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Heterogeneity in cognitive functioning of schizophrenic patients evaluated by a lexical decision task

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ABSTRACT

Background. The disorganization pattern in schizophrenia, which involves formal thought disorders, is thought to be correlated with a deficit in integrative processes of contextual information. We tested the hypothesis that thought disordered schizophrenics, unlike non-thought disordered schizophrenics, would present a deficit in the processing of the context during a task which involves these integrative processes.

Methods. A group of 22 schizophrenic patients diagnosed in accordance with DSM-III-R criteria and a group of 11 control subjects were compared using a semantic priming version of the lexical decision task. The experimental design used low-level structuration of verbal material to reveal the difficulty that schizophrenic patients encounter in using semantic regularities.

Results. A significant difference in priming effect was found between the three groups. Control subjects and non-thought disordered schizophrenics exhibit a priming effect for related word pairs when compared with unrelated pairs (respectively $F(1,10) = 17{\cdot}7$; $P < 0{\cdot}002$ and $F(1,10) = 14{\cdot}5$; $P > 0{\cdot}003$) but thought disordered schizophrenics did not ($F(1,10) < 1$; NS).

Conclusions. This finding provides evidence for the cognitive heterogeneity of schizophrenic subjects. This absence of priming effect in thought-disordered schizophrenic subjects supports the hypothesis that these patients present a deficit in the post-lexical controlled information processing that permits the integration of semantic information.

INTRODUCTION

Early studies of information processing in schizophrenic patients sought to find a specific disorder associated with one processing stage such as an abnormality in perceptive processing or an abnormality in language processing (the lexical module was considered to be a good candidate). However, these studies indicated the absence of a specific deficiency in any one particular processing stage. Nevertheless, irrespective of which component was tested (visual or auditive perception, selective attention, language or motor activity) or which type of experiment was used, schizophrenic patients exhibited performance abnormalities. However, as these abnormalities did not always represent a deficiency, with schizophrenic patients performing better on some tasks than normal subjects, the hypothesis of a generalized non-specific defect was excluded (Knight, 1979; Place & Gilmore, 1980).

More recently, integrative models, which suggested a deficit in a supramodular cognitive process, were proposed to explain performance abnormalities in various types of processing.

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These included action monitoring disorder (Frith, 1987, 1992), action planning and control disorder (Widlöcher & Hardy-Baylé, 1989), attentional resource reduction (Nuechterlein & Dawson, 1984) and conscious action control (Weinberger & Berman, 1992).

We have found that a particularly relevant way of observing dysfunction in schizophrenic patients is to study language disorders. The clinical importance of language abnormalities in schizophrenic patients, as emphasized by Bleuler (1911) and included in the European Psychiatric School's definition of schizophrenia, suggests that language behaviour reflects a more generalized cognitive dysfunction.

Integrative cognitive models led to the hypothesis of a deficit in the processing of context. Chapman *et al*. (1976) showed that in a competitive verbal association task, schizophrenic patients chose the dominant meaning of an ambiguous word, even when the context of the sentence implied the non-dominant meaning. Similarly, Swinney (1979) observed that in schizophrenic subjects the meaning of a homonym, even though irrelevant to the context, remained activated for longer than the normally accepted period when it was the most frequent interpretation of the homonym. Cohen & Servan-Schreiber (1992) showed that this incapacity to forget the dominant meaning of an ambiguous word was present only when the context of the sentence preceded the ambiguous word. They concluded that there was a disruption in the representation and maintenance of the contextual information necessary to select the correct response.

The following two hypotheses have clearly emerged from studies of lexical abnormalities in relation to the processing of context in schizophrenic patients.

(i) A deficit in the automatic processing of language. Based on the biological model of hyperdopaminergy, supporters of this hypothesis postulate an automatic hyperactivation of semantically related words and a slower decrease in this hyperactivation (Maher, 1983). This phenomenon might explain schizophrenic patients' inability to use linguistic information integration processes as well as the intrusion of words which are inappropriate to the context during speech.

