 1, 73 patients and 71 controls took part in the study. At the follow-up visit (6 months later), every attempt was made to invite subjects to come back for the second assessment. They were sent appointments and contacted by phone if available but only 48 patients and 47 controls took part in the assessment. Those who did not attend the second assessment gave no specific reason for that but a very small number moved out of area.

Figure 1. Flow chart of patients' selection for the study.



3.1 Typical Parametric Analysis

a. Comparing performance of patients (n=73) with controls (n=71) at the first interview

As a group, and using the t-test [Table 4],

1) Category fluency test: patients performed worse that controls (mean=17.37 ± 5.06 vs. 21.97 ± 5.95; t= 4.98, $p < 0.001$).

2) Picture naming test: patients performed worse that controls (mean=45.22 ± 2.27 vs. 46.18 ± 5.95; t= 2.8, $p = 0.006$)

3) Category Comprehension (Word-picture matching) test: Patients performed worse than controls but it did not reach statistical significance (mean=47.70 ± 0.64 vs. 47.87 ± 0.44; t= 1.9, $p = 0.06$).

4) Naming to description test: patients performed worse that controls (mean=20.25 ± 3.76 vs. 22.25 ± 1.66; t= 4.17, $p < 0.001$).

5) Picture sorting test:

- Level one: there were no significant difference in performance on this task between patients and controls (mean= 47.97 ± 0.16 vs. 47.97 ± 0.16, t= 0.028, p = 0.978).

- Level two: patients performed worse than controls (mean= 45.23± 2.1 vs. 46.21 ± 1.54, t= 3.19, p = 0.002).

- Level three: there were no significant difference in performance on this task between patients and controls (mean= 22.84 ± 1.08 vs. 23.00 ± 1.01, t =0.94, p=0.35).

Table 4

Scores for schizophrenic patients and controls on the semantic memory battery at the first interview

Test	Patients (N = 73)		Controls (N = 71)		p	t
	Mean	S.D.	Mean	S.D.		
CATEGORY FLUENCY						
	17.37	5.1	21.97	5.9	<0.001	4.98
PICTURE NAMING						
Total Correct (48)	45.22	2.27	46.18	5.95	0.006	2.8
CATEGORY COMPREHENSION (WORD-PICTURE MATCHING)						
Total Correct (48)	47.70	0.64	47.87	0.44	0.06	1.9
NAMING TO DESCRIPTION						
Total Correct (24)	20.25	3.76	22.25	1.66	<0.001	4.17
PICTURE SORTING						
Level 1 (48)	47.97	0.16	47.97	0.16	0.978	0.028
Level 2 (48)	45.23	2.1	46.21	1.54	0.002	3.19
Level 3 (24)	22.84	1.08	23.00	1.01	0.35	0.94

b. Comparing performance of patients (n=48) with controls (n=47) at the second interview

As a group, and using the t-test [Table 5],

1) Category fluency test: controls performed better than patients (mean=23.04 ± 5.46 vs 18.46 ± 6.75; t = 3.63, p<0.01). [figure3]

2) Picture naming test: patients on average did marginally worse than controls but it did not reach statistical significance (mean=46.00 ± 1.8 vs. 46.60 ± 1.5; t = 1.7, p=0.09).

3) Word-picture matching test: both groups performed very well, (mean=47.73 ± 0.6 Vs 47.94 ± 0.04; t =1.9, p=0.06).

4) Naming to description test: patients performed worse than controls (mean=20.94 ± 3.02 vs. 22.26 ± 1.7 ; t= 2.6, p = 0.01)

5) Picture sorting test, [Figure 2]

   - Level one: there were no significant difference in performance on this task between patients and controls (mean= 48 ± 0.0 vs. 48 ± 0.0).

   - Level two: patients performed marginally worse than controls (mean= 46.00± 1.57 vs. 46.62 ± 1.4, t= 1.99, p = 0.049).

   - Level three: there were no significant difference in performance on this task between patients and controls (mean= 22.90 ± 1.08 vs. 23.21 ± 1.01, t =1.22, p=0.22).

Table 5

Scores for schizophrenic patients and controls on the semantic memory battery at the second interview

Test	Patients (N = 49)		Controls (N = 48)		p	t
	Mean	S.D.	Mean	S.D.		
CATEGORY FLUENCY						
	18.46	6.75	23.04	5.46	0.00	3.63
PICTURE NAMING						
Total Correct (48)	46.00	1.8	46.60	1.5	0.09	1.98
CATEGORY COMPREHENSION (WORD-PICTURE MATCHING)						
Total Correct (48)	47.73	0.6	47.94	0.04	0.06	1.9
NAMING TO DESCRIPTION						
Total Correct (24)	20.94	3.02	22.26	1.7	0.01	2.6
PICTURE SORTING						
Level 1 (48)	48.00	0.00	48.00	0.00	ns	0.0
Level 2 (48)	46.00	1.57	46.62	1.4	0.049	1.99
Level 3 (24)	22.90	1.08	23.21	1.01	0.22	1.22

c. Comparing patients performance across the two interviews

The results of the patients' scores can be divided into three subcategories according to the criteria used to analyse the results. In addition, Patients' symptoms were assessed using the Scales for the Assessment of Negative Symptoms and Positive Symptoms (SANS and SAPS, respectively; Andreasen & Olsen 1982).

3.1.1 Consistency

Comparing patients' performance at the first and second interviews, using paired sample T-test, the results were as follows,

1. Category fluency test [Table 6]: there were no significant differences between patients' performance at the first interview (n=73) (mean = 17.37±5.1) and the second interview (n=48) (mean = 18.46 ± 6.7), (p= 0.48). Controls followed a similar pattern, where performance at first interview (n=71) was not statistically different from second interview (n=47) (mean=21.97±5.9 vs. 23.04±5.4, p=0.67).

Table 6
Comparison between Category Fluency Test Score on Test 1 and Retest for Patients and Controls

	Patients Test 1 (N = 73)	Patients Retest (N = 48)	t	p
Mean Category Fluency Test	17.37 (5.1)	18.46 (6.7)	-0.7	0.483
	Controls Test 1 (N=71)	Controls Retest (N=47)	t	p
Mean Category Fluency Test	21.97 (5.9)	23.04 (5.4)	-0.42	0.673

2. Picture naming test [Table 7]: there was slight improvement, but statistically significant, in patients' performances at the second interview compared with the first interview (mean = 46.00±1.8 vs. 45.22±2.27, t=2.6, p= 0.01). Controls

showed no difference in performance between first and second interview (mean = 46.34±1.7 vs. 46.61±1,5, t=1.01, p= 0.27).

Table 7
Comparison between Picture Naming Test Scores on Test 1 and Retest for Patients and Controls

	Patients Test 1 (N = 73)	Patients Retest (N = 48)	t	p
Picture Naming Test Mean (SD)	45.22 (2.27)	46 (1.8)	-2.6	0.01
	Controls Test 1 (N=71)	Controls Retest (N=47)	t	p
Picture Naming Test Mean (SD) (N=47)	46.34 (1.7)	46.6 (1.5)	-1.01	0.27

3. Picture sorting test: [Table 8]

- Level one: there were no significant differences between patients' performances at the two interviews (mean=48 vs. 48, P = 0.322). Similar pattern was observed in controls (mean=48 vs. 48, P = 0.16).

- Level two: there were small but statistically significant differences between Patients' performances at the two interviews (mean = 45.23±2.1 vs. 46±1.5, t=1.97, P = 0.05). However, no differences were observed in controls (mean = 46.21±1.5 vs. 46.6±1.4, t=1.4, P = 0.17).

- Level three: there were no significant differences between patients' performances at the two interviews (mean=23±1.0 vs. 22.9±1.5, P= 0.53). Similar pattern was observed in controls (mean=23±1.0 vs. 23.2±0.9, P = 0.17)

Table 8

Comparison between mean scores on a Category Sorting Test on Test 1 and Retest for Patients and Controls

	Patients Test 1 (N = 73)	Patients Retest (N = 48)	t	p
Mean Total Category Sorting Score	116.03 (1.9)	116.94 (2.2)	-2.07	0.04
Level 1	47.97 (0.16)	48.0	-1.0	0.322
Level 2	45.23 (2.1)	46 (1.5)	-1.97	0.05
Level 3	23 (1.0)	22.9 (1.5)	-0.62	0.53
	Controls Test 1 (N=71)	Controls Retest (N=47)	t	p
Mean Total Category Sorting Score	117.2 (1.9)	117.8 (1.8)	-1.91	0.62
Level 1	47.97 (0.1)	48.0	-1.43	0.16
Level 2	46.21 (1.5)	46.6 (1.4)	-1.4	0.17
Level 3	23 (1.0)	23.2 (0.9)	-1.4	0.17

4. Word-picture matching (category comprehension) test [Table 9]: there was no significant difference in patients' performances between first and second interview (mean=47.7±0.6 vs. 47.73±0.6, p=0.58). However, there was a very small but statistically significant difference in controls' performance between first and second interview (mean=47.87±0.4 vs. 47.94±0.4, t=2.3, p=0.02).

Table 9

Comparison on a Category Comprehension test for Patients and Controls on Test 1 and Retest

	Patients Test 1 (N = 73)	Patients Retest (N = 48)	t	p
Category comprehension Mean (SD)	47.7 (0.6)	47.73 (0.6)	-0.55	0.58
	Controls Test 1 (N=71)	Controls Retest (N=47)	t	p
Category comprehension Mean (SD)	47.87 (0.4)	47.94 (0.4)	-2.3	0.02

5. Naming to description test [Table 10]: there were significant differences between patients' performance in the first interview and that of the second (mean = 20.25±3.76 vs. 20.94±3.0, t=1.69 p = 0.01) [Figure 4]. However, no significant difference in controls' performance between first and second interview (mean=22.23±1.7 vs. 22.26±1.7, t=-0.09 p=0.92) [Figure 5].

Table 10
Comparison on a Naming to Description test for Patients and Controls on Test 1 and Retest

	Patients Test 1 (N = 73)	Patients Retest (N = 48)	t	p
Naming to Description Mean (SD)	20.25 (3.76)	20.94	1.69	0.01
	Controls Test 1 (N=71)	Controls Retest (N=47)	t	p
Naming to Description Mean (SD)	22.23 (1.7)	22.26 (1.7)	0.09	0.92

6. On comparing performance across tests; using paired sample T-test,

- Picture naming versus word-picture-matching tests (number of shared items=48), showed significant differences in both of the interviews. In the first interview: mean=45.22 vs. 47.70, p=0.001. In the second interview, and in spite of improvement in picture naming test's performance, there was still significant difference (mean=46 vs. 47.73, p=0.003).

- Picture naming versus category sorting (level one) tests (number of shared items = 48), showed significant difference in the first (mean=45.22 vs. 47.97, $p<0.001$) and the second (mean=46 vs. 48.0, $p=0.002$) interviews.

3.1.2 Attribute Information

To make it possible to compare means of different levels of Category Sorting test's score, as the total number of items per level differs between levels, each level's mean score was converted to percentage. There were significant differences between patients' performance at level one (mean percentage=99.95% and 100%) and level two (mean percentage= 94.38% and 95.83) at the first ($p<0.001$) and second ($p<0.001$) interviews respectively. However there was no significant difference between their scores on level two and level three at the first and the second interviews (level three mean percentage =95.30% and 95.42% respectively).

The pattern was similar in controls; there were significant differences between performance s on level one and level two for the first interview (mean percentage= 99.4% vs 96.41) and second interview (mean percentage= 100% vs 97.12%). Also no significant differences were found between level two and three at both first and second interviews (level three mean percentage=95.99% and 96.70% respectively).

3.1.3 Cueing effect

- Picture naming test: using paired sample T-test, patients performed significantly better after Cueing on the second interview compared to performance at the second interview

without Cueing (mean=47±1.2 vs. 46±1.8, t=6.03, p<0.01) [Figure 2]. Controls showed similar benefit from Cueing (mean=47.17 ±1.0 vs. 46.6±1.5, t=5.02, p< 0.001) [Figure 3].

Figure 2

Picture Naming Test mean score for Patients, On Test 1 and Retest Before and After Cueing

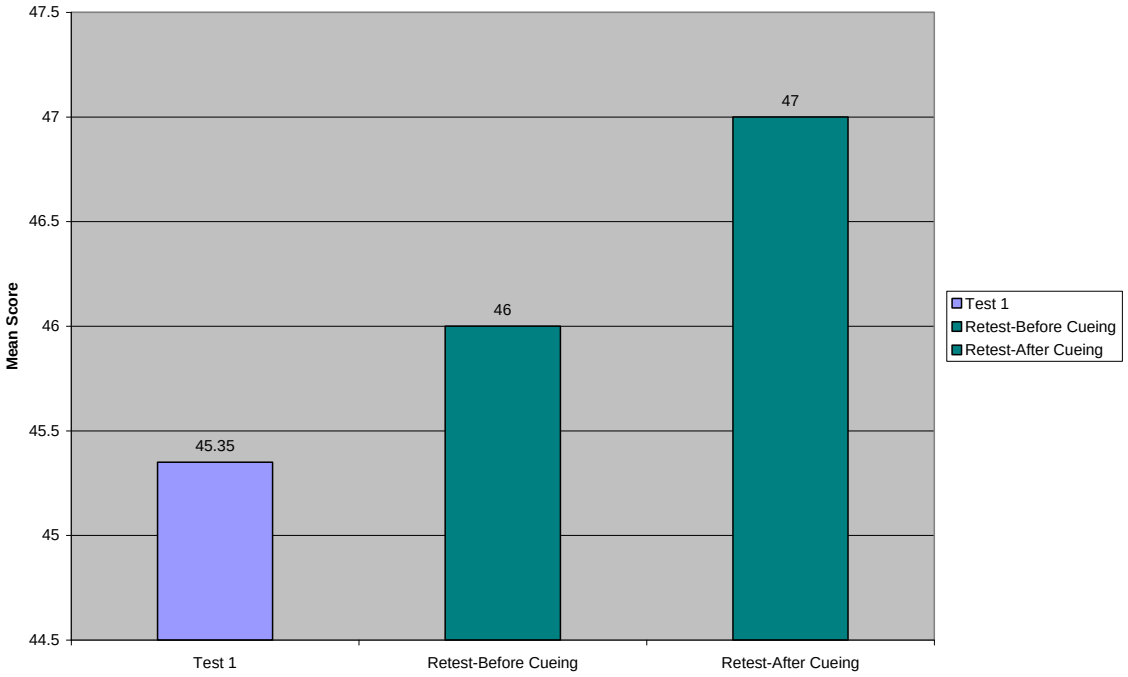
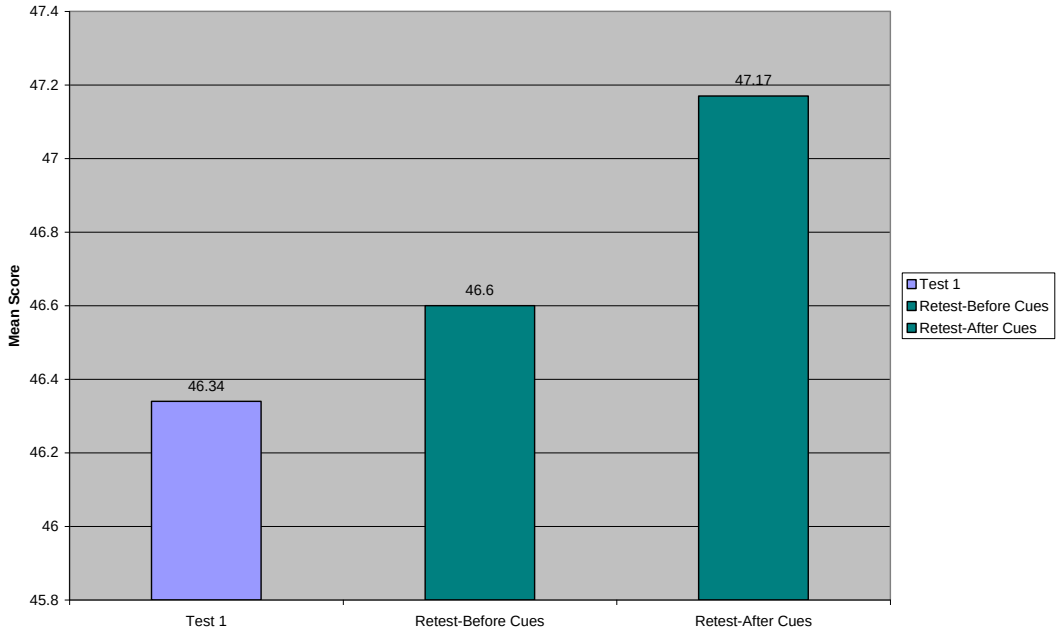


