ELSEVIER

PSYCHIATRY RESEARCH

Psychiatry Research 87 (1999) 169–181

www.elsevier.com/locate/psychres

A breakdown of event schemas in patients with schizophrenia: an examination of their script for dining at restaurants

Agnes S. Chan[a,*], Helen Chiu[b], Linda Lam[b], Alfred Pang[b], Lok-yee Chow[b]

[a] *Department of Psychology, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, China*
[b] *Department of Psychiatry, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, China*

Received 16 September 1998; received in revised form 4 May 1999; accepted 31 May 1999

Abstract

Event schemas, the conceptualization of past experience, in schizophrenic patients were examined based upon script theory. Forty schizophrenic patients and 40 age- and education-matched normal control subjects participated in this study. This experiment consisted of three tasks. In the recall task, subjects recalled a typical scenario of going to a formal restaurant. In the frequency judgment task, subjects determined whether the given events happen frequently, occasionally or rarely in a restaurant. In the sequencing task, the subjects put the randomly presented events in the correct order. The responses of the schizophrenic patients in the recall task, when compared with those of the normal control subjects, had significantly fewer concepts and a greater proportion of highest-frequency concepts. In addition, the sequence of their responses was less accurate than that of normal individuals. This abnormality is unlikely due primarily to a retrieval deficit (i.e. generating fewer concepts in the recall task) given that their performances on the frequency judgment and sequencing tasks, tasks that require less retrieval effort, were consistent with those of the recall task. These results suggest that event schemas in schizophrenic patients contain little detailed information and are incoherent in organization.

Keywords: Memory; Cognition; Free recall; Sorting task

* Corresponding author. Tel.: +86-852-2609-6654; fax: +86-852-2603-5019.
E-mail address: aschan@psy.cuhk.edu.hk (A.S. Chan)

0165-1781/99/$ - see front matter
PII: S0165-1781(99)00051-7

1. Introduction

Language impairment is one prominent characteristic of schizophrenia. Schizophrenic patients often manifest incoherent speech patterns that contain delusional ideas or inappropriate associations. Empirically, performance deficits have been reported for schizophrenic patients on several language tasks including confrontation naming (Barr et al., 1989), auditory and reading comprehension (Silverberg-Shalev et al., 1981), word definition (Paulsen et al., 1994) and verbal fluency (Allen et al., 1993; Goldberg et al., 1995).

Several hypotheses have been proposed to explain the language deficits of patients with schizophrenia. Early hypotheses included deficiency in deductive reasoning (Von Domarus, 1944), over-inclusive thinking (Cameron, 1939, 1954), excessive concreteness of thought (Goldstein, 1944), regression (Gardner, 1931; Kasanin, 1944) and loosening of association (Bleuler, 1911). Some recent evidence also suggests that the language deficits of schizophrenic patients can be attributed to the social perceptual deficits in which those patients were impaired in understanding abstract concepts and emotional aspects of particular situations (Penn et al., 1997; Corrigan and Nelson, 1998). In addition, another hypothesis suggests that the language impairment observed in patients with schizophrenia may be attributed to a breakdown of semantic memory.

Semantic memory was used by Tulving (1985) to describe the stored knowledge for use in language that includes a broad spectrum of information such as the interrelationships among concepts (Collins and Loftus, 1975; Anderson, 1983), and the abstract understanding of past experiences and events (Bartlett, 1932; Schank, 1975; Rumelhart and Ortony, 1977; Schank and Abelson, 1977). Semantic memory was also proposed to be organized in a hierarchical fashion with the most general concepts at the top and more specific features at the bottom (Rosch et al., 1976). A 'bottom-up' breakdown of semantic knowledge is a loss of the specific attributes of some concepts with a relative preservation of more general knowledge.

Evidence supporting the hypothesis of a breakdown of semantic knowledge in patients with schizophrenia came primarily from findings that schizophrenic patients demonstrated impairment on tasks of category verification (Chen et al., 1994), word association (Johnson et al., 1964; Lisman and Cohen, 1972), categorization (McKay et al., 1996), naming (McKay et al., 1996), similarity judgment (Paulsen et al., 1996), and lexical priming (Spitzer et al., 1993; Ober et al., 1995). Although these studies have provided compelling evidence that the organization of semantic knowledge is abnormal in schizophrenia, they were focused on examining the organization of isolated concepts (e.g. the relative closeness between dog and cat). Hence, relatively little is known about the semantic organization of past experiences or typical events (e.g. what is the procedure for doing laundry) in schizophrenia.