(ii) A deficit in the processes that inhibit activations that are not relevant to the context. This absence of inhibition, rather than the presence of hyperactivation, might explain this intrusion of words.

Results obtained using the classic word identification task with semantic priming do not provide a clear choice between these two hypotheses. Some authors argue in favour of an abnormality in automatic processing in schizophrenic patients based on findings of hyperpriming in a lexical decision task (Manschrek *et al*. 1988; Spitzer, 1993) and in a perceptive clarification task (Kwapil *et al*. 1990). However, even though very few studies have used a methodology which directly tests automatic processes in verbal information processing, they do provide evidence that these processes are preserved. Henik *et al*. (1992) reported the preservation of repetition priming in schizophrenic patients during a lexical decision task. Ober *et al*. (1995) and Vinogradov *et al*. (1992) used pronunciation tasks, which found that schizophrenic patients, including those with thought disorder, exhibited normal priming effects. Schmand *et al*. (1992) and Schwartz *et al*. (1993) observed semantic priming effects in schizophrenic patients during implicit memory tasks that involve automatic processes. These results are in contrast with the abnormalities frequently observed in schizophrenic patients in memory tasks involving explicit memory (Koh *et al*. 1973; Koh, 1978; Calev, 1984; Goldberg *et al*. 1989).

On the other hand, several studies, which were designed to assess controlled processing, found a reduction in priming and concluded that there was a deficit in these processes in schizophrenic patients (Murchie & Weckowicz, 1980; Henik *et al*. 1992; Vinogradov *et al*. 1992; Ober *et al*. 1995; Passerieux *et al*. 1995).

It is often very difficult to interpret these experiments on semantic priming in schizophrenic patients as most of them have been based on an elementary notion of the distinction between automatic processes and controlled processes. Moreover, this distinction has not always been clearly established. For example, in several studies (Manschrek *et al*. 1988; Kwapil *et al*. 1990; Spitzer, 1993; Blum & Freides, 1995), the presentation time of the context word

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implied the use of controlled processes, whereas the hypothesis centred on automatic processes. On the other hand, the distinction between automatic and controlled processes was based on the incorrect idea that only the conscious processes of anticipation or hypothesis testing could give rise to inhibition.

In fact, preliminary studies on semantic priming, which were designed to test the validity of the distinction between automatic and controlled processes, indicated that the use of very short presentation times of the context word guaranteed the absence of the inhibition effect, which characterizes the so-called 'controlled' processes which can be considered as processes of conscious anticipation.

However, this working hypothesis has been contested ever since the research conducted by de Groot and co-workers (de Groot *et al.* 1982; de Groot, 1984). They found inhibition effects even with time intervals that were just long enough to allow the target word to be identified. These effects increased proportionally with the number of semantically-related pairs and the percentage of non-words. According to these authors, inhibition effects occurred after access to the lexicon and indicated the use of irrepressible compatibility testing between the context word and the target word (post-lexical checking). Even if subjects were unable to anticipate the nature of the target word from the context word, they tested the semantic relationship between these words after lexical access. A similar argument was put forward by Lorch and coworkers (1986).

Post-access semantic inhibition effects signify the start of an irrepressible verification process concerning the relationship between the context word and the test word. In other words, the subject cannot ignore the relationship between the context word and the target word to make a decision on the latter. Our study focused on this irrepressible use of semantic context, which appeared as a priming effect, in schizophrenic patients. The absence of priming effect in these patients might indicate a dysfunction in the integrative processing of the semantic information contained in the context and the test word.