Figure 3

Picture Naming Test mean score for Control Subjects, On Test 1 and Retest Before and After Cueing



- Naming to description test: using paired sample T-test, patients performed significantly better after Cueing on the second interview compared to performance at the second interview without Cueing (mean=22.52±2.1 vs. 20.94±3.0, t=5.83, p< 0.01) [Figure 4]. Controls showed similar benefit from Cueing (mean=23.32±0.8 vs. 22;26±1.7, t=5.02, p< 0.01) [Figure 5].

Figure 4

Naming to Description Test mean score for Patients, On Test 1 and Retest Before and After Cueing

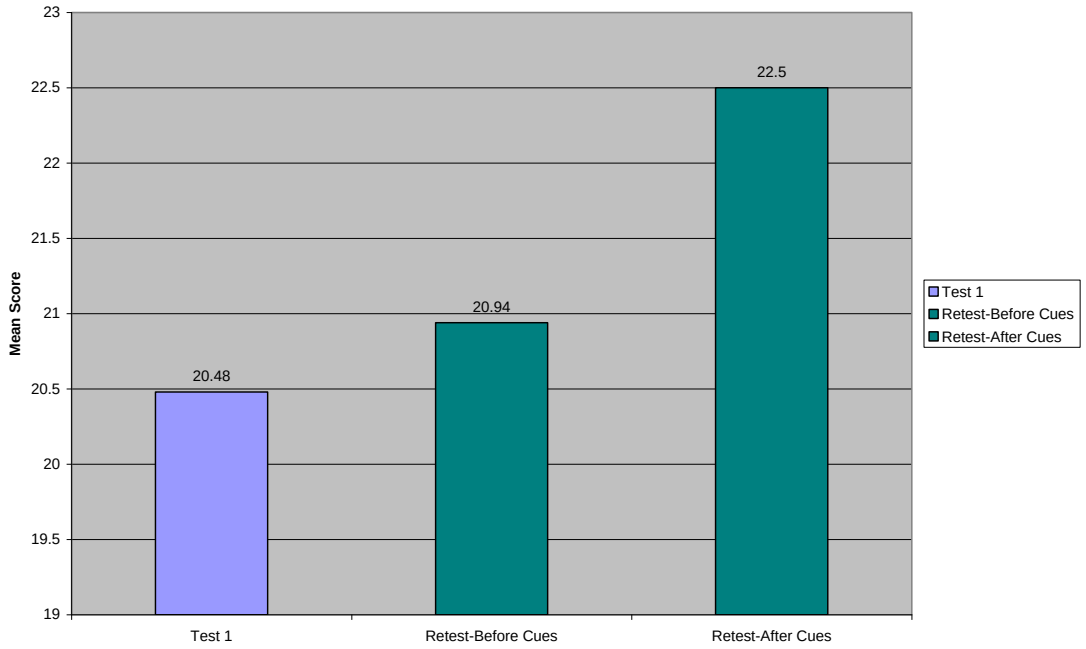
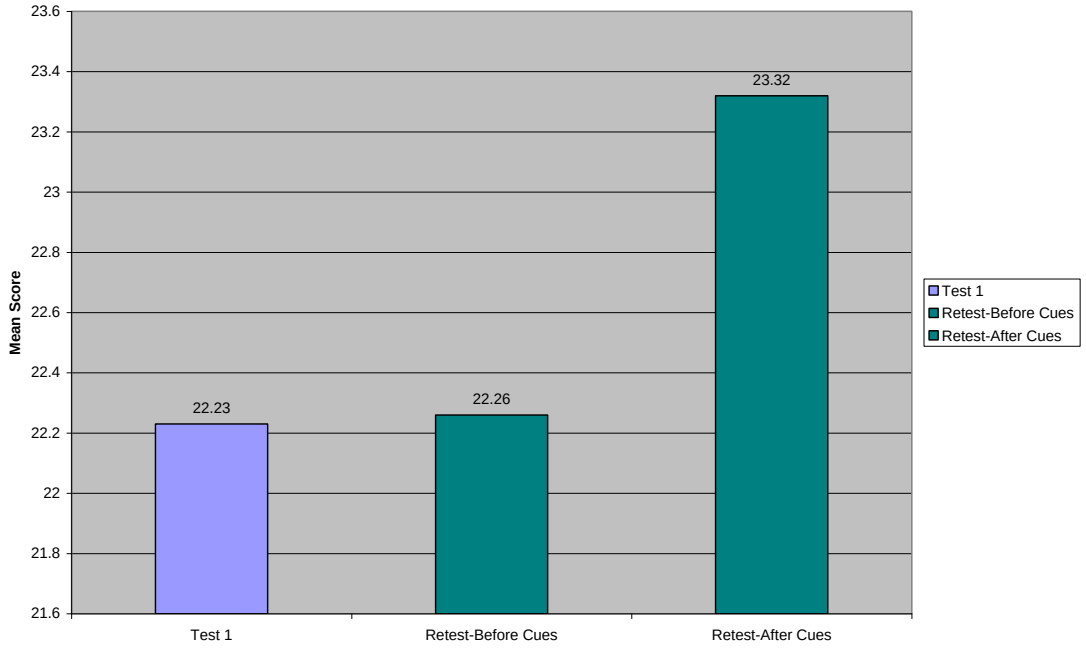


Figure 5

Naming to Description Test mean score for Control Subjects on Test 1 and for Retest Before and After Cueing



3.1.4 Clinical Rating

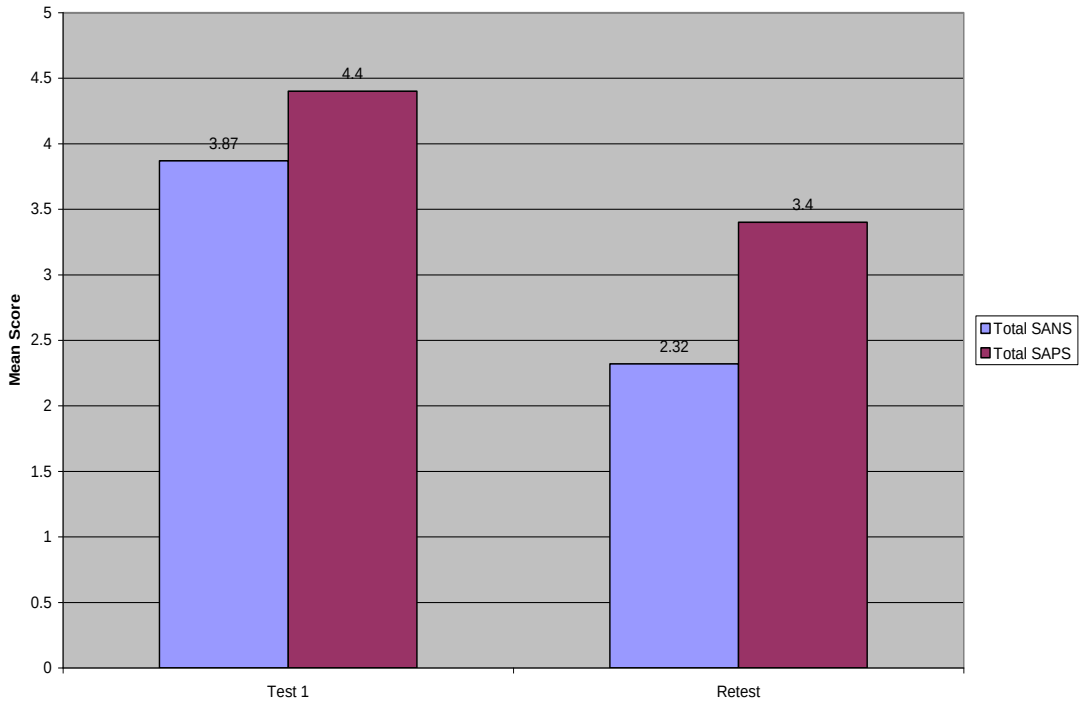
The Schedule for Assessment of Positive Symptoms (SAPS) and The Schedule for Assessment of Negative Symptoms Scale (SANS) were used to assess patients' symptoms [Figure 6];

- SAPS mean score was significantly higher at the first interview (mean=4.4, S.D. = 3.0) compared to the second interview (mean = 3.4, S.D. = 3.8) (t= 2.56, p = 0.014).

- SANS mean score was significantly higher at the first interview (mean=3.87, S.D. = 4.9) compared to the second interview (mean = 2.32, S.D. = 3.9) (t= 3.1, p = 0.003).

Figure 6

Mean Total SANS and SAPS Scores on Test 1 and Retest



3.2 Atypical Analysis

Bootstrap methods comprise one alternative set of methods for dealing with data with abnormal distributions. Bootstrap methods require far fewer assumptions than traditional parametric tests regarding data distributions and are advisable in circumstances where many zero data points occur (e.g. controls scoring very highly or patients very lowly: see Deluchhi & Bostrom, 2004). With bootstrap techniques, a relevant test statistic (*t* or *F* etc) is chosen to determine whether a difference in group means is significant for the original data. The same statistic is then computed for the *n* bootstrap samples i.e. *n* permutations of the original group data. When this occurs *with replacement*, a data point goes back into the sampling pool and may be redrawn numerous times. After many permutations, this results in a distribution of test statistics (rather than data points). The value of the original statistic is then compared to this new distribution and declared statistically significant at, for example, the 0.05 level, if it is among the most extreme 5% of cases. Hence bootstrap methods may be applied to data collected using traditional stimuli (even when ceiling effects are present).

The means and standard deviations for patients and controls are presented in Table 4 & 5. It is notable that, as with all previous studies using this battery, controls performed many tasks at or near ceiling (picture naming, naming-to-description, category sorting and category comprehension).

Skewness and kurtosis statistics (g_1 and g_2) were computed for the healthy controls and patient data. Further, D'Agostino- Pearson omnibus test for normality, which uses both g_1 and g_2 as input, was calculated to determine if the distributions differed significantly

from normality. As Table 11 shows, all distributions, except category fluency for controls, deviated highly significantly from normality. Therefore, bootstrap methods were used because they make far fewer assumptions about the distribution of the responses (e.g. Deluchhi & Bostrom, 2004), followed by ran of a series of bootstrap ANCOVA analyses (using education, NART IQ and age as covariates).

Table 11
Data distribution for Controls

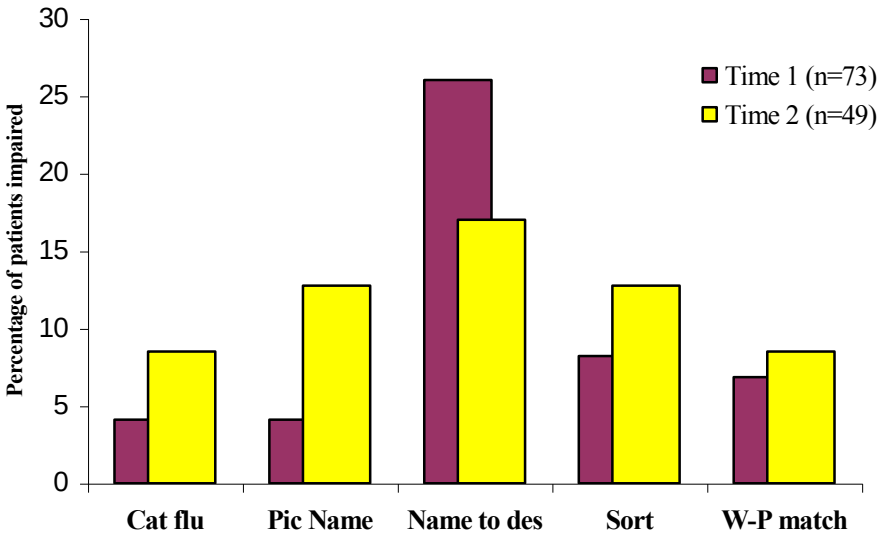
	Skewness g_1	**Kurtosis g_2**	***D'Agostino-Pearson Omnibus test K^2***	***p***
Category Fluency	0.2	-0.2	0.94	.62
Picture naming	-1.4	2.3	23.9	<.0001
Naming to description	-1.8	4.500	36.5	<.0001
Category sorting	-0.8	-0.01	7.8	.02
Word-Picture matching	-4.6	25.3	101.8	<.0001
Data distribution for Patients				
	Skewness g_1	**Kurtosis g_2**	***D'Agostino-Pearson Omnibus test K^2***	***p***
Category Fluency	0.7	1.3	9.8	.007
Picture naming	-1.4	2.9	26.9	<.0001
Naming to description	-2.6	9.5	61.6	<.0001
Category sorting	-1.4	3.2	27.7	<.0001
Word-Picture matching	-2.3	4.9	46.9	<.0001

The adjusted means for all comparisons are presented in Table 1 & 2. This created 1000 bootstrap samples, each equal in size to the original sample, by randomly re-sampling with replacement from the original patient data. For each bootstrap sample, an observation was selected at random to be included in the sample and then made available to be selected again for that same sample. Therefore, a bootstrap sample may contain several copies of one data point and none for another data point. Then, for each of the 1000 bootstrap samples, the statistic (in this case F for ANCOVA) is recomputed and a distribution of *test statistics* is created. This distribution of results is then compared to the original result and declared significant if it is amongst the most extreme 5%.