It has been well understood that our memories of past experiences or acquired knowledge are organized in a meaningful way. Several theories, including the relatively general ideas of schema (Bartlett, 1932) to a more defined and orderly proposal of scripts (Schank and Abelson, 1977), have been developed to conceptualize the organization of past experiences. Bartlett (1932) first proposed the concept *schema* to refer to memory of generalized concepts underlying situations. Schank (1975) refined the idea and suggested that our knowledge about stereotypic events, such as going to a restaurant, can be encoded according to the parts and sequences of the event. For instance, going to a restaurant may be divided into four parts, namely, entering, ordering, eating and exiting. The four sub-events come one after another, in a particular sequence. Schank used the term *script* to describe these phenomena.

It has been shown that common events have a very similar structure from individual to individual. For example, when subjects were asked to name the 20 most important concepts in an episode of going to a restaurant, concepts such as sit down, look at menu, order, eat, pay bill, and leave were mentioned by at least 73% of the subjects (Bower et al., 1979). The present study adopted the version of script theory proposed by

Schank (1975), and utilized the norms reported by Bower et al. (1979) to examine event schemas in patients with schizophrenia.

The present experiment consisted of three sub-tasks, namely, free-recall, frequency judgment and sequencing. In the free-recall task, subjects would be asked to describe typical events that happen when going to a restaurant. The typicality and the recall order of the items would be analyzed to reveal subjects' general conceptualization of an event. However, given that performance on the free-recall task requires an effortful retrieval, any abnormality may be attributed to a deficit of accessing the semantic knowledge rather than a breakdown of the structure. To distinguish among these possibilities, the frequency judgment and sequencing tasks, which require relatively less retrieval effort, were administered. The frequency judgment task provides information on the individual's understanding of the relative typicality of various items in the schema of going to a restaurant. The sequencing task provides information about the subject's knowledge on the sequential order of the items in the schema. If a breakdown in the structure of semantic knowledge is a prominent characteristic of schizophrenic patients, they would be impaired in recalling, judging and sequencing the items in an event schema.

Table 1
Demographic and clinical characteristics of normal controls and schizophrenic patients[a]

Variable	Normal controls ($n = 40$)	Schizophrenic patients ($n = 40$)
Age (years)	30.4 (9.7)	28.8 (8.5)
Education (years)	10.9 (2.2)	10.2 (1.5)
Gender (% of male)	48%	55%
MMSE	29.7 (0.8)	25.6 (5.5)*
WAIS-R digit span		
Forward	12.9 (1.5)	12.3 (1.6)
Backward	9.1 (3.0)	5.6 (2.5)*
Animal fluency test	17.7 (4.2)	13.2 (3.2)*
Brief Psychiatric Rating Scale		
Total score	–	10.1 (10.7)
Withdrawal/depression factor score	–	4.4 (4.6)
Agitation factor score	–	1.3 (1.6)
Cognitive dysfunction factor score	–	0.6 (1.1)
Hostile suspiciousness factor score	–	0.8 (1.5)
Psychotic distortion factor score	–	2.0 (2.9)
Duration of illness (years)	–	6.3 (5.9)
Age of onset of illness	–	21.8 (7.2)

[a]The values for continuous variables represent means (with S.D. values); *$P < 0.01$.

2. Method

2.1. Subjects

There were 40 patients meeting DSM-IV criteria for schizophrenia, and 40 age- and education-matched normal individuals who consented to participate in the study (Table 1). All patients were recruited from the psychiatric unit of the Chinese University of Hong Kong, which is located at the Prince of Wales and Shatin Hospitals. Patients were diagnosed by senior psychiatrists using a structured interview. The normal individuals were healthy volunteers who were members at the hospitals, and they were recruited through written or verbal invitations. All subjects were Cantonese native speakers and residents of Hong Kong. All normal control subjects reported a negative history of head trauma, alcohol or other substance usage, and any psychiatric and neurological disorders. None of the schizophrenic patients met criteria for a diagnosis of depression, and they had no history of alcohol or substance abuse.