In view of these observations, a review of the literature on lexical decision tasks in schizophrenic subjects provided further evidence of an abnormality in integrative processes. Interpreted as the outcome of post-lexical checking, the priming effect increased with the degree of 'structuration' of the verbal material (i.e. the proportion of semantically related pairs). This proportion did not affect the automatic process of spreading activation. All the studies of lexical decision tasks in schizophrenic patients, which reported a preservation or increase in priming effect, used highly-structured material (proportion of semantically related pairs $> 20\%$) (Manschreck *et al.* 1988; Kwapil *et al.* 1990; Spitzer, 1993; Henick *et al.* 1995). On the contrary, all the studies (except one) that showed a reduction in priming effect, used a percentage of semantically-related pairs equal to 17% (Vinogradov *et al.* 1992; Ober *et al.* 1995; Passerieux *et al.* 1995).

Cognitive studies in psychopathology raised a second set of questions that focus on the link between clinical phenomena and cognitive function. Which clinical disorders are correlated with the cognitive abnormalities observed in schizophrenic patients? Numerous arguments have been put forward as evidence of the cognitive heterogeneity of schizophrenic patients (Harvey, 1987; Liddle, 1987; Liddle & Morris, 1991). The cognitive heterogeneity of schizophrenic patients might explain some of the disagreement in the results of lexical decision studies. We observed that the inhibition effect in two schizophrenic subtypes (i.e. undifferentiated and disorganized) differed in a classic semantic lexical decision task (Passerieux *et al.* 1995). However, we argue that cognitive abnormalities correlate better with behaviour than with diagnosis, and we agree with Liddle about the importance of the clinical pattern of disorganization. This pattern, and especially that of formal thought disorder, seemed to us to be a better candidate for a correlation with the absence of priming effect in schizophrenic patients.

The aim of this study was to replicate the finding of an absence of the use of context in undifferentiated schizophrenic patients and to examine the cognitivo-clinical correlation with formal thought disorder. We, therefore, included schizophrenic patients of differentiated and disorganized type in this experiment but excluded paranoid-type schizophrenic patients.

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Our sample was, therefore, not representative of all types of schizophrenia.

METHOD

Subjects

Twenty-two schizophrenic patients and 11 normal controls were included. Our patients were selected on the basis of whether they belonged to the disorganized or undifferentiated subtypes and formal thought disorder was assessed. Diagnoses were based on DSM-III-R criteria (American Psychiatric Association, 1987). Twelve schizophrenic patients corresponded to the undifferentiated subtype criteria, eight corresponded to the disorganized subtype and two to the residual subtype. Normal controls and schizophrenic patients were similar for socio-cultural variables (Table 1). All were native French speakers.

All the patients tested were followed up as out-patients and their symptoms were stable. All were under neuroleptic treatment. The patients were clinically evaluated by two independent, experienced psychiatrists who were not involved in the experiment. To evaluate thought disorder, the schizophrenic patients were assessed on the TLC scale (Thought, Language and Communication Scale, Andreasen, 1979). The schizophrenic patients were divided into two subgroups on the basis of their score on the TLC: the 'non-thought disordered' schizophrenic group (NTD schizophrenic patients) with a TLC score < 7; and the 'thought-disordered' schizophrenic group (TD schizophrenic patients) with a TLC score $\geqslant 7$ (Table 2).

Table 1. *Demographic characteristics of normal and schizophrenic samples*

	Normal ($N = 11$)	Schizophrenic patients	
		NTD	TD
Mean age, years (S.D.)	28·7 (7·4)	27·1 (7·3)	28·4 (9·2)
Sex			
Female	5	5	3
Male	6	6	8
Left-handed subjects	2	3	3
Socio-educational level			
Primary	1	2	2
Secondary	2	3	3
Graduate	5	2	3
Postgraduate	3	4	3

Material

Various types of semantic relationships were tested: words of the same semantic category, antonymic verbs and adjectives, ambiguous words and their dominant meaning. Two lists were used in the experiment and were balanced across subjects (i.e. each subject saw only one list). They included 90 'prime word/target word' pairs. Each target word appeared in both lists; in one list the target word was immediately preceded by a related prime word (related condition), and in the other list this same target word was preceded by an unrelated word (unrelated condition). A counterbalanced design was used and the lists were matched for word frequency (*Trésor de la Langue Française*) and number of letters. The proportion of related prime-target pairs was 16·7%. Each list contained the same number of word/non-word pairs and word/word pairs.

