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Negative Features, Retrieval Processes and Verbal Fluency in Schizophrenia

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Twenty chronic schizophrenic patients, ten matched normal controls and nine depressed controls performed categorical verbal fluency tasks for three minutes each on five separate occasions. On each occasion the schizophrenic patients generated significantly fewer words than the controls. Comparison of the different occasions showed that the schizophrenic patients had as many words available in their inner lexicons but were inefficient in retrieving them. The schizophrenic patients also generated fewer clusters of related words and more words outside the specified category. Reduced ability to generate words while the lexicon remained intact was more marked in patients with negative features. Patients with incoherence, in contrast, were more likely to produce inappropriate words. We propose that both poverty of speech and incoherence of speech reflect problems in the retrieval of words from the lexicon. To cope with these problems patients with poverty of speech terminate their search prematurely while the patients with incoherence commit errors in selecting words for output.

Much research concerned with schizophrenia has focused on studying the mechanisms underlying positive symptoms (incoherence of speech, hallucinations and delusions) rather than those underlying negative symptoms (poverty of speech, flattening of affect). Thus while there are volumes of research concerning positive symptoms (e.g. Rochester & Martin, 1979; Neale & Oltmanns, 1980; Oltmanns & Maher, 1989; Slade & Bentall, 1988) there are as yet no detailed analyses of the processes underlying negative symptoms.

For several decades following Schneider's (1959) recognition of the diagnostic importance of certain delusions and hallucinations, negative symptoms were regarded as a less important manifestation of schizophrenia. Crow's (1980) formulation of schizophrenia has reinstated the Kraepelinian notion of negative symptoms as primary features of schizophrenia and increased interest in researching negative symptoms (e.g. Andreasen, 1982). This research supports Kraepelin's view that negative symptoms are the manifestations of intellectual impairment, as evidenced by impoverished thought and monotonous mental activity (Kraepelin, 1919; Johnstone *et al*, 1978). However we do not yet know whether the observed intellectual impairments are due to a loss of knowledge, as suggested by Kraepelin, or whether the impairment could be specific and due to a deficit in the initiation of cognitive processes, as suggested by Frith (1987). The issue is of crucial importance theoretically and clinically and is addressed in the present study through the detailed analysis of verbal fluency task outputs.

What processes are involved in the verbal fluency task? Subjects are asked, for instance, to name as many animals as they can. They must initiate and sustain a *self-directed search* through their semantic memory. If the subject produces only a few words, this could be a consequence of either a specific difficulty with the self-directed search process (impaired access), so that fewer words are retrieved, or corruption of semantic memory (degraded store), so that fewer words are available. Frith's theory predicts the former type of impairment. Frith & Allen (1988) have suggested that this same impairment is also reflected in positive and negative speech disorders: for instance, in generating new ideas. In the face of this difficulty some patients produce little or nothing in the way of speech, while other patients produce repetitive or inappropriate speech. While the former are described as having poverty of speech, the latter are referred to as incoherent. We would therefore predict that these two types of patients would perform differently on the verbal fluency task even though both abnormalities arise from an impairment of self-directed search. Patients with poverty of speech would produce few words, while patients with incoherence would produce inappropriate (i.e. out of category) words. In the present study we examined this hypothesis. We used a repeated verbal fluency task in which subjects were asked to produce exemplars for three categories (animals, parts of the body and fruit) for three minutes each, on five separate occasions.

Previous research (Patterson, 1972; Graesser & Mandler, 1978) indicates that if the subject has a

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normal semantic memory, but difficulty in retrieving from it, then, while a single attempt would result in few words, repeated attempts would tend to come up with different words and there would be little overlap between attempts. Indeed the degree of overlap can be used to estimate the size of the word pool through which the subject is searching.

As far as the nature of retrieval is concerned the literature suggests that its success relies crucially upon organisation and that this organisation involves two processes – the subject generates a semantic dimension (e.g. 'pet') and then searches for words associated with this semantic dimension (e.g. 'cat', 'dog') (Gruenewald & Lockhead, 1980). Graesser & Mandler's (1978) work also indicates that semantic dimensions are represented by *shared* items (words that occur in all of the repeated outputs) while exemplars of categories within these dimensions are represented by *variable* items (words that do not appear in all the outputs).