In this context, the data was re-analysed using randomization re-sampling techniques (compared to initial analysis of standard parametric analyses). Five ANCOVA analyses were run for each of the semantic memory tests (Category fluency, picture naming, naming to description, picture sorting and word-picture matching). There were significant differences between patients and controls performance on Category fluency test at time 1 ($F=15.3, p<.01$) and time 2 ($F=10.4, p=05$). There were significant differences on Naming to description test at time 1 ($F=8.7$,$p=.03$), but not at time 2. However, there were no significant differences between patients and controls performances on the remaining tests (picture naming, category sorting and category comprehension) at time 1 or 2. The differences between patients and controls were demonstrated in Figure 7.

Figure 7

Percentage of patients scoring below the 5th percentile of the control sample



3.2.1 Correlation with demographics

Analysis of the correlations within the patient group reveals that performance on each of the five semantic memory tests was inversely related to the degree of negative symptoms, but not significantly related to positive symptoms [Table 12]. As might be expected some semantic tests were related to the NART IQ measure and all five tests were significantly related to the level of education in the patients.

Table 12.

Correlations between semantic tasks and background variables

	NART	**Current Age**	**Age at onset**	**Illness duration**	**Education**	**SAPS**	**SANS**
Category Fluency	0.23	-0.24	-0.20	-0.09	0.51***	0.24	-0.27*
Picture naming	0.47***	-0.01	0.04	0.03	0.29*	-0.10	-0.34*
Naming to description	0.46***	-0.09	0.25	-0.02	0.35**	-0.14	-0.33*
Category sorting	0.37**	-0.05	0.10	-0.08	0.31*	-0.14	-0.46***
Word-Picture matching	0.25	-0.27*	-0.35**	0.07	0.27*	0.11	-0.43***
Probability 2-tails : * - .05 ** - .01 ***. -.001							

3.2.2 Follow-up testing and change across time

Forty-eight patients and 47 healthy controls were retested on the same semantic battery after 6 months. The change scores for patients between time 1 and 2 were examined to see if they showed any differential change across time when compared to the change scores for controls. Again, randomization techniques were used because of the small amounts of change and because of the possibility of ceiling effects. This revealed no significant differences in the change of performance shown by patients and controls on any tasks.

3.2.3 Change in performance and change in symptom ratings for patients

Re-sampling correlations were used to examine the relationship between change in performance across time and change in symptom score (SAPS +SANS) across time. This approach holds the scores constant on one variable (symptoms) and then randomly reshuffles the second variable (semantic variable) 100,000 times. It then determines the number of reshuffles that exceed the correlation for the actual data and thus the likelihood of it occurring by chance (or at least in 100,000 reshuffles).

This revealed significant correlations for naming-to-description (r=-0.46, *p*=.002) and for category fluency (r=0.29, *p*=.05); however not for picture naming (r=0.02, *p*=.85), picture sorting (r=0.10, *p*=.50), or word-picture matching (r=0.13, *p*=.41). In other words, the change in symptoms only corresponds with a change in semantic performance on the naming to description task (as symptoms improved, so did naming-to-description and semantic fluency). It is interesting to compare with picture naming, where the correlation was non-significant and almost non-existent (being superseded by 85,236 reshuffles of the data compared to only 156 for naming to description; 4988 for semantic fluency).

4 DISCUSSION

4.1 Methodology

This is the first study, to my knowledge, that attempted to examine semantic memory in a community-based population of patients with schizophrenia. It also has the largest sample size of reported studies of semantic memory in schizophrenia. The exclusion criteria were designed so that patients disadvantaged in terms of cognitive functions were not included to provide more conservative estimate of the level of impairment. This is based on the assumption that people with co-morbidity, organic brain disorders, and whose first language is not English might present with impairment which is not necessarily related to the disorder studied (Schizophrenia). In addition, the patients who did not consent to take part in the study shared almost all demographic and clinical characteristics with those who participated in the study. Therefore, this study can be considered as the closest to a prevalence design when taking all methodological obstacles facing studies of cognitive functions into consideration.

The prevalence of schizophrenia in the study population (1.9 per 1000) is towards the lower end of what is expected (1.4- 4.6 per 1000 population, Jablensky, 2000). This could be explained by the demographic characteristics of the catchment area. As a suburban district, it is more likely to have a lower prevalence of psychotic disorders compared to city centres, which are associated with higher morbidity in general (Mortensen *et al,* 1999). In addition, patients who develop schizophrenia might well migrate towards the city centre, especially when they need supported or hostel accommodation, which is most likely to be available in city centre. This was

particularly the case in this study as patients who needed rehabilitation services and supported accommodation were moved outside the catchment area.

The patients who took part were relatively young, have low level of symptoms as evidence by their scores on symptoms rating scale (SANS & SAPS), living in the community and with no documented co-morbidity. The exclusion criteria were also designed to avoid any disadvantaged patients in terms of age and language. Except for participants having spent on average less years in education, there were no significant demographic or clinical differences between patients who took part in the study and those who declined. The control group were from the same population and matched for gender. There were some statistically significant differences between patients and controls but these were not clinically significant.

This is a prospective study, which looked into performance of a cohort of patients, on a battery of cognitive tests, and across time. I conducted all clinical assessments and that should increase inter-rater reliability. The diagnosis of schizophrenia was checked, according to ICD-10 criteria, clinically as well as with the case notes. The patients were in a stable mood during the interviews and were motivated to take part in the study. This was evident in their performance as none of them performed badly on all the tests, which should be the case if a patient was in a disturbed mood or lacking motivation. This is a common explanation that was provided for patients' impaired performance on cognitive assessment. The exclusion criteria made sure that this cohort of patients and controls' performance is not influenced by neurological abnormalities or dependent substance misuse.

The findings of this study are consistent with previous ones which reported semantic memory impairment in schizophrenia. In addition, this study was able to quantify this impairment and its correlation to symptoms profile. It also addressed an important methodological issue which is the ceiling effect. This study provides evidence that there are components of the semantic memory that is more affected by the illness than the others. In particular, category fluency and naming to description are more affected than others such as comprehension. This is in support of previous report that naming to description might be an early marker for semantic memory impairment in schizophrenia (Al-Uzri *et al* 2004). This test examines the patient ability to process information and then retrieve stored information. The impairment identified suggests that the processing of the information or/and retrieval of information might be impaired.

The effect of medication on performance was not studied specifically. Patients were performing differently across tests and time; some of them performed at ceiling levels across the battery, and some on some of the tests. Whether the medication has a non-specific effect was not very clear, but would be unlikely in view of inconsistency of performance across tests. If medication has any effect it would be, probably, enhancing performance, because schizophrenic patients in McKenna *et al* (1994) performed worse than this study's patients on the same battery. However, such a claim would be premature, as there are other variables involved (such as severity and chronicity of the illness).

In this study, the battery used has many advantages, being comprehensive and tests different perceptual modalities as well as information processing (categorisation, comprehension, …etc). McKenna *et al* (1994), wrote "The experimental investigation

of semantic memory has almost exclusively devoted to a study of simple concepts like dog, animals, fruit, and vegetable and the relationships between them", this battery was no exception but it covered a wide range of items from essential items in our every day life to a less familiar items. The items were carefully chosen to reflect different abilities and interests. The first edition of this battery included a generation of verbal definitions test; however, in this study it was replaced by naming to description test. It was felt that the latter was easier to administer and the answers can be rated more accurately, being a single word, which gives a better reliability to the rating, in other words, correct or incorrect answer. In addition, it provides opportunity for a direct comparison with picture naming. Definition generation test gives good idea of the subject thought processes, but it involves a judgment by the interviewer, which can be sometimes debatable.

In addition, there has been some shortening of some of the tests, for instance on the verbal fluency test, the patients where asked to generate the names of as many animals as they can in one minute. In the original version of the tests, subjects were asked to generate names from several other categories (e.g. birds, sea creatures, household items, vehicles …etc.). The reason for the shortening was to make it easier for the patients to be tested and the fact that category fluency test is not an exclusive test of semantic memory. This shortening might have reduced the possibility of picking a deficit in semantic categories other than animals.

The only possible addition that this comprehensive battery might benefit from is a sentence verification test, in which a statement (like a " a dog is a bird") showed to a subject, who then has to respond true or false and the time taken for the response would

be recorded. This test was used in the past (Tamlyn *et al* 1992, Clare et al 1993, Rossell *et al* 1998) and was very useful in identifying the difficulties schizophrenic patients have in their semantic memory. Another minor point would be changing the "kettle" item, from the 'non-electrical' category, into a less controversial item as electrical kettles are widely used.

There were also methodological issues which needed addressing,

1. Patients and Controls were matched in terms of gender and other demographic variables. However, controls were of statistically significant younger age and higher NART IQ. On close examination, these differences were not clinically significant and they were corrected for in the analysis using robust statistical methods (ANCOVA with re-sampling technique).

2. It is difficult to be confident about possible practice effect in this study as, for most tests, patients performed near to ceiling effect and there were limited significant differences across both interviews. This may suggest no or very little practice effect is evident, which could be due to the nature of the tests as it gives the patient no hints or clues to whether they have produced correct or incorrect answers at any stage, time or test of the battery. The battery tests the subjects knowledge about certain items, which either they have it or not. And during the period between the two tests there was no contact between the patients and the examiner, and the patients had no access to the test data or the correct answers. However, in few of these tests (Naming to description test, Picture naming test, and Level two of Picture sorting test) there were significant statistical

improvement between performance in first and second interview. The reason for that is not very clear as it could be practice effect but in Naming to description test, which is the most significant test, the difference across both interviews was related to improvement in symptoms rating (SANS score). Therefore, it is possible that practice effect has, if any, very limited role in the improved performance of patients on some tests of this semantic memory battery across time.

3. Controls, to a larger extent, and patients both performed at ceiling level on most of the tests. This is not unusual as studies comparing the semantic memory performance of schizophrenic patients with controls often include normal control groups whose performance is at or near ceiling. This raises challenges in terms of analysis strategies used. Therefore, it was necessary to explore typical and atypical analysis strategies when examining and reporting the data. This approach has helped demonstrate the different outcome associated with each analysis, as well as provide possible explanation for the variability of results of previously published studies about semantic memory in schizophrenia.

It can be argued that the use of a T-test has shown what might be considered a rather misleading significant difference between patients and controls. This is supported by examining the performance on individual tests for patients and comparing it with controls, which showed that about a quarter of patients performed in below 5^{th} percentile zone compared with controls. Furthermore, atypical analysis (re-sampling technique) limited the significant differences to two tests (Category fluency test and Naming to description test).

Paired sample T-test was used in comparing performance of the patients at the first and second interview. That was because the comparison is between performances of the same sample on two occasions. T-test was also used to study the cueing effect, again for the same reason.

When comparing semantic memory battery results with that on episodic memory test for the same sample it would be reasonable to conclude that the extent of semantic memory impairment is less than that of episodic memory (see Al-Uzri *et al* 2006).

4.2 Results/Summary

Patients' test results were significantly worse than those of the comparison group in two out of five tests (category fluency test and Naming to description test). However, performance on the rest of the tests was at a ceiling level for patients and the comparison group. Therefore, the findings of this study are in support of the argument that patients suffering from schizophrenia may have semantic memory deficit but may not be as extensive as some earlier studies reported (see McKenna *et al* 1994). This could be due to differences in the sample characteristics as well as symptoms profile.

The performance on semantic memory correlated inversely significantly with negative symptoms score but not positive symptoms score. In addition, improvement in symptoms score was associated with improvement in the two most discriminating tests (naming to description and category fluency tests).

On the question of the type of deficit (whether it is store or access) and according to Warrington and Shallice criteria, the following points were observed:

1. Consistency: there were significant differences in performance of some of the tests of the battery across time. They were specifically in picture naming, Level two of Picture sorting test, and naming to description. Performance, more significantly, was inconsistent across tests which share same items but accessed utilising different modalities. There were significant differences between performances on the picture-naming test and that on category sorting, and word-picture matching tests at both first and second interview. This would be in support of the view that patients has difficulty in accessing semantic information rather than a disorder of store, at which we would expect a picture of consistent deficit across modalities.

2. Attribute information: there was no significant difference between performances at level two and three, but there was significant difference between performance at level one and level two. A different pattern was noticed in degraded store disorder (see Hodges et al 1992). Therefore, the results on this point can be interpreted as in support of an access disorder.

3. Cueing effect: there was significant improvement with cueing in both tests used (picture naming test and naming to description test) at the second interview. These results provide the clearest of evidence in support for an access type disorder.

a. Comparison of patients and controls

In the first part of the results, the comparison between the comparison group and the patients on the first interview performance was analysed. The results confirming previous reports of the presence of semantic memory deficit in schizophrenia but limited to mainly two tests; naming to description and category fluency tests.

In category fluency, patients were on average producing fewer items from the animal category compared to comparison group, which is consistent with reports from previous studies (Allen *et al* 1993, Joyce *et al* 1996). It's worth mentioning that usually in verbal fluency tests subjects are asked to generate as many items as they can from several categories giving one minute for each category, therefore, semantic memory problems may constrain fluency performance but other and separate limitation may play a role (Laws *et al* 1998). Therefore the impairment on this test alone should not be considered as an evidence of semantic memory deficit, but rather an indicator of a possible such impairment.