Non-words were constructed from French words not included in the rest of the material. They were formed by changing a letter or inverting two letters. The phonological rules of French were respected and the graphemic structure of the non-words resembled that of words.

Apparatus

An Olivetti M24 with a monochrome screen was used for the lexical decision task. The words were displayed in the centre of the screen. The response keys were at the extreme left and right ends of the bottom line of the keyboard. The 'YES' response was on the side of the patient's dominant hand and the 'NO' response on the side of the non-dominant hand. The microcomputer was programmed to control presentation time and measure response time.

Procedure

A preliminary experiment with a lexical decision task with semantic priming (data not included in the results) allowed the subject to become familiar with the task. The experiment took about half an hour. The prime word was displayed for 450 ms. After a blank interval of 50 ms, the target word was displayed and deleted when the patient responded. The experimenter controlled the appearance of the words and could interrupt the task at any time.

Subjects were seated in front of the screen and

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Table 2. *Clinical characteristics of the schizophrenic patients*

	NTD group ($N = 11$)	TD group ($N = 11$)
	Mean (S.D.)	Mean (S.D.)
Age at disorder onset, years	21·4 (4)	23·3 (8·4)
Duration of disorder, years	5·7 (4·6)	6·7 (4·7)
TLC score	4·3 (3·2)	17·6 (2·8)

given the following instructions by the experimenter: 'On this screen you are going to see words flashing on and off. They will be in pairs and come one immediately after the other. Sometimes the word will be a real French word and sometimes it will be a nonsense word, just jumbled letters. Your task is to decide whether or not the second word in each pair is really a word. If you think it is, press the "YES" key; if you think it isn't, press the "NO" key. You should try to do this as quickly and as accurately as possible. Remember, you have to decide whether the second word is a real word; just ignore the first word.' During the training stage, the instructions were sometimes reformulated in a slightly different way. When subjects completed the training task correctly, that is to say when they made no more errors and exhibited uniform response times, the test phase commenced and the instructions were no longer reformulated.

RESULTS

All the subjects were able to complete the task. Table 3 presents the mean reaction times for correct responses and for each group. The mean reaction time was calculated from the median reaction time obtained for each experimental subject. This is because in pathological subjects,

Table 3. *Reaction time, means and standard deviations* (S.D.) *for all groups reported in milliseconds*

	Normal controls ($N = 11$)	Schizophrenic patients	
		NTD ($N = 11$)	TD ($N = 11$)
Related words	1087 (134)	1309 (255)	1398 (396)
Unrelated words	1160 (128)	1388 (282)	1390 (360)
Non-words	1188 (157)	1452 (292)	1621 (380)
Priming effect	73 (58)	78 (68)	−8 (72)

Table 4. *ANOVA results comparing semantically related and unrelated pairs of words on the lexical decision task for normal controls and schizophrenic subjects*

Source of variation	Sum of squares	df	*F*	*P*
Mains effects				
Groups	899910	1	6·04	0·02
Conditions	43382	1	15·6	0·0004
Interaction Groups × Conditions	5384	1	1·9	0·17
Error-between	4617012	31		
Error-within	86123	31		

a few long latencies often contribute disproportionately to arithmetic means. The medians are a better reflection of the central tendencies of the underlying reaction time distributions.

Non-parametric analyses were conducted on the sociocultural variables of the normal and schizophrenic subjects. There was no difference between the groups for age, sex ($\chi^2 = 0{\cdot}25$; $P < 0{\cdot}61$) and socio-educational level ($\chi^2 = 6{\cdot}3$; $P < 0{\cdot}18$).