The Brief Psychiatric Rating Scale (Overall and Gorham, 1962) was used to measure the psychiatric symptoms of the schizophrenic patients (Table 1). The total score and five factor scores (Overall and Beller, 1984) suggested that the schizophrenic patients manifested relatively few psychiatric symptoms. Although the schizophrenic patients obtained a significantly lower mean Mini-Mental State Examination (MMSE) score (25.60) than the normal individuals (29.70), their

scores were above the cut-off point for a diagnosis of dementia.

2.2. Procedure

Each subject was tested individually in a quiet room at the Prince of Wales Hospital or the Shatin Hospital. The procedure was administered in a fixed order, and instructions were given in Cantonese. Before doing the experiment, a Cantonese version of the MMSE, the WAIS-R digit span and the animal fluency test were administered to each subject.

For the experimental procedure, the free-recall task was administered first. In this task, the subject was first given an example of the typical order for doing laundry. After the subject reported understanding the instruction, he/she would be given 10 min to generate as detailed a list as he/she could of the typical things that happen, in the right order, when a person goes to a formal sit-down restaurant. The subject was reminded to give only things that usually happen and are typical of going to a restaurant. The responses of the subject were tape-recorded for later transcription and analysis.

After the free-recall task, the frequency judgment task was administered. The subject was shown the following 16 events written on index cards in Cantonese:

> be seated, look at menu, pay bill, leave, order meal, order dessert, eat food, leave tip, waiter brings wrong food, wait 45 min for a table, see a friend, yell at the waiter, wash your car, cut some wood, type a letter, and take a battery out

The first eight items, according to the data reported by Bower et al. (1979), represent the events that usually or always happen when an individual goes to a restaurant. The 9th to 16th items represent unusual events with four infrequent and four improbable events. The events were presented one at a time in a fixed random order, and the subject was told to judge whether each event happens always, occasionally or rarely when he/she goes to a restaurant. A letter size card with the instructions and the three choices of answers was placed in front of the subject. No feedback was given during the task, and the total number of times the subject correctly judged the frequency of the events was calculated at the end of the task.

In the sequencing task, the eight typical events mentioned above were presented again. The examiner put the cards on the table in a fixed random order, and the subject was asked to put the cards into the right order. The response of the subject was recorded without giving any feedback. A subject would obtain one point for correctly putting each pair of adjacent events together, for a possible total score of seven.

2.3. Coding of the free-recall task

The responses of each subject were transcribed and coded according to the sequence in which they were generated (see, e.g., Table 2). There are 25 target items classified as highest-, high-, and mid-frequency events according to the results of Bower et al. (1979). The highest-frequency items are those that were given by over 73% of their subjects, whereas the high- and mid-frequency events were provided by 48% and 25% of their subjects, respectively (see Table 3). The responses that were not target items were classified as low-frequency responses or intrusion errors. Low-frequency responses include events that can, but do not usually, happen in a restaurant (e.g. see a friend). Intrusion errors refer to responses that are very unlikely to happen in a restaurant (e.g. buy a shirt).

The order of the responses was coded and then analyzed. First, the schema were divided into four sub-sections as proposed by Schank and Abelson (1977): (1) entering; (2) ordering; (3) eating; and (4) leaving. After all the responses were classified into these sub-sections, the recall orders of the responses in all sub-sections were averaged (Table 2). The average score was referred to as the temporal index. If a subject recalled the events in an accurate order, the temporal indices of the four sub-sections would increase from entering to leaving. (see Table 2). However, if a subject's response consisted of minor ordering errors (e.g.

Table 2
An example to demonstrate the coding system developed for analyzing the responses of subjects in the present study[a,b]

Items in each section	Generated order	Typicality rank
(1) Entering		
I enter the restaurant	1	High frequency
Look for a table	2	Mid frequency
I sit down	3	Highest frequency
Temporal index: $(1 + 2 + 3)/3 = 2$		
(2) Ordering		
Order	4	Highest frequency
Pork chop	5	Low frequency
Temporal index: $(4 + 5)/2 = 4.5$		
(3) Eating		
I eat	6	Highest frequency
Pretty good	7	Low frequency
Temporal index: $(6 + 7)/2 = 6.5$		
(4) Exiting		
I leave	8	Highest frequency
Go home	9	Low frequency
Temporal index: $(8 + 9)/2 = 8.5$		

[a]A response: I enter the restaurant, and look for a table. I sit down, order pork chop. I eat, it is pretty good. I leave, go home.
[b]Typicality rank was constructed based upon the normative data of Bower et al. (1979).

a subject mentions that he orders food when he is recalling the events about entering the restaurant), the difference of the temporal indices between sub-sections would be less prominent.