Naming to description test can be considered as a test of processing information presented to one perceptual modality (auditory). The test involves semantic processing at different attributions levels, depending on the information provided and previous knowledge. This test has been used in schizophrenic patients before and probably was the most difficult test in this battery. In this study performance on this test showed the greatest of differences between patients and controls. This

is very much in support of the theories that schizophrenia, in general, is an impairment of the knowledge of the world as well as in processing that knowledge (McKenna *et al* 1994). That is to say that the problem is in the way the knowledge is used. For instance what meaning schizophrenic patients adhere to the words they read and hear. Therefore, the naming to description test is a useful tool in assessing semantic memory and separate controls from patients suffering from schizophrenia. That is not to say that it should be used in diagnosing schizophrenia, but it can be used to identify the area of the cognitive deficit and its relation to psychopathology. It is of significance that at the second interview patients' performance improved and the significant difference disappeared when using atypical analysis technique. This is particularly important as the improvement was associated by improvement in negative symptoms score, which provide evidence for link between the two. The importance of this association is that it may represent a therapeutic target and outcome measure.

The performance of the patients on the picture-sorting test is different from earlier reports on difficulties schizophrenic patients encounter when given sorting tasks (Chen *et al* 1995, Koh 1978, Rossell *et al* 1998). Patients performed at ceiling level and comparable with controls when using atypical analysis. This is also contrary to previous report (see Al-Uzri *et al* 2004), and this could be due to difference in sample characteristics as well as analysis technique. Patients were more able to categorise items at level one (living items vs. non-living items) than the other two levels (e.g. level two; household items vs. vehicles items and Level three; electrical vs. non-electrical). However, there was no significant difference between patients' performance at level two and level three. The pattern was

similar in controls in terms of differences between different levels of attribution, as controls also performed significantly better at level one than at level two and three. Different findings were noticed when Hodges *et al* (1992) used the same test in Alzheimer's disease patients: the gap were bigger between performance at level one and level two, and performance got worse at level three. This is an early indication that semantic memory problems in schizophrenia are different in pattern from that in Alzheimer's disease.

It's interesting that patients and controls performances on the picture naming test were comparable when using atypical analysis. The use of atypical analysis was necessary as the data was skewed, as described earlier. This is also different from previous reports of studies used the same battery (McKenna *et al* 1994). Several previous studies reported that schizophrenic patients have difficulty on different naming tests (Laws *et al* 1998, McKay *et al* 1996). So why should there be no significant difference between those studies, keeping in mind all these tests were using same items? There are two explanations for this observation; first; there is a difference sample characteristics as McKenna *et al* (1994) sample included older and more chronically ill patients than the sample in the study. The second possibility is that type of analysis was different in previous studies compared to this one. However, it is also possible that both reasons contributed collectively to the difference in results reported in this study and that of previous ones.

On the word-picture matching test, there was near ceiling performance for both controls and patients. Because the distracters were from the same semantic category, this task is a relatively stringent name recognition task demanding use

of semantic knowledge within semantic memory in order to differentiate close exemplars. Probably this was the easiest test, and that might be so because it involved visual recognition (picture) of the item aided by auditory cue (name). This test, in spite of failing to show significant differences, has important implications. It confirmed that this cohort of patients has no subtle neurological abnormalities or perceptual defect preventing them from understanding what is requested from them. It was used in a previous study of semantic memory in Alzheimer's disease when the patients performed significantly worse than controls (Hodges *et al* 1992). This is another evidence that semantic memory deficit in Alzheimer's disease is different from that in schizophrenia. Therefore, and because the deficit in the former is one of storage, it would be reasonable to conclude that it's not a storage deficit in the latter. This is a very important point, which will be discussed in the second part of the results when the nature of semantic memory deficit in schizophrenia is addressed.

In McKenna *et al* study (1994), schizophrenic patients performed significantly worse than controls on all the tests of Hodges semantic memory except for one (word-picture matching test). The patients in the current study performed significantly worse, than the comparison group, on only two tests from the Hodges semantic battery. Furthermore, patients' mean scores in the current study were better than the mean scores of McKenna *et al* patients (except naming to description because they did not use it). The sample tested by McKenna *et al* was described as being non-elderly schizophrenics, hospitalised with chronic severe illness, while the sample in this study was more community based and independent. This difference would bring the issue of deficit severity mentioned

earlier (Laws *et al* 1998) back. This means that the type of deficit seen in schizophrenia might be related to the severity of the disorder and would indirectly highlight the importance of semantic memory in contributing to the overall picture of patient ability to live and function independently.

The finding that neurocognitive deficits in schizophrenia (Green 1996) can be a predictor of future functioning provides a very useful tool in identifying patients' needs and accordingly plan interventions. Semantic memory impairment represents, arguably, a lot of potential to be a "neurocognitive rate-limiting factor" in schizophrenia preventing patients from obtaining their optimal level of functioning. In the absence of previous work, this field promise to be an area of significant interest and fruitful research.

The question of why some patients with schizophrenia exhibit semantic memory deficit while others do not, is a challenging one. It is beyond the scope of this study to answer such a question, however, one cannot help thinking about it. The first thought that comes to the mind is that the most established characteristic of schizophrenia is that it is clinically heterogeneous. Clinicians find no problem in diagnosing schizophrenia, in a significant minority, in the absence of hallucinations that is in spite of the fact that it has no great bearing on the outcome. Therefore, one should not be surprised to find that not every patient with schizophrenia exhibit semantic memory deficit. This brings back the ultimate question that went, possibly, through the minds of every clinician and researcher; will there be a day when this umbrella that called schizophrenia unveil into more than one disorder? The work of Liddle (1987) and Andreason *et al* (1995) on the

syndromes and dimensions (respectively) of schizophrenia are an obvious examples of how seriously this question been taken. Both of them included thought disorder, which several studies suggested an association with semantic memory abnormalities, in their description of disorganisation syndrome/dimension (one of the three syndromes/dimensions they both proposed). Therefore, semantic memory deficit might not present in every patient suffering from schizophrenia, but only exhibited in association with certain clinical symptoms. This supported by the finding of this study when the association was significant with negative symptoms score but not with positive symptoms score.

Whether the cognitive deficit in schizophrenia is the primary psychopathology or secondary to other psychopathological processes is not very clear. However, it is well recognised that it is part of the clinical picture from the early days of the illness (Sharma 1999). In addition, suggestions were made that memory impairment (both newly acquired and remote information) is not underlined by deficit in attention (Kenny & Meltzer 1991). In this study, the fact that patients are not failing all of the tasks suggests a characteristic pattern rather than a generalised deficit. This is very much in line with McKay *et al* (1996) suggestion that semantic memory impairment in schizophrenia represents, possibly, a specific neuropsychological deficit.

This kind of deficit (semantic memory deficit) can provide a potential area of research to help coming up with evidence whether schizophrenia is a neurodevelopmental disorder or an element of degeneration also present. The

neuropathological studies provide strong evidence against a classic neurodegenerative pathogenesis of schizophrenia. Clinically, schizophrenia is obviously different from Huntington's or Alzheimer's disease, which are examples of neurodegenerative diseases. However, imaging data provide strong evidence that excessive brain volume loss occurs after maximum brain expansion and equivocal evidence that it continues after onset of overt illness (Wood 1998). If the deficit in semantic memory is stable and not progressive it will be in support of the, currently dominant, neurodevelopmental theory of schizophrenia. However, if it proved to be progressive, serious questions will be asked about the validity of this theory.

After identifying a semantic memory deficit in schizophrenia, obviously the next step should be studying the nature of this deficit. There were some indications from the first part of the study that the deficit can be in certain areas of semantic memory, i.e. recall of semantic information (category fluency test) and processing of information (naming to description test). However, a better understanding of the nature of this deficit, whether store or access, should be achieved by reviewing the second part of the results of this study.

b. Correlation of semantic memory

It is notable that overall patients scored rather low on the symptoms rating scale used (SANS & SAPS), which could be interpreted as indication of the severity of the illness they were experiencing at the time of the study. This indicates semantic memory impairment exists that even with low level of symptoms, albeit the impairment might not be as severe as that reported in some previous studies.

Patients' symptoms rating score was reduced significantly at the second interview compared to the first interview. This was true for both negative and positive symptoms. It is not very clear why this improvement in symptoms across time. However, there is a possibility that, like what happens in many research projects, patients receive additional attention that might contribute into better detection of needs and improved intervention during the period of the study. It was beyond the scope of the study to answer this specific question. More relevant, the study examined the relationship between symptoms change and semantic memory in this sample.

An interesting finding, which has not been reported before, is the inverse association between negative symptoms and performance on semantic memory battery. This would suggest that negative symptoms and semantic memory might share some underlying mechanism or substrate. This is further supported by the improvement of negative symptoms in association with improvement on two semantic memory tests (category fluency and naming to description tests) across the two times of testing. This is in line with previous reports of correlation between negative symptoms and cognitive dysfunction in schizophrenia. This study provides the potential to have a quantifiable measure of negative symptoms through the use of some of the tests used. In particular, category fluency and naming to description tests have the potential to provide another objective source for assessing negative symptoms that can validate clinical rating and vice versa.

The association between semantic memory and years in education and pre-morbid IQ (NART) might be expected, but not a finding that has been reported widely

before. It is important as one of these variables (years in education) is modifiable in a way that can enhance semantic memory by increasing years in education. This can be viewed as an important preventative measure to reduce the risk of one the deficits associated with schizophrenia.

c. Nature of the deficit

On the consistency point, comparison between performance of the patients at the first and second interviews showed that performances were significantly better at the second interview on two of the tests: picture naming and naming to description test. These are examples of inconsistency of performances across time and in support of access type disorder.

On the category fluency test, there were differences between the first and the second interviews performance but failed to reach significance. These findings are consistent with Allen *et al* (1993) reports that schizophrenic patients produce fewer items in subsequent testing; they found that the number of shared words (between different trials) is less than that of controls, but the number of variable words (i.e. different words in each trial) is equal to that of controls. These findings suggest that schizophrenic patients have the same word pool as controls and no loss of lexical knowledge, but patients exhibited inefficient search (i.e. impaired access) through that pool.

With regard to word picture matching test, there was no significant difference between the first and the second interview performers. The obvious explanation for this finding is that ceiling effect which was reached on both occasions. As

mentioned earlier when Hodges *et al* (1992) used this test on Alzheimer's disease patients, they performed significantly worse than the same controls. And as the semantic memory deficit in Alzheimer's disease is one of store disorder, it would be reasonable to conclude that the deficit in the patients of this study is at least not a store disorder.

There was significant difference between first and second interview only on level two of the three levels of picture sorting test. The performance has improved, however, picture sorting test performance was designed not to study consistency, but to study the criterion of superordinate and attribute information because it tests the core structure (categorisation) of semantic memory. This might made this test less sensitive to changes across time.

Inconsistency between performances on different tests, which uses similar items, would also support the access theory. This was evident on performance on three tests of the battery (Picture naming, Picture sorting and Category comprehension tests), which share the same 48 items. This would suggest that the information is stored as some level but recalling this information would depend on the way it was accessed and also could be a reflection of the ease, or difficulty, with which information accessed. Off significance was that patients' performance was not significantly different than controls, using robust analysis, and was similar in pattern which would also support the access disorder theory.

On the attribute information point and specifically on picture sorting test, patients' performance was rated on percentage rather than number. The reason for that is:

level one and two has 48 items while level three has only 24 items. Patients performed significantly better at level one (living vs. non-living) comparing to levels two (e.g. land animals vs. birds) and three (e.g. native animals vs. foreign animals, to Britain) at both interviews. These findings fit neatly with Shallice (1988) description of the difference in depth of processing between access and store disorders, he wrote "For both types of impairment, it should be easier to obtain the superordinate category than to identify the item" and "Once the superordinate has been obtained, the type of impairment should differ in the ease with which attribute information can be accessed". That was also consistent with the finding reported when Hodges *et al* (1992) applied this test on their cohort of Alzheimer's disease patients. They performed significantly worse than controls and the gap between their performance at level one and levels two and three was greater than the one found in this study. Furthermore, performance was further worse on level three comparing to level two on the former study, while there was no significant differences in performance between levels two and three in the current study. These findings are also suggestive that the disorder is one of access in this cohort.

Cueing is the third criterion of the access/store dichotomy, which was examined in this study. Patients' performance improved significantly when a cueing paradigm was introduced in picture naming and naming to description tests at the second interview. The theory proposes that in access disorder the information exist, but accessing it is not always possible. Therefore, cueing would act as an enhancing technique to access this information. Obviously in store disorders no benefit can be obtained from cueing, as the information is lost. The finding of

significant effect of cueing on the performance of this cohort of patients is again in support of an access disorder theory.

The overall picture, in this cohort, makes access disorder as the most likely possibility of the two types, according to Warrington and Shallice criteria. However, inconsistency here is the issue rather than improvement according to the criteria. By definition, in degraded store disorder; performance can only be the same or worse especially if the disorder was a progressive one on all the tests.

The findings of this study are in support of previous suggestions that the semantic memory deficit in schizophrenia is one of access type (Allen *et al* 1993, Joyce *et al* 1996, McKenna 1994). However, there have been several studies suggesting that it might not be the case (Mortimer *et al* 1995, Laws *et al* 1998 and in press). There are possible explanations for these different suggestions:

One of the criticisms of access-degraded store dichotomy is that it is a theoretical distinction, and there are patients who can meet the criteria for both of the disorders. This might be an example of such a limitation, which was addressed by Shallice (1988). This point takes further strength from previous work suggesting a degraded store type, and specifically Laws *et al* (1998) when they reported mixed picture of access and store type disorder. They suggested that the concept of access-store dichotomy might be misleading, and went on to introduce the notion of "deficit severity". They proposed that access-store dichotomy may not be a dichotomy but a dimension and underlying this dimension is deficit severity.

These important suggestions might be considered that it challenges the access-store theory at two levels:

Firstly, it challenges its validity and applicability, but that can be easily refuted as the concept was applied successfully in Alzheimer's disease (Hodges *et al* 1992).

Secondly, it challenges its application in schizophrenia, and this need addressing more carefully, because the presence of both disorders does not necessarily undermine the whole access-store theory. One can recall that Laws *et al* (1998, in press) made their suggestions out of using one test, and as mentioned in the introduction no single test can cover the complex structure and processes of semantic memory. Therefore, the results might reflect some aspect of the semantic memory system, but it does not tell the whole story. For instance, the latter study looked into the naming deficit, which in spite of its importance is not the whole of semantic memory. This is why in this study a battery of different tests was used to avoid the limitation of using a single test. In addition, the samples were different at least in age and years in illness. And this is where "deficit severity" can be a very useful notion as an adjunct to explain the different findings reported in several studies, rather than an alternative. That is to say, that both types of disorders might exist (access and store) but they are influenced by deficit severity.