In order to establish the presence of an association effect, a repeated measures ANOVA was conducted on the lexical decision times as a function of the presence or the absence of an associative relationship between the prime word and the target word. This analysis was conducted with diagnosis (controls/schizophrenic patients) as the between-group factor and relationship (related/unrelated pairs) as the within-group factor (Table 4). This first analysis showed a significant effect for the relationship factor ($F(1, 31) = 15{\cdot}6$; $P < 0{\cdot}0004$) and the diagnostic factor ($F(1, 31) = 6{\cdot}04$; $P < 0{\cdot}019$). There was no interaction between these factors ($F = 1{\cdot}9$). The priming effect was significant for the normal controls ($F(1, 10) = 17{\cdot}7$; $P < 0{\cdot}002$), but less significant for the schizophrenic subjects ($F(1, 21) = 4{\cdot}1$; $P < 0{\cdot}055$). As we will see, this reduction in priming in schizophrenic patients was due to the cognitive heterogeneity of the schizophrenic group and the absence of priming in one of the subgroups.

To test our first hypothesis, which postulated that the undifferentiated and the disorganized subtypes would differ on this experiment, a second set of repeated measures ANOVAs was conducted with the type of schizophrenia (according to DSM-III-R criteria) (controls/undif-

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ferentiated schizophrenic patients/disorganized schizophrenic patients/residual schizophrenic patients) as the between-group factor (Table 5). This analysis revealed a significant effect for the type of pairs (related/unrelated) ($F(1, 29) = 6{\cdot}7$; $P < 0{\cdot}01$) and the diagnostic factor ($F(3, 29) = 4{\cdot}42$; $P < 0{\cdot}01$), but the interaction was still not significant. The priming was marginally significant in the disorganized group ($F(1, 7) = 4{\cdot}3$; $P < 0{\cdot}08$) and not significant in the undifferentiated group ($F < 1$).

A third set of repeated measures ANOVAs was conducted to test our main hypothesis of a better correlation between cognitive abnormalities (i.e. absence of semantic priming) and the formal thought disorder symptomatic pattern. Consequently, in this third analysis, we distinguished between the TD schizophrenic patients and the NTD schizophrenic patients (Table 6). We found a significant effect for the relationship factor (related/unrelated pairs) ($F(1, 30) = 17{\cdot}4$; $P < 0{\cdot}0002$), a significant effect for the diagnostic factor (TD schizophrenic patients/NTD schizophrenic patients/controls) ($F(2, 30) = 3{\cdot}01$; $P < 0{\cdot}06$) and a marked interaction between conditions and groups ($F(2, 30) = 5{\cdot}9$; $P < 0{\cdot}007$). Unrelated pairs resulted in much longer response times than related pairs in non-thought disordered patients (1388 ms *v.* 1309 ms). However, no difference was observed in the thought disordered patients (1390 ms *v.* 1398 ms). Specific comparisons confirmed the significant effect of the relationship factor (related/unrelated) in the first group of patients ($F(1, 10) = 14{\cdot}5$; $P < 0{\cdot}003$) and not in the second group of patients ($F < 1$). As the difference in response times between the unrelated pairs and related pairs was considered as an indicator of the priming effect, we concluded that only non-thought disordered patients were sensitive to this effect.

There were few errors in the different groups (3·4% in normal controls, 4·2% in non-thought disordered schizophrenics and 4·7% in thought disordered schizophrenics). A repeated measures ANOVA was conducted on the error rates with diagnosis (controls/NTD schizophrenics/TD schizophrenics) as the between-group factor and relationship as the within-group factor. We found no significant effect.