The present data were coded and scored as mentioned above by two native Cantonese-speaking raters who were blind to the identification of the subjects. All the variables of the free-recall task were evaluated by a Pearson correlation, and the results suggested the inter-rater reliability was significant ($r = 0.92$, $P < 0.01$).

3. Results

3.1. Nature of the concepts in an event schema

3.1.1. Free-recall task

The total number of responses in the free-recall task for the normal individuals (mean = 15.88, S.D. = 8.85) and the patients with schizophrenia (mean = 9.10, S.D. = 3.66) were significantly different ($t = 4.38$, $P < 0$ 001). To evaluate the pattern of recall in the sub-sections, repeated measures ANOVA with group as an independent variable and number of items generated in each sub-section as dependent variables was performed. Given that the Mauchly sphericity test was significant ($W = 0.81$, $P < 0.01$), the degrees of freedom on all significant results were adjusted by a Greenhouse–Geisser Epsilon of 0.89. The results showed that while the effects of the Group $\times$ Section interaction ($F_{3,234} = 1.24$, n.s.) and of section ($F_{3,208} = 2.74$, n.s.) were not significant, the effect of group was significant ($F_{1,69} = 20.02$, $P < 0.01$). These results showed that the normal individuals generated more items than did the patients in describing an episode of going to a restaurant. However, for both the normal subjects and the schizophrenic patients, the numbers of items generated across the four sections were not significantly different.

The analyses on the percentages of individuals' total responses (Fig. 1) that were highest-, high- and mid-frequency items revealed that the effects of the Group $\times$ Response type interaction ($F_{2,156}$

Table 3
Empirical script norms adopted from Bower et al. (1979) and obtained from the present study[a]

Adopted from Bower et al. (1979)	Normal controls ($n = 40$)	Schizophrenic patients ($n = 40$)
(1) Entering		
Open door		
Enter	Enter (48%)	Enter (30%)
Give restaurant name		
	Look for table (35%)	Look for table (40%)
Wait to be seated		
Go to table	Go to table (25%)	
BE SEATED	Be seated (65%)	Be seated (55%)
(2) Ordering		
Order drinks	Order drinks (60%)	Order drinks (28%)
Put napkins on lap		
	Get menu (28%)	
LOOK AT MENU	Look at menu (48%)	
Discuss menu		
ORDER MEAL	ORDER MEAL (93%)	ORDER MEAL (78%)
Talk		
Drink water	Drink water (28%)	
(3) Eating		
Eat salad or soup		
Meal arrive	Meal arrive (50%)	
EAT FOOD	EAT FOOD (73%)	Eat food (50%)
Finish meal	Finish meal (58%)	Finish meal (43%)
Order dessert		
Eat dessert		
(4) Exiting		
Ask for bill	Ask for bill (48%)	Ask for bill (33%)
Bill arrives		
PAY BILL	PAY BILL (85%)	Pay bill (68%)
Leave tip		
Get coats		
LEAVE	LEAVE (83%)	LEAVE (75%)

[a]Concepts in all capital letters were generated by the most subjects (73%), underlined concepts by fewer subjects (48%), and concepts in small case letters by the fewest subjects (25%).

$= 4.44$, $P = 0.01$) and of response type ($F_{2,156} = 97.01$, $P < 0.01$) were significant. The percentage of total responses that were highest-frequency items generated by the schizophrenic patients was significantly higher than that of the normal individuals ($t_{78} = 2.22$, $P < 0.05$). However, the percentages of total responses generated by the normal individuals and the schizophrenic patients that were high-frequency items ($t_{78} = 1.60$, n.s.) and mid-frequency ones ($t_{78} = 0.22$, n.s.) were not significantly different. These results suggested that the responses generated by the schizophrenic patients, as compared with the normal controls, consisted of a significantly greater proportion of highest-frequency items.