One possibility is that the retrieval difficulty experienced by schizophrenic patients stems from a form of perseveration. Having activated one semantic dimension, the patient has difficulty in abandoning this and accessing another. This problem is analogous to that shown in the Wisconsin Card Sorting Test in which schizophrenic patients have difficulty in shifting from one sorting dimension to another (Kolb & Wishaw, 1983). To examine this possibility we varied the interval between repeated performance of the verbal fluency task. Three trials were carried out in which the subject repeated the task immediately, and three in which there was an interval of at least a week between successive trials. If their retrieval problem was due to perseveration, we would expect the poor performance of schizophrenic patients to be exaggerated with immediate repeats since the perseveration should carry over from one trial to the next.

On the basis of these various considerations we made the following predictions:

(a) schizophrenic patients have as many words available to them as controls, but can retrieve fewer of them in a three-minute period
(b) this effect will be exaggerated when the verbal fluency task is repeated across a very short interval
(c) patients with poverty of speech will retrieve fewer words than those without
(d) patients with incoherence of speech will retrieve inappropriate items.

Method

Three natural categories were selected for the verbal fluency task: animals, parts of the body, and fruit. Each subject participated in each of three sessions, which were held at weekly intervals. Three consecutive three-minute outputs were required for the same category in a single session (subjects were asked to start anew as soon as the previous output had been completed), followed by one three-minute output for each of the other two categories. This gave a total of five trials for each category: three trials separated by very short intervals, and three trials separated by intervals of a week.

For each output, subjects were given three minutes to name as many instances of the category as they could, in whatever order the instances occurred to them. The presentation of the categories to subjects was both verbal and by means of a card, bearing the category name which remained in front of the subject throughout the output period. Outputs were tape-recorded for later analysis.

Twenty psychiatric in-patients were selected who satisfied DSM–III–R criteria for chronic schizophrenia (American Psychiatric Association, 1987). They were in a stable phase, insofar as they had not suffered an acute exacerbation of illness within the preceding two months.

To control for non-specific effects of illness, nine in-patients meeting Research Diagnostic Criteria (RDC; Spitzer *et al*, 1978) for depression and scoring at least 25 on the Beck Depression Inventory (BDI; Beck *et al*, 1961) were selected. Ten normal controls were selected from the staff of the hospital. As can be seen in Table 1, the controls and the schizophrenic patients were well matched for sex ratio, age, premorbid IQ, as estimated from the National Adult Reading Test (NART; Nelson & O'Connell, 1978) and education. The depressed patients achieved somewhat higher scores on the NART.

Table 2 gives clinical information about the patients. The schizophrenic patients were all chronic, and had had at least one previous admission. All the schizophrenic patients were receiving neuroleptic medication. The depressed patients were all receiving tricyclic medication. As in our previous studies (Liddle, 1987), chronic schizophrenic patients were selected whose symptoms had been stable over some time. To confirm this stability, symptom ratings were obtained by examining the patients within one week of testing using the standardised psychiatric assessment scale of Krawiecka *et al* (1977). Positive symptoms were more marked than negative features in this sample. There were significant correlations between the ratings of the three negative symptoms (poverty of speech, flattening of affect, and retardation; $r = 0.49, 0.59, 0.73$) and therefore these ratings were combined to give a single rating of negative features. Incoherence did not significantly correlate with any other features: in particular, there was no relationship between incoherence and negative features. None of the depressed patients showed morbid levels of poverty or incoherence of speech.

Because of the independence of positive and negative speech disorders the comparisons required by our hypotheses could be made independently. To study the effects of negative features the schizophrenic patients were divided into three groups: no negative features, score 0 ($n = 7$); borderline, score 1 ($n = 8$); and morbid, score >1 for any negative item ($n = 5$). To study the effects of incoherence the schizophrenic patients were divided into two groups, normal ($n = 10$) and morbid ($n = 10$). No patient scored at the borderline level on incoherence.