Table 5. *ANOVA results comparing semantically related and unrelated pairs of words on the lexical decision task for normal controls, disorganized schizophrenic subjects, undifferentiated schizophrenic patients and residual schizophrenic patients*

Source of variation	Sum of squares	df	*F*	*P*
Mains effects				
Groups	1730522	3	4·4	0·01
Conditions	19407	1	6·7	0·01
Interaction Groups × Conditions	7049	3	< 1	NS
Error-between	3786401	29		
Error-within	844457	29		

Table 6. *ANOVA results comparing semantically related and unrelated pairs of words on the lexical decision task for normal controls, non-thought disordered (NTD) schizophrenic subjects and thought disordered (TD) schizophrenic subjects*

Source of variation	Sum of squares	df	*F*	*P*
Mains effects				
Groups	923233	2	3·01	0·06
Conditions	38016	1	17·4	0·0002
Interaction Groups × Conditions	25852	2	5·9	0·007
Error-between	4593690	30		
Error-within	65655	30		

DISCUSSION

The first significant result of this study was the differences between the subgroups of schizophrenic subjects. The result of our first study of the difference between undifferentiated schizophrenic patients and disorganized schizophrenic patients (Passerieux *et al.* 1995) was only partly confirmed. In the *post hoc* analyses, the undifferentiated subgroup, unlike the control subjects, exhibited a priming effect that did not significantly differ from zero. For the disorganized subgroup, the priming effect was only marginally significant but this could be explained by the small size of the sample ($N = 8$). However, when the clinical criterion was formal thought disorder, the differences in priming effect were very clear. Only the schizophrenic patients without thought disorder, or with very mild thought disorder, exhibited a significant priming effect and appeared to be sensitive to context. The

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thought disordered schizophrenic subjects clearly differed from control subjects and non-thought disordered schizophrenic patients. This finding supports the cognitive heterogeneity of schizophrenic patients already reported in the literature (Harvey, 1987; Liddle, 1987). Likewise, in their study of word recognition, Kwapil *et al*. (1990) concluded that it is probable that individual differences exist between schizophrenic patients. However, the material used in their experiment did not allow them to distinguish between a list effect and the cognitive differences between subjects. Our study clearly showed these individual differences and thus, demonstrates the necessity of evaluating the individual profiles of the patients to be tested in order to identify the differences between groups of patients.

This result differs from that of Blum (1995) who found no difference in priming effect between 10 non-thought disordered schizophrenic patients and 10 thought disordered schizophrenic patients. This could be due to differences in experimental design rather than to differences between diagnostic groups. Unlike Blum, we excluded paranoid-type patients from our study. Nevertheless, it is these patients who exhibit the lowest level of formal thought disorder (cf. DSM-III-R), a relative preservation of cognitive functioning and little or no impairment on neuropsychological or other cognitive testing (DSM-IV; Koyama *et al*. 1994).

The second significant result of this study was the type of cognitive abnormality observed in the thought disordered schizophrenic patients group. As we have seen, this type of task revealed a priming effect (longer response times with unrelated word pairs than related word pairs), which indicated the use of semantic matching between the context word and the target word. This effect, present in normal subjects, was only found in non-thought disordered patients. Results obtained with thought disordered schizophrenic patients (absence of priming) supports the hypothesis that these patients present a deficit in semantic information integration processes. The absence of a semantic relationship between the context and target words did not appear to affect the processing of the latter.

To explain the difference between our findings and those of Blum (1995), we suggest that this deficit in thought disordered schizophrenic patients is functional. Our hypothesis was that the schizophrenic patients' difficulty in using the strategic processes of context processing would only appear in the condition of low structuration of the verbal material (low percentage of related pairs). This has been demonstrated in studies of memory: whereas schizophrenic patients regularly exhibited a deficit in using encoding strategies in explicit memory, they performed normally when the structure of the verbal material was reinforced (Koh, 1978). Similarly, as in Blum's study, a high proportion of related words (suggesting the use of semantic matching) should allow thought disordered schizophrenic patients to use this process and thus induce a priming effect. On the contrary, as in our study, these subjects might be insensitive to semantic regularities in a low-structured condition and thus exhibit a deficit in priming effect. This hypothesis needs to be tested by varying the proportion of related pairs in semantic lexical decision tasks performed by the same subjects and, as far as possible, using larger subject groups.