Given that the participants in the present study were Chinese, and those in Bower and his colleagues' study were Caucasian, the event schema of going to a restaurant may vary between the two cultures. Hence, the frequencies of responses of

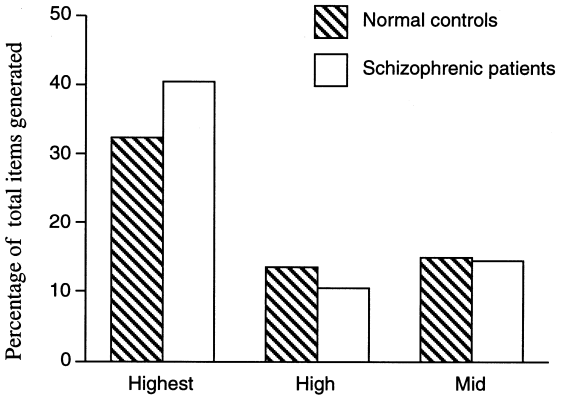

Fig. 1. Percentage of total items generated that were highest-, high- and mid-frequency responses in the free-recall task for normal controls and schizophrenic patients.

the normal control subjects and the schizophrenic patients were examined in detail (Table 3). Four out of the six (4/6) highest-frequency responses reported by Bower and his colleagues were also generated by more than 73% of the normal individuals in the present study. In addition, two out of the nine (2/9) high-frequency responses and five out of the 10 (5/10) mid-frequency responses were generated by more than 48% and 25% of the normal individuals, respectively. On the other hand, patients with schizophrenia generated 2/6, 0/9 and 2/10 highest-, high- and mid-frequency responses, respectively.

Next, the schema of the schizophrenic patients was compared with that of the normal control subjects. Six highest-frequency (generated by at least 60% of the normal control subjects), nine high-frequency (given by at least 25% of the subjects) and six mid-frequency (recalled by at least 15% of the normal controls) target items were classified. In addition to the items listed in Table 3, the following items (with percentage of the subjects generating the items) were also included: wait to be seated (18%), talk (20%), order dessert (15%), eat dessert (15%) and leave tip (15%). When compared with normal individuals, the schizophrenic patients generated, on average, 56% (S.D. = 24.07), 22% (S.D. = 14.39) and 12% (S.D. = 13.71) of the highest-, high- and mid-frequency target items, and these differences were significant ($F_{2,78} = 86.78$, $P < 0.01$).

For the schizophrenic patients, the highest-frequency target items represented 28% (S.D. = 11.56) of the total responses, whereas the high- and mid-frequency items accounted for 17% (S.D. = 11.07) and 6% (S.D. = 6.82) of the total responses, respectively. In addition, the responses generated by the schizophrenic patients consisted of significantly more highest-frequency responses than high-frequency ones ($t_{39} = 5.17$, $P < 0.01$), and more high-frequency responses than mid-frequency ones ($t_{39} = 5.22$, $P < 0.01$).

3.1.2. Frequency judgment task

The performances on the frequency judgment task (Fig. 2) were analyzed by a repeated measures ANOVA with Group as an independent variable and Response Type as a dependent variable. The results showed significant effects of Group ($F_{1,70} = 16.46$, $P < 0.01$; degrees of freedom were corrected by an Epsilon of 0.90) and Response Type ($F_{2,140} = 28.82$, $P < 0.01$). The Group × Response Type interaction was marginally significant ($F_{2,140} = 3.02$, $P < 0.05$). The schizophrenic patients, when compared with the normal individuals, committed 19% more errors on judging the events that sometimes happen ($t = 3.27$, $P < 0.01$), 10% more errors on identifying the usual items ($t = 2.36$, n.s.), and 5% more errors in selecting the seldom occurring events ($t = 1.76$, n.s.). These results, consistent with those obtained from the free-recall task, suggested that the event schema in the schizophrenic patients seems to be deteriorated, and with the disproportionate loss of more infrequent concepts than typical ones.

3.2. Sequence of the concepts in an event schema

3.2.1. Free-recall task

The sequence of recall was analyzed by a (Group × Index) repeated measures ANOVA. The results showed that the Group × Index interaction ($F_{3,234} = 15.94$, $P < 0.01$), Group ($F_{1,78} = 19.93$, $P < 0.01$) and Index ($F_{3,234} = 145.63$, $P < 0.01$) effects were significant. Post hoc t-tests showed that the normal individuals' temporal indices of entering ($t_{78} = 2.49$, $P < 0.05$), ordering ($t_{78} = 3.86$, $P < 0.01$), eating ($t_{78} = 4.62$, $P < 0.01$)