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Table 1
Background information about the three groups of subjects

	Schizophrenic	Depressed	Control
Number	20	9	10
Sex	M 13, F 7	M 4, F 5	M 6, F 4
Age: mean (range)	35 (18-47)	39 (29-50)	32 (22-48)
NART score: mean (range)	103 (95-116)	117 (107-124)	104 (85-116)
Education			
No. with secondary level only	16	4	8
No. with secondary + 'O' levels	4	5	2
Occupation (numbers)			
Semi-skilled/skilled	6	8	9
Unskilled	12	1	1
Unemployed	2	0	0

Statistical analysis

The data were analysed using analysis of variance (ANOVA) with repeated measures. There was one between-subject factor (diagnosis or symptom rating) and several within-subject factors (trials, intervals between trials, categories). The data for estimated word pool size was highly skewed so a logarithmic transformation was applied to this variable. Many subjects produced no words that were inappropriate to the category and so this variable was analysed non-parametrically.

Four variables were studied relating to the number of words produced: the mean number of words in three minutes; shared words (the number of words that appeared in all of the five trials); variable words (the number of words that appeared on only one of the five trials; e.g. 'cat' might appear in all five trials, 'aardvark' only in one); estimated word pool. The last of these is an estimate of the total number of words available to the subject. A few words will be produced on each trial that were not given on any of the previous trials. The number of these 'new' words will decrease as the number of repeated trials increases and will tend to zero. At this point we assume that the subject has produced all the words available in that category. Using the observed degree of overlap between the five trials, the best-fit curve relating new words to number of trials was calculated. An estimate of the size of the word pool was then derived as the total number of different words that would have been produced on the trial where the number of new words reached zero. (A BASIC program for carrying out these procedures is available from C. Frith.)

Two variables were studied relating to the type of words produced: clustering and inappropriate words. In the former, related words like 'cat' and 'dog' tend to be produced one after another. We examined this tendency by counting the number of times a pair of words occurred adjacent to one another across the five trials. This was expressed as a percentage of the number of occasions the word appeared in any context. For the latter, we counted the number of words produced that were not in the specified category. Examples are 'chips' (inappropriate for animal); 'mind' (inappropriate for body part) and 'ginger', 'potatoes' (inappropriate for fruit).

Results

The interval between trials had no effect on either the patients or the controls. Repeating the task across very short intervals did not reduce output. Thus there was no evidence in the schizophrenic patients of perseveration on a semantic dimension.

Table 2
Numbers of patients having normal, borderline or morbid symptom ratings on the Krawiecka Scales (Krawiecka *et al*, 1977)

	Schizophrenics			Depressed		
	0	1	>1	0	1	>1
Depression	13	4	3	0	0	9
Anxiety	8	4	8	0	4	5
Delusions	7	1	12	4	3	2
Hallucinations	11	0	9	9	0	0
Incongruity	13	5	2	8	0	1
Incoherence	10	0	10	9	0	0
Poverty of speech	12	3	5	8	1	0
Flattening of affect	13	4	3	8	0	1
Retardation	14	4	2	8	0	1

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Table 3
Mean (s.d.) numbers of words produced

	Schizophrenics	Depressed	Controls	F(d.f. = 2,36)	P
No. of words in three minutes	22 (1.7)	39 (2.0)	40 (4.3)	12.9	<0.001
Variable words	25 (2.8)	34 (6.6)	21 (2.1)	NS	
Shared words	5.2(1.0)	9.9(1.9)	12.3(3.9)	6.0	<0.01
Estimated word pool	134 (50)	111 (17)	75 (5.9)	NS	

There were highly significant differences between the three categories. Far fewer examples of fruit were produced than animals or parts of the body. This result is entirely consistent with the category norms. Category did not interact with any of the other factors. In all the results that follow, performance with different intervals and different categories have been combined.