The mechanism by which both disorders (access and store) exist can be explained through Neuroplasticity (the capacity of the brain cells to adapt continually to the demands placed on it by experience). Spitzer (1999) discussed

this phenomenon in the context of " neural network model" of semantic memory. As mentioned in the introduction, human beings acquire information, encode them and then store them. Through continuous and repetitive exposure these information storage get facilitated, and the more exposed (through every day use) the more this information is facilitated. This is true of other sensory input as well, for instance people who do not use their eyesight become more dependent on their other sensory abilities, which become more developed in comparison to people use eyesight. This increased dependency on other sensations leads into larger representation and development at the relevant brain areas. Equally, under-usage or under stimulation of sensory abilities will lead to reduced representation and underdevelopment of the relevant areas in the brain. These observations and explanations were confirmed by human and animal studies (Spitzer 1999). In physical terms, disuse atrophy of the body muscles from non-use is probably the nearest example.

In schizophrenia, it seems there is a problem in accessing the information in the first place, the evidence for which comes from increasing number of studies and the finding of this study. However, following that and depending on several factors such as the course of the illness and its severity, the picture might change later in the course of the illness into losing the store of information because of non-use and/ or continuous interference with its use. This parsimonious explanation of a complicated observation might seem difficult to prove. However, there are increasing numbers of reports in support.

Maher *et al* (1996) reported that semantic priming (an access type disorder criterion) has an inverse correlation with length of illness, i.e. the longer years in illness the less evidence of semantic priming. This can be considered as evidence that a process is happening in which patients move from meeting the criteria of access disorder into meeting the criteria of degraded store type disorder. In support of that, the finding reported by Laws *et al* (1998), in which they found evidence of degraded store disorder, were of an older sample and longer years in illness than that reported in this study. However, the cases that meet the access criterion were more community dwelling (like the sample in this study) and probably has less cognitive impairment, i.e. had less severe deficit.

The neuroplasticity theory can explain this transition, as the access problem continues (probably through dysfunction at a synaptic level) this will lead to continuous interference with the facilitation process of information acquired. In a neural network model: dysfunctional access should lead, through plastic synaptic changes, to degradation of the representation. With time the information will be lost and patients will exhibit symptoms of degrade type disorder. This would explain findings reported that some schizophrenic patients' performance on cognitive testing approached that seen in a group of patients suffering from Alzheimer's disease (McKay *et al* 1996). The sample was described as chronically hospitalised patients with severe schizophrenia.

Obviously several factors can influence the course of the illness and surely time is not the only factor. Deficit severity, suggested by Laws et al., can play an important role .A possible explanation into how it works is: the more severe the deficit the more the

interference with accessing the information and subsequently interfere with facilitation leading to earlier transition to a store type disorder.

This gain some support from a review of one of the characteristics of samples reported in previous studies, and in particular age of patients. (See Table 13, which is adopted from Al-Uzri 2004). It is noticeable that with increase of age of sample reported the type of disorder becomes more likely to be degraded. Age could be a proxy measure for increase chances of longer illness duration, increased risk of episodes/hospitalisation and secondary handicap. Nevertheless, a more detailed and possibly robust meta-analysis would be needed to provide substantial evidence to this theory, as well as examining other potentially confounding variables. Alternatively, longitudinal studies of schizophrenic patients, especially those in the beginning of their illness, are needed to provide further and direct evidences for the above-mentioned suggestions. They will be more useful if they were designed to examine whether the cognitive deficit is associated with certain clinical symptoms and the effect on long-term outcome in terms of functioning.

Table 13

Studies of semantic memory in schizophrenia that reported access or storage profiles ordered by mean patient age

Study	Task	Methods	Type of deficit	Mean Age (Years)
Spitzer *et al* 1993	Priming	Priming	Access	27
Gouzoulis-Mayfrank *et al* 2003	Priming	(Hyper) priming	Access	32.19
Al-Uzri, Laws & Mortimer, 2004	Picture naming	Consistency+ cueing+ attribute Information	Access	34.9
Allen, Lidle & Frith, 1993	Fluency	Consistency	Access	35
Joyce, Collinson & Crichton 1996	Fluency	Cueing	Access	36
Laws, McKenna & Kondel, 1998	Picture naming	Consistency + cueing	Mixed	41
Chen *et al* 2000	Fluency	Consistency	Store	42.3
Laws, Al-Uzri & Mortimer, 2000	Picture naming	Consistency + frequency	Largely store	46
McKay *et al* 1996	Picture naming	-	Similar to Alzheimer patients	64-72
Kondel *et al* 2002	Picture naming	Consistency + cueing	Store	75

4.3 Implications

The above-mentioned suggestions have important clinical implications in addressing recovery and assessing outcomes in schizophrenia. The fact that there is an access disorder (to start with at least) means that there is a potential of improving the accessing problem. This may be easier, and more fruitful, than minimising further damage to the presentation, which seems the only therapeutic option in store disorders (e.g. Alzheimer's disease). This is where examining semantic memory would be useful to incorporate into the wider assessment of people with schizophrenia to address their needs and promote early recovery. Attempts and resources should be directed towards preventing the transition to store type disorder from access type disorder, and indeed try to improve the accessing process in the first place. These suggestions echo previous ones proposed that the longer the delay in starting treating schizophrenic patients the worse the prognosis (Loebel *et al* 1992, Scully *et al* 1997) and early interventions are superior to late interventions in terms of outcomes (Birchwood *et al* 1997).

Treatment of schizophrenia needs not to mean only medication, as psychological and social interventions may reduce the impact and the severity of the illness. In turn this may lead to less interference with accessing and facilitating information within the semantic memory system. Just like different sensory modalities need stimulation to develop, semantic memory needs stimulation and facilitation of information to ensure that, at neuronal level, the necessary plastic synaptic change takes place. This model might explain how psychological interventions work. Also, this is where choosing a therapeutic environment that provides the necessary stimulation, and facilitate previous learning, of semantic memory is crucial. Hence the choice of rehabilitation facilities has

an important role to bring back the patients into as near as possible to pre-morbid level of functioning. Obviously that would be difficult to achieve once the disorder becomes a degraded store type.

In an era when containing symptoms alone is not satisfactory as a target for treatment, medication have an important role not only in treating the disturbing symptoms of schizophrenia, but also in improving cognitive functioning. The study results provide a potential of additional target for therapeutic interventions, through the association between negative symptoms and semantic memory, to improve outcome in schizophrenia. Recent advances in psychopharmacology, and in particular atypical anti-psychotics, suggest that might be the case (Green *et al* 1997, McGurk 1999). However, more recent reports and review of the data were less optimistic. Clearly, more work and evidence are needed to what might prove to be a great challenge in psychopharmacology; that is improving cognitive functions.

On a different note, and regarding the debate whether schizophrenia is a neurodevelopmental or progressive disorder, the suggested model of an access type disorder that can deteriorate into a degraded store disorder can provide a better understanding of the course of the illness. It would be in support of a neurodevelopmental theory, but might explain the late deterioration described in schizophrenia. This deterioration might happen if the patients were not treated early and adequately enough. However, a firm conclusion cannot be drawn without larger studies, designed to answer the relevant questions, are conducted.

5 CONCLUSION

This study's findings suggest that there is a semantic memory deficit in minority of this cohort of schizophrenic patients and is not as extensive as been reported in some previous studies. These suggestions came in view of comparing patients' performance to controls on the Hodges' semantic memory battery. The deficit was especially significant in tests that examined recall, categorisation and processing of information. This finding can be interpreted as in support of previous suggestions that there is a disorder of knowledge in schizophrenia, which may result from semantic processing abnormalities. However, sample characteristics, such as being community-base and relatively younger age group with low level of symptoms especially negative symptoms, might explain the extent of the deficit reported here. The correlation between semantic memory and negative symptoms, years in education pre-morbid IQ might represent potential for therapeutic interventions.

The results of examining this cohort across time, using the same battery, suggest that the semantic memory deficit in this cohort is mainly of an access type (according to Warrington and Shallice criteria). Also noticeable was the pattern of performance was similar between patients and controls on aspects of consistency, level of attributes and benefiting from cueing. However, patients performed not as well as controls on some tests. Considerable previous work suggested that there might be a degraded store type disorder as well in schizophrenia. A possible explanation to these different reports is that both types may exist in schizophrenia. The deficit may be an access type initially, but can become later a store type. In a neural network model this change can take place

through neuroplsticity at a synaptic level. The process of change can be influenced by several factors, such as age, deficit severity, and course of the illness. A better understanding of the nature of semantic memory deficit and its correlates will, hopefully, have a positive effect on the way we manage schizophrenia.

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APPENDIX 1

SEMANTIC BATTERY SUMMARY

Registry ID _____ Date (M/D/Y) _____ Examiner_____
Name _____ Age_____ DOB_____ Education _____

CATEGORY FLUENCY TEST				
	Animals	F	A	S
Total Words				
Correct Responses				
Total Errors				
Error Types:				
1) Perserverations				
2) Intrusions				

NAMING TEST
Total correct _____/48

Total living	_____/24	Total Manmade	_____/24
Land animals	_____/12	Household	_____/12
Sea creatures	_____/6	Vehicles	_____/6
Birds	_____/6	Musical	_____/6

CATEGORY SORTING TEST

Living	_____/24		
Manmade	_____/24		
Total	_____/48		
Land animals	_____/12	Household	_____/12
Water animals	_____/6	Musical	_____/6
Birds	_____/6	Vehicles	_____/6
Total	_____/24	Total	_____/24

SUBORDINATE

Animals		Household	
Native	_____/5	Electrical	_____/6
Foreign	_____/7	Non-electrical	_____/6

CATEGORY COMPREHENSION TEST

Total Correct	_____/48
Animals	_____/24
Manmade	_____/24

NAMING TO DESCRIPTION

TOTAL CORRECT:

land animals	/4	household items	/4	total living	/12
water creatures	/4	vehicles	/4	total manmade	/12
birds	/4	musical instruments	/4	Overall Total	/24

CATEGORY FLUENCY TEST

Patient's Name_____ **Date** _____

1) Animals	F	A	S
Total			
Total Correct			
Perserverations			
Intrusions			

CATEGORY NAMING TEST

Patient's Name_____ **Date** _____

	RESPONSE	CORRECT: YES/NO
1. Telephone		
2. Fish		
3. Desk		
4. Chicken		
5. Truck		
6. Lion		
7. Iron		
8. Seal		
9. Guitar		
10. Deer		
11. Refrigerator		
12. Rabbit		
13. Bus		
14. Bear		
15. Record player		
16. Duck		
17. Stove		
18. Monkey		
19. Couch		
20. Tiger		
21. Aeroplane		
22. Eagle		

CATEGORY NAMING TEST (CONT)

	RESPONSE	CORRECT: YES/NO
23. Violin		
24. Alligator		
25. Bicycle		
26. Swan		
27. Trumpet		
28. Rhinoceros		
29. Kettle		
30. Owl		
31. Helicopter		
32. Mouse		
33. Harp		
34. Lobster		
35. Motorcycle		
36. Squirrel		
37. Accordion		
38. Frog		
39. Rolling pin		
40. Zebra		
41. Toaster		
42. Fox		
43. Spinning wheel		
44. Giraffe		
45. French horn		
46. Seahorse		
47. Rocking chair		
48. Penguin		

NAMING TEST SCORE SHEET

Patient's Name_____

1. Land animals _____
2. Sea animals _____
3. Birds _____
4. Total animals _____
5. Household items _____
6. Musical instruments _____
7. Vehicles _____
8. Total manmade items _____
9. Total Correct _____

CATEGORY SORTING TEST

Patient's Name_____ Date _____

	Number correct	Number of errors
LEVEL 1		
Living (24)		
Manmade (24)		
LEVEL 2		
a) Land animals (12)		
Water animals (6)		
Birds (6)		
b) Household items (12)		
Musical instruments (6)		
Vehicles (6)		

LEVEL 3	
a) LAND ANIMALS	
Foreign vs Native animals	F N
b) HOUSEHOLD ITEMS	
Electrical vs Non-electrical	E NC

CATEGORY COMPREHENSION TEST – SCORE SHEET

Patient's Name_____ **Date** _____

DOMESTIC ANIMALS					
Rabbit	Squirrel	Fox	Mouse	Bear	Deer
FOREIGN ANIMALS					
Rhino	Monkey	Zebra	Giraffe	Tiger	Lion
SEA CREATURES					
Crocodile	Lobster	Frog	Seal	Fish	Seahorse
BIRDS					
Swan	Eagle	Chicken	Owl	Penguin	Duck
ELECTRICAL ITEMS					
Iron	Telephone	Refrigerator	Record player	Stove	Toaster
HOUSEHOLD ITEMS					
Desk	Rolling pin	Kettle	Spinning wheel	Rocking chair	Sofa
VEHICLES					
Helicopter	Bicycle	Aeroplane	Bus	Motorcycle	Truck
MUSICAL INSTRUMENTS					
Harp	Violin	Guitar	Accordion	Trumpet	French horn

Total animals _____ /24
Total manmade _____ /24

TOTAL _____ /48

NAMING TO DESCRIPTION

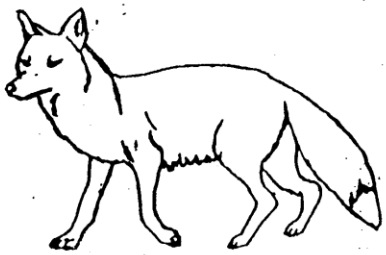
Name_____ Date _____

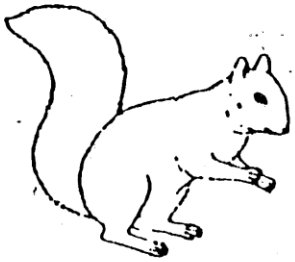
Instructions: Say "I'm going to read you some descriptions of different things and I want you to tell me what I've described". For each description, ask the subject "What do we call…?"