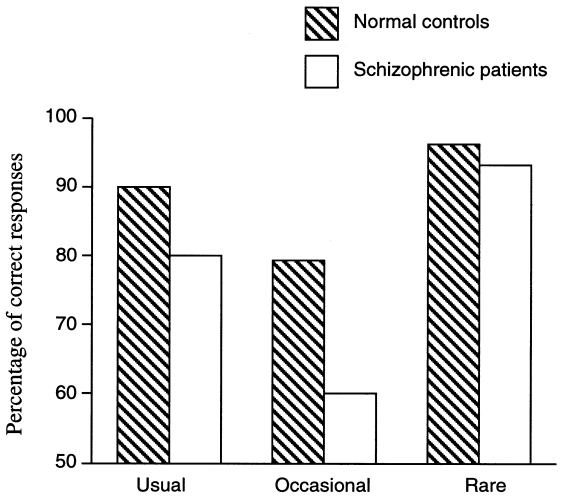

Fig. 2. Percentage of correct responses in classifying usual, occasional and rare concepts in the judgment of frequency task for normal controls and schizophrenic patients.

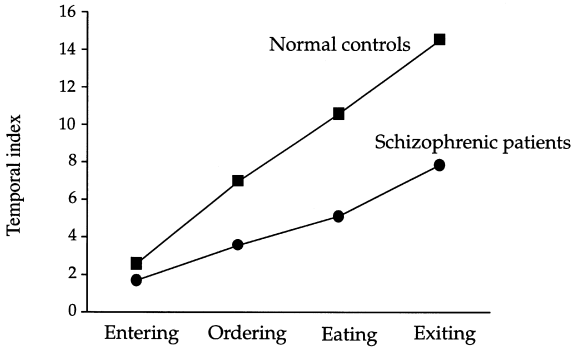

Fig. 3. The temporal indices of the four sub-sections in the free-recall task.

and exiting ($t_{78} = 4.39$, $P < 0.01$) were significantly higher than those of the schizophrenic patients (Fig. 3). These results were not surprising as the normal individuals generated significantly more concepts than the schizophrenic patients in all sections. To evaluate the increasing rate of the temporal indices between the two groups of subjects, the difference between the temporal indices of adjacent sections (i.e. ordering–entering, eating–entering, and exiting–eating) were calculated. The results showed that the difference between temporal indices of ordering and entering of the normal individuals (mean = 4.40, S.D. = 3.23) was significantly higher ($t_{78} = 4.07$, $P < 0.01$) than that of the schizophrenic patients (mean = 1.89, S.D. = 2.19). The differences of the temporal indices between entering and eating for the normal individuals and the schizophrenic patients were 3.60 (S.D. = 3.28) and 1.53 (S.D. = 3.26), respectively, and were significantly different ($t_{78} = 2.83$, $P < 0.01$). The difference in temporal indices of the latter two sections were 3.40 (S.D. = 3.32) and 2.73 (S.D. = 3.51) for the normal control subjects and schizophrenic patients, respectively. These scores were not significantly different ($t_{78} = 1.61$, n.s.). Thus, the schizophrenic patients, like the normal control subjects, tended to follow the sequential order of the four sub-sections in recalling the event, but committed some errors in describing the details.

As mentioned before, the temporal indices should be ascending from the sections entering to exiting. Chi-square analyses were performed to examine the number of subjects whose recall did not follow this pattern. The results showed that eight schizophrenic patients have a temporal index for the entering section which is higher than that of the ordering section whereas none of the normal individuals demonstrated this pattern ($\chi^2 = 8.89$, $P < 0.01$). When comparing the temporal indices of ordering and eating, 13 schizophrenic patients and two normal individuals demonstrated a higher temporal index for ordering than for eating ($\chi^2 = 9.93$, $P < 0.01$). In addition, seven schizophrenic patients showed a higher temporal index of the section eating than that of exiting, whereas only one normal individual demonstrated this pattern ($\chi^2 = 5.00$, $P < 0.05$).

3.2.2. Sorting task

The results of the sorting task were consistent with those of the free-recall task in which the schizophrenic patients (mean = 5.88, S.D. = 2.20) committed significantly more errors than the normal individuals (mean = 6.78, S.D. = 0.83) in putting the events in correct order ($t = 2.42$, $P <$

0.01). Thus, it seems that the abnormality demonstrated by the schizophrenic patients in the free-recall task cannot be totally due to a retrieval problem.