The four measures of word production are shown in Table 3. The schizophrenic patients produced far fewer words than the controls or the depressed patients ($P<0.001$). Across trials, however, the words they generated varied more. Thus, schizophrenics produced much fewer words that appeared in all five lists (shared words, $P<0.01$), but as many variable words (i.e. different words in each trial). This combination of few shared words but many variable words implies an inefficient or poorly organised search through a large word pool. The estimated size of the word pool being searched did not differ between patients and controls.

Table 4 shows the three variables concerning the type of words produced. The schizophrenic patients differed from the controls on both of these measures. They showed less clustering of words and produced more words that were not in the category requested.

Table 5 shows the effect of negative features on the number of words produced. Schizophrenic patients with negative features produced significantly fewer words. They did not produce fewer variable words and their estimated word pool size was also normal. There were no effects of negative features on the types of word produced.

Table 6 shows that patients previously rated as having incoherence of speech differed from patients without incoherence on a number of variables. Incoherent patients did not produce substantially more words within three minutes. However, they produced more variable words across the three trials and this was associated with a larger estimated word pool. They also gave more category-inappropriate words. If category-inappropriate words were excluded then the differences in variable words and word pool size disappeared. In addition, patients with incoherence of speech showed less evidence of clustering in their retrieval.

Discussion

These results confirm that chronic schizophrenic patients show impaired verbal fluency. This, however, is not a consequence of a loss of lexical knowledge. Their production of normal numbers of variable words and our estimates of their word pool size suggests that the patients have as many words available to them as the controls. Thus the problem in word output must be a consequence of deficiencies in the retrieval processes. We have suggested previously that this problem with self-initiated

Table 4
Type of words produced

	Schizophrenics	Depressed	Controls	F(2,36)	P
Mean (s.d.) clustering: %	14 (1.3)	20 (3.0)	21 (1.6)	3.8	<0.05
Mean (s.d.) number of inappropriate words	2.2(3.7)	0.16(1.5)	0.10(0.14)	8.9	<0.01

Table 5
Negative features and mean (s.d.) numbers of words produced by schizophrenic patients

	Negative feature ratings				
	0	1	>1	F(d.f. = 1,17)	P
No. of words in three minutes	28 (4.1)	22.2(4.3)	19.6(2.3)	3.7	<0.05 (1-tailed)
Variable words	26.0(2.1)	19.3(3.2)	20.9(5.4)	<1	NS
Shared words	10.0(3.1)	8.6(1.5)	6.1(1.8)	1.2	NS
Estimated word pool	113 (15)	77 (17)	96 (35)	<1	NS

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Table 6
Incoherence and verbal fluency in schizophrenic patients

	Incoherence ratings 0+1	>1	F(1,18)	P
Mean (s.d.) number of words in three minutes	22.7(2.8)	24.0(2.2)	<1	NS
Mean (s.d.) number of variable words	17.6(2.4)	26.4(2.6)	6.1	<0.05
Mean (s.d.) number of shared words	9.9(2.0)	7.0(1.6)	1.2	NS
Mean (s.d.) estimated word pool	61 (10)	207 (97)	7.8 (log)	<0.01
Mean (s.d.) clustering: %	17.1(1.8)	11.0(1.4)	7.5	<0.02
Mean (s.d.) number of inappropriate words	0.6(0.26)	3.9(1.4)	3.20	<0.05

retrieval underlies both the positive and the negative speech disorders associated with schizophrenia (Frith & Allen, 1988). The present results are consistent with this position. The patients with negative features, including poverty of speech, showed a particularly restricted output. The patients with incoherence showed less restricted output than those with negative features but at the expense of coherence, by producing category-inappropriate words. We have recently obtained similar results in a large sample of schizophrenic patients (Frith *et al*, 1991*b*). In this sample negative features were associated with slow output and incoherence with unusual output.