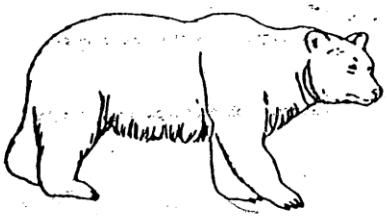
TOTAL CORRECT:	**land animals**	**/4**	**household items**	**/4**	**total living**	**/12**
	water creatures	**/4**	**vehicles**	**/4**	**total manmade**	**/12**
	birds	**/4**	**musical instruments**	**/4**	**Overall Total**	**/24**

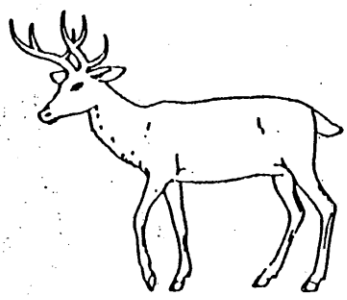
Y/N indicates whether item is also in generation of definitions test

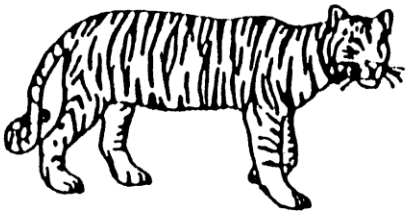
No	CATEGORY	Y/N	DEFINITION	CORRECT RESPONSE	SUBJECT'S RESPONSE
1	Musical instrument	Y	A large stringed instrument which is triangular in shape and is plucked with the fingers	Harp	
2	Bird	Y	A large bird that spreads long colourful tail feathers	Peacock	
3	Water creature	N	A small, green animal which leaps around ponds	Frog	
4	Household item	Y	An electrical kitchen appliance which is used for browning bread	Toaster	
5	Land animal	Y	A very large four-legged animal from Africa which has one or two horns on its nose	Rhinoceros	
6	Vehicle	N	A small vehicle with runners used on snow or ice	Sledge	
7	Water creature	Y	A four-legged reptile whose skin is sometimes used to make shoes and handbags	Crocodile	
8	Household item	N	A jar or ornament in which we keep flowers	Vase	
9	Musical instrument	Y	A musical instrument with a squeeze-box and keys	Accordion	
10	Land animal	N	A small furry animal which lives in trees and has a long bushy tail	Squirrel	
11	Musical instrument	N	A musical instrument which is played by beating it with sticks	Drum	
12	Water creature	Y	A sea animal with a hard shell, large claws and a tail	Lobster	
13	Household item	Y	A round piece of wood which is used to flatten pie dough	Rolling pin	
14	Land animal	N	A large grey animal with a trunk	Elephant	
15	Vehicle	Y	A vehicle which is lifted into the air by a large propeller on its top	Helicopter	
16	Bird	Y	A large, white, long-necked bird which lives on or near water	Swan	
17	Household item	N	A kitchen item which is used for heating and boiling water	Kettle	
18	Vehicle	N	A two-wheeled vehicle propelled by the rider	Bicycle	
19	Bird	N	A large flightless bird found in Africa which runs quickly on two legs	Ostrich	
20	Vehicle	Y	A two-wheeled vehicle which runs on petrol	Motorcycle	
21	Water creature	N	A fish-eating sea animal which has flippers and is hunted for its fur	Seal	
22	Land animal	Y	A cunning animal which has reddish fur and a bushy tail, and is often hunted for sport	Fox	
23	Musical instrument	N	A stringed musical instrument which is held on the shoulder and played with a bow	Violin	
24	Bird	N	A bird which flies at night	Owl	

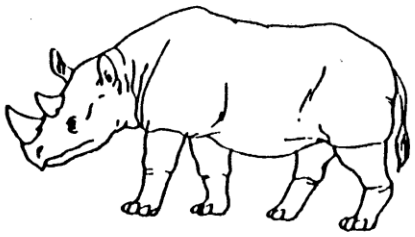


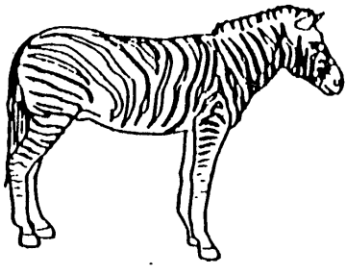


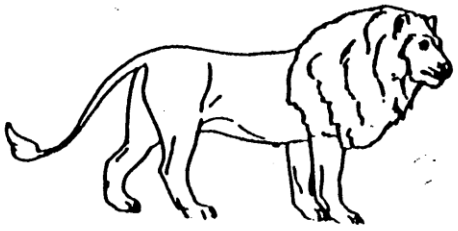


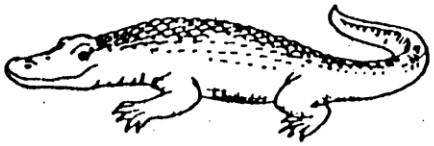


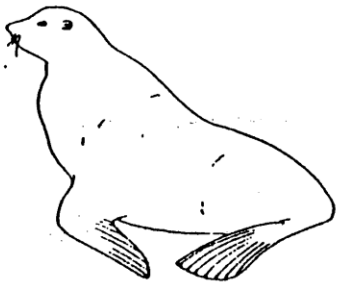


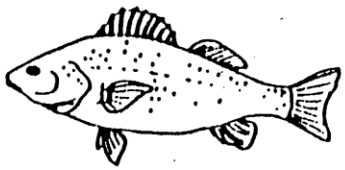


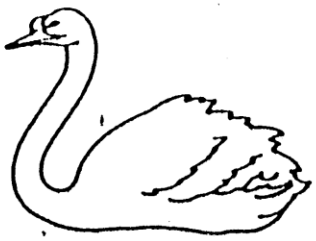


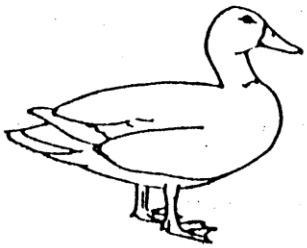


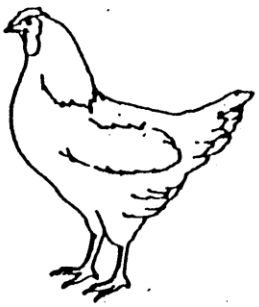


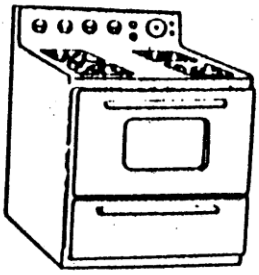


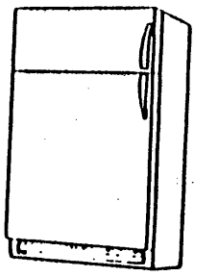


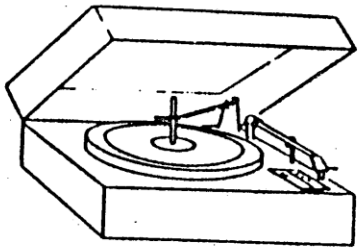


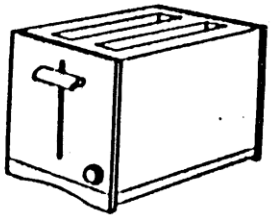


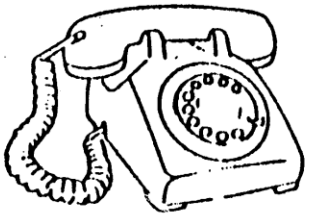


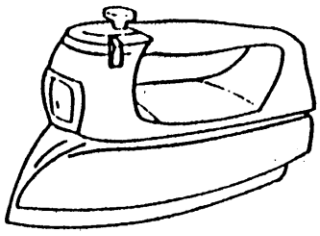


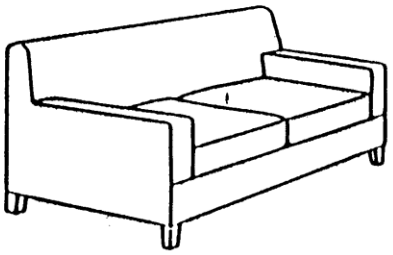


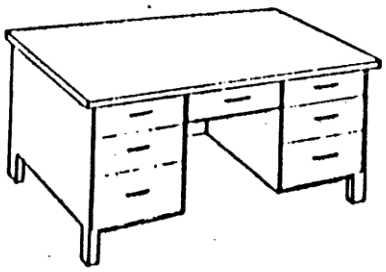


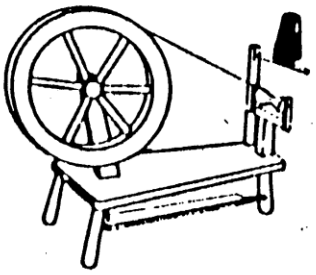


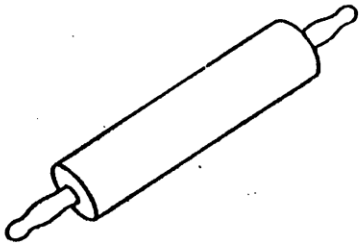


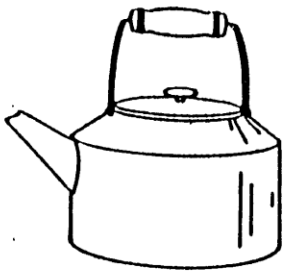


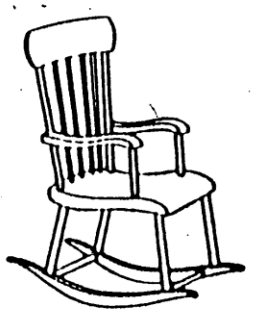


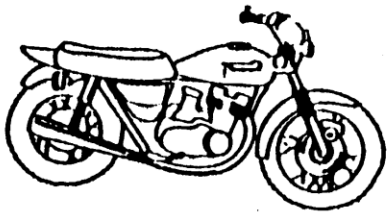


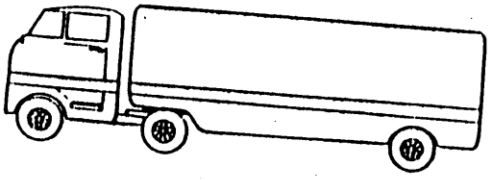


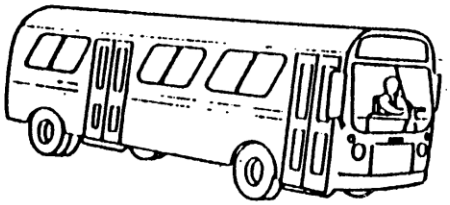


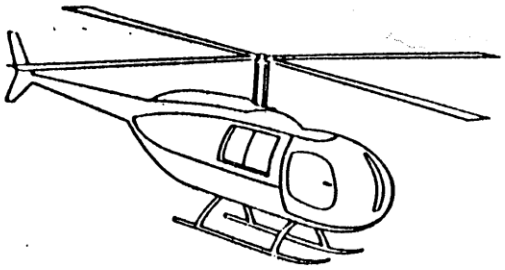


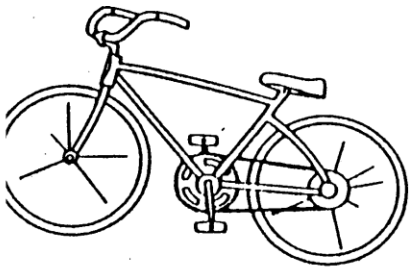


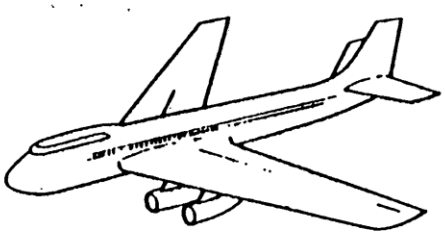


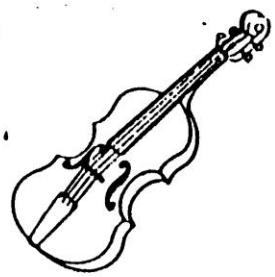


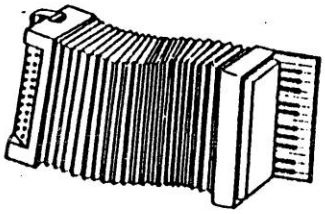












APPENDIX 2

SANS and SAPS

INITIALS_____ ID _ _ _ _ _ _ _ _ (1-8)

ø = (9-12)

WEEK # (Nonweekly=00) _ _ (13-14)

PROCEDURE: (15)

Weekly	0		
Xenon - on meds	1	DI-SPECT - on meds	7
Xenon - off meds	2	DI-SPECT - off meds	8
IMP - on meds	3	Behavioral - on meds	9
IMP - off meds	4	Behavioral - off meds	10
HMPAO - on meds	5	PET/^{15}O H_2O - on meds	11
HMPAO - off meds	6	PET/^{15}O H_2O - off meds	12

ASSESSMENT: 1st time studied 1 (16)
2nd time studied 2

RELIABILITY MEASUREMENT #: Original 1 (17)
Second 2
Third 3
Fourth 4

FORM/VERSION 0 1 0 1 (18-21)

CARD 0 1 (22-23)

DATE _ _/_ _/_ _ (24-29)

RATER _ _ (30-31)

STATUS: (at intake) (32)

Normal Control	0
Neuroleptic Naive	1
Neuroleptic Non-Naive	2
Almost Neuroleptic Naive	3
Totally Psychoactive Drug Naive	4

MEDICATION: (33)

No Medication	0
Medication	1

SOURCES:

	No	Yes	
Interview	0	1	(34)
Staff	0	1	(35)
Family	0	1	(36)
Friends	0	1	(37)
Other	0	1	(38)

RELIABILITY: (39)

Very Good	1
Good	2
Fair	3
Poor	4
Very Poor	5

04/03/92 ky

SANS

0=None 1=Questionable 2=Mild 3=Moderate 4=Marked 5=Severe

AFFECTIVE FLATTENING OR BLUNTING

1 *Unchanging Facial Expression* 0 1 2 3 4 5 (40)
The patient's face appears wooden, changes less than expected as emotional content of discourse changes.

2 *Decreased Spontaneous Movements* 0 1 2 3 4 5 (41)
The patient shows few or no spontaneous movements, does not shift position, move extremities, etc.

3 *Paucity of Expressive Gestures* 0 1 2 3 4 5 (42)
The patient does not use hand gestures, body position, etc., as an aid to expressing his ideas.

4 *Poor Eye Contact* 0 1 2 3 4 5 (43)
The patient avoids eye contact or "stares through" interviewer even when speaking.

5 *Affective Nonresponsivity* 0 1 2 3 4 5 (44)
The patient fails to smile or laugh when prompted.

6 *Lack of Vocal Inflections* 0 1 2 3 4 5 (45)
The patient fails to show normal vocal emphasis patterns, is often monotonic.

7 *Global Rating of Affective Flattening* 0 1 2 3 4 5 (46)
This rating should focus on overall severity of symptoms, especially unresponsiveness, eye contact, facial expression, and vocal inflections.

ALOGIA

8 *Poverty of Speech* 0 1 2 3 4 5 (48)
The patient's replies to questions are restricted in amount, tend to be brief, concrete, and unelaborated.

9 *Poverty of Content of Speech* 0 1 2 3 4 5 (49)
The patient's replies are adequate in amount but tend to be vague, overconcrete, or overgeneralized, and convey little information.