3.3. The event schema of schizophrenic patients at acute and chronic stages

To examine the effects of chronicity of illness on the event schema, schizophrenic patients were divided into two groups. Subjects with duration less than 5 years were considered as acute and subjects with duration of illness more than 5 years were considered as at a chronic stage of illness. Patients at the acute stage (24) were significantly younger than those at the chronic stage (33.5; $t_{38} = 4.20$, $P < 0.01$), and the two groups of patients were matched for the level of education (chronic: 10.1, acute: 10.4, $t_{38} = 0.53$, n.s.)

As shown in Table 4, there were no significant differences on the total numbers of items generated in the free-recall task ($t = 0.34$, n.s), nor were there significant differences on the numbers of responses in the entering ($t = 0.32$, n.s.), ordering ($t = -0.42$, n.s.), eating ($t = 0.76$, n.s.) and exiting ($t = 0.51$, n.s.) sections. The percentages of highest- ($t = 0.37$, n.s.), high- ($t = 0.18$, n.s.) and mid-frequency ($t = 0.45$, n.s.) generated by the acute and chronic groups were also not significantly different. For the frequency judgment task, the number of times that the chronic group correctly identified the usual events ($t = 0.66$, n.s.), occasional events ($t = 1.59$, n.s.) and seldom events ($t = 0.58$, n.s.) was not significantly different from that for the acute group. The performance of the two groups of patients on the sorting task was also not significantly different ($t = 0.50$, n.s.). Overall, these results revealed that performance of the schizophrenic patients at both the acute and chronic stages did not differ significantly in tasks for examining an event schema.

Table 4
The performance of patients at the acute stage and at the chronic stage on the free-recall, frequency judgment and sorting tasks[a]

Items	Acute patients ($n = 20$)	Chronic patients ($n = 20$)
(A) Free-recall task		
Total number of responses	9.3 (3.6)	8.8 (3.8)
Items generated in the sub-section of		
Entering	2.3 (2.1)	2.0 (1.9)
Eating	2.4 (2.3)	1.9 (1.8)
Ordering	2.4 (1.7)	2.9 (2.3)
Exiting	2.4 (1.6)	2.1 (1.6)
Percentage of possible responses of		
Highest-frequency items	57.5 (17.5)	54.2 (23.5)
High-frequency items	13.2 (10.3)	12.5 (11.5)
Mid-frequency items	12.7 (8.0)	11.4 (11.0)
(B) Frequency judgment task		
Percentage correct in judging		
Usual events	91.3 (14.7)	95.0 (25.1)
Occasional events	67.5 (31.1)	52.5 (28.0)
Rare events	77.5 (26.2)	82.5 (21.6)
(C)Sorting task		
Number correct	6.1 (1.9)	5.7 (2.5)

[a] The values for continuous variables represent means (with S.D.).

4. Discussion

Results of the present study suggest that event schemas of the patients with schizophrenia are abnormal as compared with their age- and education-matched counterparts. That is, although their event schemas contain general structure, they are characterized by a deterioration of detailed information and by an incoherent organization. Specifically, when patients with schizophrenia were asked to describe an episode of going to a restaurant, their description consisted of four sub-sections (i.e. entering, ordering, eating and exiting) which suggested that the general structure of their event schema is relatively preserved. However, their description, when compared with normal control subjects, was dominated by typical events and consisted of relatively fewer details. In

terms of the sequence of their responses, they generated the episode according to the typical order (i.e. entering–ordering–eating–exiting). However, they tended to confuse the sequential orders of detailed events among the sub-sections.

It should be noted that the performance of schizophrenics in the free-recall task most likely reveals a deterioration of the event schema rather than an inability to access an intact schematic structure. Evidence supporting this notion came from the patients' performance on the frequency judgment and sorting tasks. These tasks, compared with the free-recall task, require less effortful retrieval ability. However, schizophrenic patients were impaired on judging the typicality of the items and putting the items in a correct sequence. Thus, although the schizophrenic patients generated less information than normal individuals in the free-recall task, this retrieval deficit cannot totally account for their impairment on the description of an event schema.