In a study of the relationship between schizophrenic symptoms and verbal fluency and other putative frontal lobe tasks, Liddle & Morris (1991) found that both psychomotor poverty syndrome (which includes core negative features such as poverty of speech) and disorganisation syndrome (of which the cardinal feature is positive formal thought disorder) were associated with impaired verbal fluency performance. However, the pattern of correlation with impairments in other putative frontal lobe tasks indicated that the association between impaired verbal fluency and psychomotor poverty arose from a slowness in initiating mental activity, while the association with disorganisation syndrome arose from an impaired ability to select appropriate responses.

In the present study the performance of the depressed patients was identical to that of the normal controls. This shows that poor verbal fluency is not associated with non-specific features of psychiatric illness. Furthermore, poor verbal fluency is not associated with depressed mood. However, the depressed patients did not show marked psychomotor retardation.

Our results show that the verbal fluency performance of schizophrenic patients differed from that of depressed patients. This does not preclude the possibility that some depressed patients might exhibit verbal fluency performance resembling that seen in the schizophrenic patients. In fact, recent studies of the relationships between symptoms and cerebral blood flow using positron emission tomography do provide evidence suggesting that there is overlap in the pathophysiological processes underlying poverty of speech in both conditions. For example, Liddle *et al* (1992) found that in schizophrenic patients the psychomotor poverty syndrome, which includes poverty of speech as a cardinal feature, was negatively correlated with cerebral blood flow in the left dorsolateral prefrontal cortex and left parietal cortex, while Bench *et al* (1992) found that in depressed patients, psychomotor retardation is associated with reduced perfusion at virtually identical cortical sites. Furthermore, the prefrontal cortex site implicated in reduced psychomotor activity in both schizophrenia and depression coincides with the site which Frith *et al* (1991*a*) found to be activated in normal individuals during a verbal fluency task. These findings suggest that there is likely to be some overlap in the pattern of association between symptoms and verbal fluency performance in schizophrenic and depressed patients.

Virtually all patients who exhibit formal thought disorder are capable of producing coherent utterances on at least some occasions, suggesting that the difficulty lies not in the basic ability to produce coherent speech, but rather in the ability to produce coherent speech consistently. Evidence indicates that patients are more likely to produce disordered forms of speech when faced with a challenging task (Cohen, 1978). Our results suggest that a verbal fluency task, in which the subject must generate responses with little external guidance, enhances the likelihood that patients with a propensity to formal thought disorder will produce unusual verbal output.

In this group of patients with persistent symptoms, it is reasonable to assume that the propensity to suffer disordered thought remained relatively constant throughout the study, and hence that the tendency to produce abnormal output in the verbal fluency task remained relatively constant. Insofar as observation of speech in a single clinical interview might underestimate the true likelihood of thought

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disorder, our study was biased towards underestimating the strength of association between formal thought disorder and unusual output in the verbal fluency task.

One possible explanation of the production of inappropriate words by incoherent patients could be that there had been an alteration in the structure of the semantic memory. For example, the pattern of associations might change so that a less common animal, such as 'aardvark', would become the prototypal animal and would therefore be the first animal name elicited. Furthermore the outer boundaries of the category might also be shifted. However, if this was the only problem then the patient would select as many shared words as the controls, even though the actual words selected would be unusual. Our results suggest that incoherent patients have a fundamental problem with the spontaneous retrieval of words from the lexicon.

In order to understand these retrieval difficulties in schizophrenia we need to have a model of the processes that underly performance of the verbal fluency task. We follow Marcel (1983) in distinguishing between the activation and recovery of information from semantic memory. Within this model the conscious recall of information relies not only on the activation of target items in semantic memory but also on a recovery process. In the present context the generation of semantic dimensions (e.g. 'farm animals') within a category leads to the automatic non-conscious activation of semantically related words (e.g. 'cow'). This activation is an unselective process in that all associations of a word are activated and therefore made available for recovery to consciousness (Marcel, 1983). It is in the recovery process that selection takes place.

This analysis suggests that outputs in the repeated verbal fluency task could be differentially affected by impairments in the generation, activation and recovery process. Impairments in generating semantic dimensions would be reflected in the production of fewer shared words. Impairments in the activation of words would reduce the availability of words and would in the present context lead to the production of fewer variable words. Impairments in the word-recovery process would lead to the production of category-inappropriate items or a further restriction of output due to the premature termination of the selection process when difficulties were encountered. An examination of our results within this framework suggests that the word generation and recovery processes, but not activation, are implicated in the production of deviant outputs.