REFERENCES

American Psychiatric Association (1987). *Diagnostic and Statistical Manual of Mental Disorders*, *Third Edition Revised* (*DSM-III-R*). APA: Washington, DC (Traduction française (1989): *DSM-III-R-Critères diagnostiques*, Masson: Paris).

American Psychiatric Association (1989). *Diagnostic and Statistical Manual of Mental Disorders*, *Fourth Edition* (*DSM-IV*). APA: Washington, DC.

Andreasen, N. C. (1979). Thought, language and communication disorders. I. Clinical assessment, definition of terms and evaluation of their reliability. II. Diagnostic significance. *Archives of General Psychiatry* **39**, 778–782.

Bleuler, E. (1911). *Dementia præcox oder gruppe der schizophrenien*. Traduction Française (1993): *Dementia præcox ou groupe des schizophrénies*. (ed. E.P.E.L. & G.R.E.C.) Paris.

Blum, N. A. & Freides, D. (1995). Investigating thought disorder in schizophrenia with the lexical decision task. *Schizophrenia Research* **16**, 217–224.

Calev, A. (1984). Recall and recognition in chronic nondemented schizophrenics: use of matched tasks. *Journal of Abnormal Psychology* **93**, 172–177.

Chapman, L. J., Chapman, J. P. & Dant, R. L. (1976). Schizophrenic inability to disattend from strong aspects of meaning. *Journal of Abnormal Psychology* **85**, 35–40.

Cohen, J. D. & Servan-Schreiber, D. (1992). Context, cortex, and dopamine: a connectionist approach to behavior and biology in schizophrenia. *Psychological Review* **99**, 45–77.

de Groot, A. M. B. (1984). Primed lexical decision: combined effects of the proportion of related prime-target pairs and stimulus-onset asynchrony of the prime and target. *Quarterly Journal of Experimental Psychology* **36A**, 253–280.

de Groot, A. M. B., Thomassen, A. J. W. M. & Hudson, P. T. W. (1982). Associative facilitation of word recognition as measured from a neutral prime. *Memory and Cognition* **10**, 358–370.

https://doi.org/10.1017/S003329179700562X Published online by Cambridge University Press

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.

Frith, C. D. (1992). *The Cognitive Neuropsychology of Schizophrenia*, LEA: Hove.

Goldberg, T. E., Weinberger, D. R., Pliskin, N. H., Berman, K. F. & Podd, M. H. (1989). Recall memory deficit in schizophrenia: a possible manifestation of prefrontal dysfunction. *Schizophrenia Research* **2**, 251–257.

Harvey, P. D. (1987). Laboratory research: its relevance to positive and negative symptoms. In *Positive and Negative Symptoms of Psychosis* (ed. P. D. Harvey and E. E. Walker), pp. 68–93. L.E.A., Hillsdale, New Jersey, Hove and London.

Henik, A., Priel, B. & Umansky, R. (1992). Attention and automaticity in semantic processing of schizophrenic patients. *Neuropsychiatry, Neuropsychology and Behavioral Neurology* **5**, 161–169.

Henik, A., Nissimov, E., Priel, B. & Umansky, R. (1995). Effects of cognitive load on semantic priming in patients with schizophrenia. *Journal of Abnormal Psychology* **104**, 576–584.

Knight, R. A. & Sims-Knight, J. E. (1979). Integration of linguistic ideas in schizophrenics. *Journal of Abnormal Psychology* **88**, 191–202.

Koh, S. D. (1978). Remembering of verbal materials by schizophrenic young adults. In *Language and Cognition in Schizophrenia* (ed. Schwartz), pp. 55–99. Erlbaum: Hillsdale, NJ.

Koh, S. D., Kayton, L. & Berry, R. (1973). Mnemonic organization in young nonpsychotic schizophrenics. *Journal of Abnormal Psychology* **81**, 299–310.