10 *Blocking* 0 1 2 3 4 5 (50)
The patient indicates, either spontaneously or with prompting, that his train of thought was interrupted.

2 ___

0=None 1=Questionable 2=Mild 3=Moderate 4=Marked 5=Severe

11 *Increased Latency of Response* 0 1 2 3 4 5 (51)
The patient takes a long time to reply to questions; prompting indicates the patient is aware of the question.

12 *Global Rating of Alogia* 0 1 2 3 4 5 (52)
The core features of alogia are poverty of speech and poverty of content.

AVOLITION - APATHY

13 *Grooming and Hygiene* 0 1 2 3 4 5 (53)
The patient's clothes may be sloppy or soiled, and he may have greasy hair, body odor, etc.

14 *Impersistence at Work or School* 0 1 2 3 4 5 (54)
The patient has difficulty seeking or maintaining employment, completing school work, keeping house, etc. If an inpatient, cannot persist at ward activities, such as OT, playing cards, etc.

15 *Physical Anergia* 0 1 2 3 4 5 (55)
The patient tends to be physically inert. He may sit for hours and does not initiate spontaneous activity.

16 *Global Rating of Avolition-Apathy* 0 1 2 3 4 5 (56)
Strong weight may be given to one or two prominent symptoms if particularly striking.

ANHEDONIA - ASOCIALITY

17 *Recreational Interests and Activities* 0 1 2 3 4 5 (57)
The patient may have few or no interests, Both the quality and quantity of interests should be taken into account.

18 *Sexual Activity* 0 1 2 3 4 5 (58)
The patient may show a decrease in sexual interest and activity, or enjoyment when active.

19 *Ability to Feel Intimacy and Closeness* 0 1 2 3 4 5 (59)
The patient may display an inability to form close or intimate relationships, especially with the opposite sex and family.

20 *Relationships with Friends and Peers* 0 1 2 3 4 5 (60)
The patient may have few or no friends and may prefer to spend all of his time isolated.

0=None 1=Questionable 2=Mild 3=Moderate 4=Marked 5=Severe

21 *Global Rating of Anhedonia-Asociality* 0 1 2 3 4 5 (61)
This rating should reflect overall severity, taking into account the patient's age, family status, etc.

ATTENTION

22 *Social Inattentiveness* 0 1 2 3 4 5 (62)
The patient appears uninvolved or unengaged. He may seem "spacy."

23 *Inattentiveness During Mental Status Testing* 0 1 2 3 4 5 (63)
Tests of "serial 7s" (at least five subtractions) and spelling "world" backwards:
Score: 2=1 error; 3=2 errors; 4=3 errors

24 *Global Rating of Attention* 0 1 2 3 4 5 (64)
This rating should assess the patient's overall concentration, clinically and on tests.

SAPS

HALLUCINATIONS Card 02

1 *Auditory Hallucinations* 0 1 2 3 4 5 (224)
The patient reports voices, noises, or other sounds that no one else hears.

2 *Voices Commenting* 0 1 2 3 4 5 (225)
The patient reports a voice which makes a running commentary on his behavior or thoughts.

3 *Voices Conversing* 0 1 2 3 4 5 (226)
The patient reports hearing two or more voices conversing.

4 *Somatic or Tactile Hallucinations* 0 1 2 3 4 5 (227)
The patient reports experiencing peculiar physical sensations in the body.

5 *Olfactory Hallucinations* 0 1 2 3 4 5 (228)
The patient reports experiencing unusual smells which no one else notices.

6 *Visual Hallucinations* 0 1 2 3 4 5 (229)
The patient sees shapes or people that are not actually present.

4 ___

0=None 1=Questionable 2=Mild 3=Moderate 4=Marked 5=Severe

7	*Global Rating of Hallucinations* This rating should be based on the duration and severity of the hallucinations and their effects on the patient's life.	0 1 2 3 4 5	(230)

DELUSIONS

8	*Persecutory Delusions* The patient believes he is being conspired against or persecuted in some way.	0 1 2 3 4 5	(231)
9	*Delusions of Jealousy* The patient believes his spouse is having an affair with someone.	0 1 2 3 4 5	(232)
10	*Delusions of Guilt or Sin* The patient believes that he has committed some terrible sin or done something unforgiveable.	0 1 2 3 4 5	(233)
11	*Grandiose Delusions* The patient believes he has special powers or abilities.	0 1 2 3 4 5	(234)
12	*Religious Delusions* The patient is preoccupied with false beliefs of a religious nature.	0 1 2 3 4 5	(235)
13	*Somatic Delusions* The patient believes that somehow his body is diseased, abnormal, or changed.	0 1 2 3 4 5	(236)
14	*Delusions of Reference* The patient believes that insignificant remarks or events refer to him or have some special meaning.	0 1 2 3 4 5	(237)
15	*Delusions of Being Controlled* The patient feels that his feelings or actions are controlled by some outside force.	0 1 2 3 4 5	(238)
16	*Delusions of Mind Reading* The patient feels that people can read his mind or know his thoughts.	0 1 2 3 4 5	(239)
17	*Thought Broadcasting* The patient believes that his thoughts are broadcast so that he himself or others can hear them.	0 1 2 3 4 5	(240)
18	*Thought Insertion* The patient believes that thoughts that are not his own have been inserted into his mind.	0 1 2 3 4 5	(241)

5 ——

0=None 1=Questionable 2=Mild 3=Moderate 4=Marked 5=Severe

19 *Thought Withdrawal* 0 1 2 3 4 5 (242)
The patient believes that thoughts have been taken away from his mind.

20 *Global Rating of Delusions* 0 1 2 3 4 5 (243)
This rating should be based on the duration and persistence of the delusions and their effect on the patient's life.

BIZARRE BEHAVIOR

21 *Clothing and Appearance* 0 1 2 3 4 5 (244)
The patient dresses in an unusual manner or does other strange things to alter his appearance.

22 *Social and Sexual Behavior* 0 1 2 3 4 5 (245)
The patient may do things considered inappropriate according to usual social norms (e.g., masturbating in public).

23 *Aggressive and Agitated Behavior* 0 1 2 3 4 5 (246)
The patient may behave in an aggressive, agitated manner, often unpredictably.

24 *Repetitive or Stereotyped Behavior* 0 1 2 3 4 5 (247)
The patient develops a set of repetitive action or rituals that he must perform over and over.

25 *Global Rating of Bizarre Behavior* 0 1 2 3 4 5 (248)
This rating should reflect the type of behavior and the extent to which it deviates from social norms.

POSITIVE FORMAL THOUGHT DISORDER

26 *Derailment* 0 1 2 3 4 5 (249)
A pattern of speech in which ideas slip off track onto ideas obliquely related or unrelated.

27 *Tangentiality* 0 1 2 3 4 5 (250)
Replying to a question in an oblique or irrelevant manner.

28 *Incoherence* 0 1 2 3 4 5 (251)
A pattern of speech which is essentially incomprehensible at times.

29 *Illogicality* 0 1 2 3 4 5 (252)
A pattern of speech in which conclusions are reached which do not follow logically.

0=None 1=Questionable 2=Mild 3=Moderate 4=Marked 5=Severe

30 *Circumstantiality* 0 1 2 3 4 5 (253)
A pattern of speech which is very indirect and delayed in reaching its goal idea.

31 *Pressure of Speech* 0 1 2 3 4 5 (254)
The patient's speech is rapid and difficult to interrupt; the amount of speech produced is greater than that considered normal.

32 *Distractible Speech* 0 1 2 3 4 5 (255)
The patient is distracted by nearby stimuli which interrupt his flow of speech.

33 *Clanging* 0 1 2 3 4 5 (256)
A pattern of speech in which sounds rather than meaningful relationships govern word choice.

34 *Global Rating of Positive Formal Thought Disorder* 0 1 2 3 4 5 (257)
This rating should reflect the frequency of abnormality and degree to which it affects the patient's ability to communicate.

INAPPROPRIATE AFFECT

35 *Inappropriate Affect* 0 1 2 3 4 5 (47)
The patient's affect is inappropriate or incongruous, not simply flat or blunted.

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APPENDIX 3

PAPER ON EPISODIC MEMORY

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Measuring memory impairment in community-based patients with schizophrenia
Case-control study

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Declaration of interest None.

ABSTRACT

Background The majority of memory impairment studies in schizophrenia are cohort studies using laboratory-based tests, which make it difficultto estimate the true extent and relevance of memory impairment in patients with schizophrenia in the community.

Aims To examine the extent of memory impairment in community-based patients with schizophrenia using a clinically relevant test.

Method All patients with schizophrenia (*n*=190) in one catchment area were identified, of whom 133 were potentially eligible for the study; 73 patients volunteered to take part. They were assessed using the Rivermead Behavioural Memory Test (RBMT), the National Adult Reading Test, the Positive and Negative Syndrome Scale, the Health of the Nation Outcome Scales and the Scales and the Office for National Statistics Classification of Occupation. Their performance on the memory test was compared withthat of matched controls (*n*=71).

Results Patients as a group performed significantly worse ($P<0.001$) than controls on the RBMT. Using the RBMT normative scores, 81% of patients were found to have impaired memory compared with 28% of controls.

Conclusions Using a clinically relevant test, the majority of community-based patients with schizophrenia may have memory impairment.

INTRODUCTION

Memory impairment in schizophrenia has been well documented since the early observations of Kraepelin and Bleuler in the 19th century. Recent reviews have documented significant stable and wide-ranging memory impairment in schizophrenia (Aleman *et al*, 1999). The importance of memory impairment stems from suggestions that it predicts functional outcome in schizophrenia (Green, 1996). However, the extent of memory impairment is not clear, in part because of the shortage of epidemiological studies of this problem in schizophrenia: we found only one study that used a population-based approach (Kelly *et al*, 2000). In addition, the use of a variety of different memory batteries and terminology of memory subtypes might have contributed to the difficulty of finding the true prevalence of memory impairment in schizophrenia. Furthermore, the use of memory tests in a laboratory setting has been widely considered as having little relevance to everyday memory problems. In this study we evaluated the extent of impairment in a population-based sample using a standardised memory test that can be incorporated into clinical practice.

METHOD

Sample

We identified every patient with a possible diagnosis of schizophrenia, from psychiatric records, in one catchment area of approximately 100 000 people in south Leicestershire. This included examining old records of all psychiatric patients in the catchment area to make sure no potential patient was missed. The diagnoses were confirmed using ICD-10 criteria (World Health Organization, 1992). The area can be described as a suburban British residential area with a predominantly middle-class working population. The two consultants responsible for the area have a policy of not discharging patients with schizophrenia from their care even if the patients need minimal psychiatric input. The only exceptions were cases of severe and incapacitating schizophrenia that necessitated a referral to rehabilitation psychiatry. Such patients usually move out of the area into long-term care units or sheltered accommodation.

We excluded patients with organic brain disease, head injuries or comorbidity, and those whose first language was not English. None of the participants had had electroconvulsive therapy in the year prior to taking part in the study. Patients older than 60 years were also excluded, because Kelly *et al* (2000) suggested that people above this age with

schizophrenia have a poorer cognitive performance than younger patients. The patients' performance on the memory test was compared with that of controls (*n*=71). Members of the control group live in the same city and were recruited by advertisements in the local hospital, university and supermarkets. They had no history of mental illness, and were subjected to the same exclusion criteria as the patient group.

Measures

Rivermead Behavioural Memory Test

Participants were assessed with the Rivermead Behavioural Memory Test (RBMT; Wilson *et al*, 1985). This test of everyday memory has good ecological validity, and is made up of 12 measures, each aimed at testing one aspect of everyday memory:

a. remembering a name;
b. remembering a hidden belonging;
c. remembering an appointment;
d. picture recognition;
e. immediate recall of a newspaper article;
f. delayed recall of a newspaper article;
g. face recognition;
h. remembering a new route (immediate);
i. remembering a new route (delayed);
j. delivering a message;
k. orientation questions;
l. knowing the date.

The RBMT has a screening score (0-12), and is not very demanding in terms of effort or time (it takes 25-30 min to administer). It has been used before in schizophrenia studies, for example by McKenna *et al* (1990) and Kelly *et al* (2000).

National Adult Reading Test

The National Adult Reading Test (NART; Nelson, 1982) is an estimate measure of premorbid intelligence. It has been widely used in psychiatric research and in particular in studies of schizophrenia (Gilvarry *et al*, 2001).

Positive and Negative Syndrome Scale

The Positive and Negative Syndrome Scale (PANSS; Kay *et al*, 1987) was given to patients only. It is a widely used scale for symptom ratings in schizophrenia.

Health of the Nation Outcome Scales

The Health of the Nation Outcome Scales (HoNOS; Wing *et al*, 1998) were used for assessment of the psychiatric patients' current community functioning.

Demographic factors

Demographic data for all participants were documented, including occupation group using the Office for National Statistics classification (see Appendix). In addition, duration of illness and age at onset for the patients were documented through information provided by the patient and verified from medical records, including first documentation by general practitioners. Duration of illness was defined as the period between the time that first psychotic symptoms were reported and the time of current assessment. Age at onset was defined as the age when first psychotic symptoms were reported.

Assessment procedure

A psychologist administered the cognitive assessments independently from the clinical assessment, which was made by a clinician (M.A.-U.) masked to the cognitive assessment. The responsible consultants (J.B. and S.F.) assessed the patients' level of community functioning using the HoNOS, and were also unaware of the cognitive assessment. Illness duration and age at onset were calculated independently by D.M.

Statistical analysis

Sample size was calculated to achieve statistical power of an 80% possibility of obtaining significant results at 5%, when submitted for ethical committee approval. Differences between patients and controls were examined by *t*-test or χ^2 test, as appropriate, for demographic variables; RBMT scores were examined by logistic regression; within-group differences were examined using analysis of variance (ANOVA); correlations were examined using Pearson's *r* or Spearman's rho as appropriate. The Statistical Package for the Social Sciences version 12 for Windows was used to analyse the data.

RESULTS

We identified 190 patients, of whom 133 were potentially eligible for the study. Of those not eligible, 2 did not fulfil strict diagnostic criteria for schizophrenia, 1 died before testing, 5 had a diagnosis of substance misuse, 8 had a history of organic brain disease or head injury, 30 were over 60 years old, and for 11 English was not their first language. Of the 133 eligible patients, 60 declined to take part, leaving a total of 73 (55%) patients who were eligible and volunteered to take part in the study (Fig. 1). All patients who took part in the study were in a stable state and living in the community, except one who was an in-patient at the time of the study.