Activation seems to be intact. Tables 3, 5 and 6 show that when the inappropriate responses of those with incoherence are excluded, all schizophrenics showed normal-sized word pools and produced as many variable words as the two control groups, indicating normal activation and therefore word availability. This is consistent with our previous finding which showed that schizophrenic patients did not take longer than normal controls to produce items subsumed under semantic dimensions (Allen & Frith, 1983).

As far as the generation process is concerned, results in Table 3 indicate that the increased discrepancy between availability and output is at least in part due to the impaired generation of semantic dimensions as evidenced by the production of fewer shared words. This impairment leads to a reduction in the accessing of the lexicon and therefore to the production of fewer words. This is consistent with previous results which showed that schizophrenic patients produce fewer semantic dimensions and take longer to generate them (Allen & Frith, 1983). It is also consistent with the finding across a range of studies that schizophrenic performance is impaired when it is necessary to generate ideas or organise information spontaneously without the help of external stimuli (Frith & Allen, 1988). This difficulty in generating new semantic dimensions was a general feature of schizophrenia and was not significantly related to negative features or to incoherence.

While impairments in the generation of semantic dimensions can account for the reduced outputs of schizophrenic patients, it is in the word-recovery process, where selection takes place (Marcel, 1983), that the observed disorganisation (fewer clusters and more inappropriate words) occurs. It is likely that schizophrenics with negative symptoms protect themselves against the selection of inappropriate items by prematurely terminating the selection process, or, in Hemsley's (1977) terms, by escaping from difficulties encountered in this process. This could account for their particularly restricted outputs shown in Table 5 and is also consistent with the findings of a cluster analysis carried out in a previous study (Allen & Firth, 1983), which showed that schizophrenics with negative symptoms produced a higher proportion of single-item clusters and a low proportion of multi-item clusters, indicating a premature termination in the production of clusters.

To conclude, these results support our hypothesis that negative features, including speech disorders, in schizophrenia reflect not a loss of knowledge but difficulties with self-initiated cognitive processes. More specifically, the results suggest that schizophrenic patients have reduced access to semantic memory because of difficulties in organising their search, that is generating semantic dimensions. Schizo-

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phrenics with negative features have, in addition, difficulties in the word-recovery process where selection takes place. This finding pinpoints the locus of deficit for the production of abnormal (restricted and inappropriate) verbal fluency in schizophrenics with negative features. It is hoped that future research will find out more through detailed analyses of this deficit within the retrieval process.

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References

ALLEN, H. A. & FRITH, C. D. (1983) Selective retrieval and free emission of category examplars in schizophrenia. *British Journal of Psychology*, **74**, 481–490.

AMERICAN PSYCHIATRIC ASSOCIATION (1987) *Diagnostic and Statistical Manual of Mental Disorders* (3rd edn, revised) (DSM-III-R). Washington, DC: APA.

ANDREASEN, N. C. (1982) Negative symptoms in schizophrenia. *Archives of General Psychiatry*, **39**, 784–788.

BECK, A. T., WARD, C. H., MENDELSON, M., *et al* (1961) An inventory for measuring depression. *Archives of General Psychiatry*, **4**, 561–571.

BENCH, C. J., FRISTON, K. J., BROWN, R. G., *et al* (1992) The anatomy of melancholia – focal abnormalities of cerebral blood flow in major depression. *Psychological Medicine*, **22**, 607–615.

COHEN, B. D. (1978) Referent communication disturbances in schizophrenia. In *Language and Cognition in Schizophrenia* (ed. S. Schwartz). Hillsdale, NJ: Lawrence Erlbaum.

CROW, T. J. (1980) The molecular pathology of schizophrenia: more than one disease process? *British Medical Journal*, *i*, 66–68.