Koyama, S., Hokama, H., Miyatani, M., Ogura, C., Nageishi, Y. & Shimokochi, M. (1994). ERPs in schizophrenic patients during word recognition task and reaction times. *Electroencephalography and Clinical Neurophysiology* **92**, 546–554.

Kwapil, T. R., Hegley, D. C., Chapman, L. J. & Chapman, J. P. (1990). Facilitation of word recognition by semantic priming in schizophrenia. *Journal of Abnormal Psychology* **99**, 215–221.

Liddle, P. F. (1987). Schizophrenic syndroms, cognitive performance and neurological dysfunction. *Psychological Medicine* **17**, 49–57.

Liddle, P. F. & Morris, D. L. (1991). Schizophrenic syndromes and frontal lobe performance. *British Journal of Psychiatry* **158**, 340–345.

Lorch, R. F., Balota, D. A. & Stamm, E. G. (1986). Locus of inhibition effects in the priming lexical decisions: pre or postlexical access. *Memory and Cognition* **14**, 95–103.

Maher, B. (1983). A tentative theory of schizophrenic utterance. In *Progress in Experimental Personality Research: Vol 12. Psychopathology* (ed. B. A. Maher and W. B. Maher), pp. 1–52. Academic Press: New York.

Manschreck, T. C., Maher, B. A., Milavetz, J. J., Ames, D., Weisstein, C. C. & Schneyer, M. L. (1988). Semantic priming in thought disordered schizophrenic patients. *Schizophrenia Research* **1**, 61–66.

Murchie, D. K. & Weckowicz, T. E. (1980). Semantic priming in nonproductive schizophrenia. *Journal of Communication Disorders* **13**, 249–261.

Nuechterlein, K. H. & Dawson, M. E. (1984). Information processing and attentional functioning in the course of schizophrenic disorder. *Schizophrenia Bulletin* **10**, 160–203.

Ober, B. A., Vinogradov, S. & Shenaut, G. K. (1995). Semantic priming of category relations in schizophrenia. *Neuropsychology* **9**, 220–228.

Passerieux, C., Hardy-Baylé, M. C. & Widlöcher, D. (1995). Semantic inhibition disorders patients assessed by a lexical decision task. *European Psychiatry* **10**, 36–43.

Place, E. J. S. & Gilmore, G. C. (1980). Perceptual organization in schizophrenia. *Journal of Abnormal Psychology* **89**, 409–418.

Schmand, B., Kop, W. J., Kuipers, T. & Bosveld, J. (1992). Implicit learning in psychotic patients. *Schizophrenia Research* **7**, 55–64.

Schwartz, B. L., Rosse, R. B. & Deutsch, S. I. (1993). Limits of the processing view in accounting for dissociations among memory measures in a clinical population. *Memory and Cognition* **21**, 63–72.

Spitzer, M. (1993). The psychopathology, neuropsychology, and neurobiology of associative and working memory in schizophrenia. *European Archives of Psychiatry and Clinical Neurosciences* **243**, 57–70.

Swinney, D. A. (1979). Lexical access during sentence comprehension: reconsiderations of context effects. *Journal of Verbal Learning and Verbal Behaviour* **18**, 214–241.

Trésor de la Langue Française (1971). CNRS: Nancy.

Vinogradov, S., Ober, B. A. & Shenaut, K. (1992). Semantic priming of word pronunciation and lexical decision in schizophrenia. *Schizophrenia Research* **8**, 171–181.

Weinberger, D. R. & Berman, K. F. (1992). Evidence for dysfunction of a prefrontal-limbic network in schizophrenia: an MRI and rCBF study of discordant monozygotic twins. *American Journal of Psychiatry* **149**, 890–897.

Widlöcher, D. & Hardy-Baylé, M. C. (1989). Programmation and action control in psychopathology. *European Bulletin of Cognitive Psychology* **9**, 583–616 and 694–703.

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