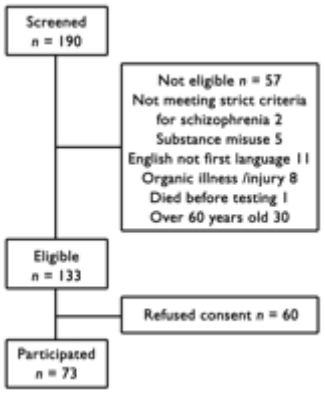

Fig. 1 Flow chart of patients' selection for the study.

We compared the known socio-demographic and clinical characteristics of patients who participated in the study and those who did not (Table 1). These characteristics included age, gender, years in education, accommodation, employment status, medication

prescribed, age at onset, length of in-patient stay and illness duration. There was no significant difference between the two groups except that the participant group had more years in education. The participants were slightly older, on average, at the time of disease onset, but this difference did not reach significance.

Table 1 Comparison between patients who participated or refused to take part in the study

	Participated (*n*=73)	Refused (*n*=60)		*P*
Age, years[1]	39.4 (11.7)	40.3 (9.6)	*t*=–0.50	NS
Age at illness onset, years[1]	27.2 (7.9)	25.7 (7.3)	*t*=1.07	NS
Illness duration, weeks[1]	669 (545.6)	752.9 (427.5)	*t*=–0.94	NS
In-patient stays, weeks[1]	185.7 (322.7)	217 (208.3)	*t*=–0.61	NS
Education, years[1]	13.6 (2.7)	12.23 (2.5)	*t*=2.96	0.004
Gender, *n*				
Male	42	35	χ^2=0.01	NS
Female	31	25		
Accommodation, *n*				
Independent	17	21	χ^2=4.21	NS
With partner	18	11		
With parents	27	18		
Supported	10	7		
Residential	1	3		
Employment[2]			χ^2=10.03	NS
Anticholinergic treatment, *n*				
Yes	27	22	χ^2=0.25	NS
No	46	37		
Antipsychotic treatment, *n*				
Atypical	37	29	χ^2=0.09	NS
Typical	24	22		
Mixed	8	6		
Antipsychotic-free	4	2		

[1.] Mean (s.d.)

[2.] Standard Occupational Classification 2000 (see Appendix)

The participating group comprised 31 women and 42 men, and the control group 33 women and 38 men. There was a small but statistically significant difference in age (t=2.48, d.f.=142, P=0.014) and NART score (t =-2.49, d.f.=132, P=0.014) between patients and controls (Table 2).

Table 2 Comparison between patients and control group demographics

	Patients (n=73)	Controls (n=71)	Inferential test statistics	P
Gender, M:F	42:31	38:33	NS	NS
Age, years: mean (s.d.)	39.4 (11.7)	34.4 (12.4)	2.48	0.014
NART score: mean (s.d.)	112.7 (6.6)	115.5 (6.4)	–2.49	0.014

F, female; M, male; NART, National Adult Reading Test

RBMT scores analysis

Binary logistic regression showed that patients as a group performed significantly worse than controls on the RBMT, even after correcting for NART score and age (B=0.665, P<0.001). Table 3 shows the distribution of both patients and controls across different scores categories of the RBMT scores. Reducing this into a 2 x 2 table (Table 4) showed that 81% of patients had impaired memory compared with 28% of controls. Thus, using RBMT scores of impaired *v*. normal gives a 76% chance of correctly predicting group membership (patients or controls respectively).

Table 3 Rivermead Behavioural Memory Test screening score

	Severely impaired (0–2)	Moderately impaired (3–6)	Poor (7–9)	Normal (10–12)
Patients (*n*=73)	2	25	32	14
Controls (*n*=71)	0	1	19	51

Table 4 Rivermead Behavioural Memory Test screening scores reduced to `impaired' or `normal'

	Impaired memory (0–9)	Normal memory (10–12)	Total
	n (%)		
Patients	59 (81)	14 (19)	73 (100)
Controls	20 (28)	51 (72)	71 (100)

χ^2=39.569, d.f.=1, *P*<0.001 (two-tailed)

Age

There was a significant inverse correlation between age and RBMT score for the whole sample (patients and controls): *r*=-0.375, two-tailed, *P*<0.001. That was also the case when correlations for both groups were examined separately, although the correlation was stronger between age and RBMT score in patients (*r*=-0.369, *P*=0.001) than in controls (*r*=-0.277, *P*=0.020). To further examine the age effect on both groups separately, we divided the two samples (patients and controls) into three age-groups: 18-30 years, 31-45 years and 46-60 years (see Fig. 2).

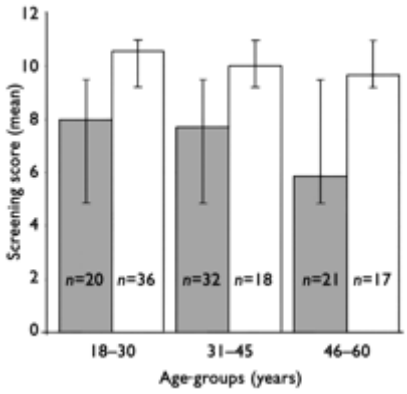

Fig. 2 Performance of different age-groups on the Rivermead Behavioural Memory Test (P<0.001 for patients *v*. controls in all age-groups). ■, patients (n=73); □, controls (n=71).

Using ANOVA, we found a significant difference in RBMT scores between diagnostic groups (patients *v*. controls) (F=72.4, d.f.=1, P<0.0001) and the three age-groups (F=6.5, d.f.=2, P=0.002), but no significant interaction between diagnosis and age (F=1.7, d.f.=2, P=0.18). The reason for the lack of significant interaction is that the age effect was not linear, but was particularly pronounced in the oldest age-group (46-60 years). There was no drop in the RBMT score with age in the control group, but there was a drop in the oldest age-group in participants with schizophrenia.

Using one-way ANOVA, there was no significant difference in RBMT scores among the different age-groups of controls. However, there were significant differences among different age-groups in patients (F=4.686, d.f.=2, P=0.007). The *post hoc* Tukey honestly significant difference test showed significant differences between the youngest (18-30 years) and oldest (46-60 years) groups (P=0.012) and between the middle (31-45 years) and oldest age-groups (P=0.018), but no significant difference between the youngest and middle age-groups.

Illness duration and age at onset

For 67 patients we were able to obtain accurate information on the illness duration (mean 669 weeks, median 504, s.d.=546), length of stay (mean 186 days, median 75, s.d.=323) and age at onset (mean 27.2 years, median 26, s.d.=7.9). Using Pearson correlation, we found a significant inverse correlation between illness duration and RBMT screening score (r=-0.335, P=0.006). In contrast, there was no significant correlation between length of stay or age at onset and RBMT screening score.

Medication

Patients were on different antipsychotic medication regimens: 29 were taking atypical antipsychotic agents, 33 typical agents, 7 were taking both, and 4 were taking no antipsychotic at the time of the study. Twenty-seven were taking anticholinergic medication. Analysis of variance showed no significant effect for type of antipsychotic on the RBMT score; it also showed no significant difference on RBMT score between patients taking or not taking anticholinergic medication.

Symptom ratings

The total PANSS rating showed mild psychopathological disorder in 73 patients (mean 50.77, mode 42, range 30-84). Using Pearson correlation there was a significant inverse correlation between RBMT score and the negative sub-scale of the PANSS (r=-0.262,

two-tailed, *P*=0.027). However, the correlation was not significant with the total score, general or positive sub-scales.

Occupation and HoNOS score
There was a significant inverse correlation between RBMT score and occupational groups (Spearman's rho=-0.332, two-tailed, *P*<0.001), i.e. the lower the score on the RBMT the higher the category of occupational group (1, managers and senior officials; 10, unemployed). This is to say that the lower a person scores on RBMT, the more likely that person would be to be unemployed.

We were able to obtain HoNOS scores for 58 patients. There was no significant correlation between RBMT score and the total HoNOS score. However, there was a significant correlation between the RBMT score and the functional impairment subscale (items 4 and 5) of the HoNOS (Pearson's *r*=-0.297, *P*=0.02).

DISCUSSION

We report a high prevalence of memory impairment (over 80%) in a population-based study of patients with schizophrenia. This is based on the screening score of the RBMT, where a score of less than 10 is considered to represent impaired memory. This is, to the best of our knowledge, the second population-based study of cognitive impairment in schizophrenia after that by Kelly *et al* (2000). Significantly, we were able to replicate their findings regarding memory impairment using the same test, but in a demographically different population.

The patients who took part in our study were relatively young and free from psychotic symptoms, living in the community and with no documented comorbidity. The exclusion criteria were also designed to avoid the participation of any patients disadvantaged in terms of age and language. Except for years in education, there was no significant demographic or clinical difference between the patients who took part in the study and those who declined. This suggests that participants might have better memory functioning than those who declined to take part in the study. Therefore, the prevalence of memory impairment reported would be a conservative estimate of its overall prevalence in schizophrenia when taking other confounding factors (clinical or demographic) into consideration. This is supported by the findings of Tamlyn *et al* (1992) who used the same test (RBMT) to examine their cohort; they reported a much higher prevalence of memory impairment in their subgroup of chronically ill and hospitalised patients, 27 out of 28 of whom scored in the impaired range.

The prevalence of schizophrenia in our study population (1.9 per 1000) is at the lower end of that expected (1.4-4.6 per 1000 population; Jablensky, 2000). This could be explained by the demographic characteristics of the catchment area. As a suburban district, it is more likely to have a lower prevalence of psychotic disorders compared with city centres, which are associated with higher morbidity in general (Mortensen *et al*, 1999). In addition, patients who develop schizophrenia might well migrate towards the city centre, especially when they need supported or hostel accommodation, which is most

likely to be available in urban areas. This was particularly true for our study because patients who needed rehabilitation services and supported accommodation were moved outside the catchment area.

RBMTand schizophrenia

Our study suggests that the RBMT is a good clinical marker for memory impairment in schizophrenia. This is supported by previous use of the RBMT in studies of schizophrenia, which consistently showed that people with this disorder underperform on this test (McKenna *et al*, 1990; Kelly *et al*, 2000). Our study had the advantage, compared with previous studies, of the inclusion of a control group. This made it possible to examine the ability of the RBMT in discriminating between patients and controls. It is not common in psychiatric research to have an instrument with such a good ability (76%) to predict patient or control status. A similar ability (76%) was reported in previous work (Palmer *et al*, 1997); however, this involved a more demanding neuropsychological battery which is difficult to incorporate into everyday clinical practice, and furthermore lacked the specificity of everyday memory. Therefore, the RBMT has the potential to become an important tool in our clinical practice for the identification of memory impairment in schizophrenia, which may help predict functional outcome.

Specificity of memory impairment

The premorbid IQ reported for the patients in this study was much higher than that reported in previous studies. This is another indication that our sample can be considered among the less ill of patients with schizophrenia, making the memory impairment reported even more significant. The difference in premorbid IQ between patients and controls was small in clinical terms, but statistically significant. However, even after correcting for this difference in premorbid IQ, patients' performance on the RBMT was worse than that of controls. Therefore, the underperformance of patients on the RBMT, as a measure of working memory, cannot be explained as a symptom of generalised reduction of intellectual ability, but is rather a specific cognitive deficit. Furthermore, this deficit was not related to symptom rating, except for negative symptoms, or medication in clinically stable patients. This supports the view that memory impairment is a core element of the clinical presentation of schizophrenia.

The association between memory impairment and the negative symptoms sub-scale of the PANSS is an important replication of previous findings (Berman *et al*, 1997). Conceptually, both denote the lack of a normally existing function. More importantly, this is further evidence that they may have a common underlying substrate (Rossi *et al*, 1997). This is an important contribution of neuropsychology towards better understanding of the underlying pathophysiology of schizophrenia.

Memory impairment and level of functioning

The association of memory impairment with occupational group provides further evidence for the importance of such impairment in schizophrenia. This echoes previous findings (Green, 1996), which suggested an association between memory impairment and functional outcome. This would have important implications for the development of any intervention that involves the use of memory. First, it suggests that patients with such impairment might not benefit from interventions that require intact memory. Second, it might be necessary to include memory remediation programmes in rehabilitation services to improve level of functioning. Further validity for the RBMT comes from the significant correlation with the functional impairment sub-scale of the HoNOS. This

finding echoes that previously reported by Kelly *et al* (2000), which reinforces the importance of memory impairment in influencing level of functioning in patients with mental illness.

Age and memory impairment
An interesting finding emerged when we divided the patient and control groups, separately, into three different age categories. The average RBMT scores for the controls were not significantly different across age-groups and remained within the normal memory category. In contrast, the patients' average RBMT scores remained within the impaired memory range across age-groups. In addition, there was a significant reduction in the average score for the oldest group of patients, which suggests that memory impairment as a subset of cognitive performance is compromised before the age of 60 years (cf. Kelly *et al*, 2000). We can conclude that memory decline might have a different course in schizophrenia compared with that in the general population and that older people with schizophrenia (aged 46-60 years) are significantly disadvantaged compared with younger people with this disorder.

The significance of the association between illness duration and memory impairment reported in this study raises important issues. Ostensibly, one can conclude that memory function in schizophrenia has a deteriorating course. However, it is important to examine the impact of potential mediating factors, such as the course of the illness, before such a conclusion can be drawn definitively. This is particularly important in the absence of clear neuropathological evidence to support a degenerative nature of the illness (Woods, 1998). Therefore, what can be concluded from the result of this study is that longer illness duration might carry a higher risk of worsening memory impairment.

Finally, it is not known whether memory impairment which was identified by the RBMT is exclusive to schizophrenia or extends to other psychotic disorders. Bipolar affective disorders have also been associated with cognitive impairment, including memory impairment, during the acute phase of the illness as well as during euthymic periods (Thompson *et al*, 2005). However, a review by Martinez-Aran *et al*, 2000 suggested that during symptom remission cognitive dysfunction in patients with bipolar disorder is more likely to improve. In addition, relatives of patients with schizophrenia show cognitive deficits such as memory impairment, whereas relatives of patients with affective bipolar disorders do not show such impairment (Keri *et al*, 2001). These findings suggest that cognitive dysfunction in general, and memory impairment in particular, may be a possible trait marker for schizophrenia to a greater degree than for bipolar affective disorders. Further research is needed to clarify this issue.

APPENDIX

Standard Occupational Classification 2000 (from the Office for National Statistics)

1. Managers and senior officials
2. Professional occupations
3. Associate professional and technical occupations

4. Administrative and secretarial occupations
5. Skilled trades occupations
6. Personal service occupations
7. Sales and customer service occupations
8. Process, plant and machine operatives
9. Elementary occupations
10. Unemployed

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