FRITH, C. D. (1987) The positive and negative symptoms of schizophrenia reflect impairments in the perception and initiation of action. *Psychological Medicine*, **17**, 631–648.

—— & ALLEN, H. A. (1988) Language disorders in schizophrenia and their implications for neuropsychology. In *Schizophrenia: The Major Issues* (eds P. Bebbington & P. McGuffin). Oxford: Heinemann Medical.

——, FRISTON, K. J., LIDDLE, P. F., *et al* (1991*a*) Willed action and the prefrontal cortex in man: a study with PET. *Proceedings of the Royal Society B*, **244**, 241–246.

——, LEARY, J., CAHILL, C., *et al* (1991*b*) Performance on psychological tests. Demographic and clinical correlates of the results of these tests. *British Journal of Psychiatry*, **159** (suppl. 13), 25–29.

GRAESSER, A. & MANDLER, G. (1978) Limited processing capacity constrains the storage of unrelated sets of words and retrieval from natural categories. *Journal of Experimental Psychology: Human Learning and Memory*, **4**, 86–100.

GRUENEWALD, P. J. & LOCKHEAD, G. R. (1980) The free recall of category exemplars. *Journal of Experimental Psychology: Human Learning and Memory*, **6**, 225–240.

HEMSLEY, D. R. (1977) What have cognitive deficits to do with schizophrenic symptoms? *British Journal of Psychiatry*, **130**, 167–173.

JOHNSTONE, E. C., CROW, T. J., FRITH, C. D., *et al* (1978) The dementia of dementia praecox. *Acta Psychiatrica Scandinavica*, **57**, 305–324.

KOLB, B. & WISHAW, I. Q. (1983) Performance of schizophrenic patients on tests sensitive to left or right frontal, temporal or parietal function in neurological patients. *Journal of Nervous and Mental Disease*, **171**, 435–443.

KRAEPELIN, E. (1919) *Dementia Praecox and Paraphrenia*. Edinburgh: Livingstone.

KRAWIECKA, M., GOLDBERG, D. & VAUGHAN, M. (1977) A standardised psychiatric assessment for rating chronic psychotic patients. *Acta Psychiatrica Scandinavica*, **55**, 299–308.

LIDDLE, P. F. (1987) The symptoms of chronic schizophrenia: a reexamination of the positive-negative dichotomy. *British Journal of Psychiatry*, **151**, 145–151.

—— & MORRIS, D. L. (1991) Schizophrenic syndromes and frontal lobe performance. *British Journal of Psychiatry*, **158**, 340–345.

——, FRISTON, K. J., FRITH, C. D., *et al* (1992) Patterns of cerebral blood flow in schizophrenia. *British Journal of Psychiatry*, **160**, 179–186.

MARCEL, A. J. (1983) Conscious and unconscious perception: an approach to the relations between phenomenal experience and perceptual processes. *Cognitive Psychology*, **15**, 238–300.

NEALE, J. M. & OLTMANNS, T. F. (1980) *Schizophrenia*. New York: Wiley.

NELSON, H. E. & O'CONNELL, A. (1978) Dementia: the estimation of premorbid intelligence levels using the new adult reading test. *Cortex*, **14**, 234–244.

OLTMANNS, T. F. & MAHER, B. A. (1989) *Delusional Beliefs*. Chichester: Wiley.

PATTERSON, K. E. (1972) Some characteristics of retrieval limitation in long-term memory. *Journal of Verbal Learning and Verbal Behaviour*, **11**, 685–691.

ROCHESTER, S. & MARTIN, J. R. (1979) *Crazy Talk*. New York: Plenum Press.

SCHNEIDER, K. (1958) *Clinical Psychopathology*. New York: Grune & Stratton.

SLADE, P. D. & BENTALL, R. P. (1988) *Sensory Deceptions: Towards a Scientific Analysis of Hallucinations*. Beckenham, Kent: Croom Helm.

SPITZER, R. L., ENDICOTT, J. & ROBBINS, E. (1978) Research Diagnostic Criteria (RDC): rationale and reliability. *Archives of General Psychiatry*, **35**, 773–782.

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