The present results suggested that the deterioration of event schema in schizophrenic patients seems to follow a 'bottom-up' pattern. That is, they demonstrated a loss of the specific attributes of an event schema with a relative preservation of more general knowledge. If the semantic representations of knowledge are viewed as being organized in a hierarchical fashion, with the most general concepts at the top and more specific features at the bottom (Rosch et al., 1976), then the schizophrenic patients in the present study demonstrated a progressive 'bottom-up' breakdown in the hierarchical organization of the semantic organization of an event.

The 'bottom-up' pattern of deterioration was also observed in the patients' organization of concepts. McKay et al. (1996) required their subjects to sort 48 stimuli into the global categories of living vs. man-made, then to sort the living items and man-made items into three superordinate categories (e.g. land animal vs. sea creature vs. bird), and finally to sort the stimuli on the basis of subordinate attributes (e.g. locality, size and fierceness). They reported that the performance of schizophrenic patients was significantly different from that of normal control subjects for all but the first-level (living vs. man-made) sorting task. These results, which were consistent with the present findings, suggested that knowledge about general concepts at the global level was relatively preserved in schizophrenic patients. However, they demonstrated a loss of knowledge on specific features or attributes.

Semantic memory impairment of schizophrenic patients has been demonstrated by many studies, although not all findings are consistent (Koh, 1978; Ober et al., 1995). A relatively more convincing result came from a study employing a comprehensive semantic memory test battery including tasks of sorting, category fluency, naming, word-to-picture matching and definition, which revealed that schizophrenic patients performed significantly worse than normal controls on almost all the subtests, although variation among schizophrenic patients was noted (McKay et al., 1996). Other studies supporting the hypothesis of semantic memory impairment in schizophrenic patients came from the sentence verification task (i.e. Silly Sentences Test) in which the schizophrenic patients were slower and made more errors than the normal controls (Tamlyn et al., 1992) and patients with alcoholic Korsakoff syndrome (Duffy and O'Carroll, 1994) in determining if a sentence was true or false. Evidence from various priming studies (Manschreck et al., 1988; Kwapil et al., 1990; Spitzer et al., 1993; Chen et al., 1994; Ober et al., 1995) and a similarity judgment task (Paulsen et al., 1995) also suggested that the semantic network of schizophrenic patients was different from that of normal individuals in various ways.

While the majority of studies on semantic memory in schizophrenic patients suggested that the semantic organization of concepts (i.e. words) in schizophrenia was impaired, the present study suggests that the semantic organization of events in schizophrenia may also be impaired. Although it is conceivable to speculate that the abnormality of the organization of an event may be a feature of the thought disorders of the patients, the present results do not support this speculation. Given that the patients participating in this study demonstrated relatively few symptoms of thought

disorder as measured by the psychotic distortion factor score of the BPRS but manifested abnormal event schema, the semantic impairment cannot be considered a symptom of their thought disorders. Rather, the semantic memory impairment may be an underlying factor of thought disorders in schizophrenia.

The present results suggested that the schematic organization of event schema in schizophrenic patients at the acute stage was as impaired as that of patients at the chronic phrase. This result is consistent with that reported by Chen et al. (1994) in which they did not find a significant correlation between the level of chronicity and the integrity of the semantic network in schizophrenia. McKay et al. (1996) also reported no major difference between chronic severe and mild groups of schizophrenic patients in various semantic memory tests. However, Paulsen et al. (1996) reported that patients with a younger age of onset, but not those with a late onset, demonstrated abnormal semantic networks. Overall, the findings of several studies suggest that the semantic memory impairment in schizophrenia is manifested at the early stage of this psychiatric illness, and the impairment does not seem to deteriorate in the later stage of the illness.

Schema theory, since initially proposed by Bartlett in 1932, has generated much research interest in the area of cognitive psychology. Studies have been conducted on understanding the structures that represent knowledge in human memory (Minsky, 1975; Schank, 1975; Rumelhart and Ortony, 1977), the influence of previous experience on subjects' memory and comprehension of new events (Anderson, 1984), the influence of mental state on the construction of event schema (Andersen et al., 1992), and the application of an expert system as a knowledge engineer (Nosek and Roth, 1990). While schema theory has enjoyed much attention in the area of cognitive psychology, this model has not been widely applied in neuropsychology or neuropsychiatric domains. Hence, very little is known about the neuropsychological aspects of schematic development and organization. Given that schizophrenic patients are known to have frontal-lobe dysfunction (Weinberger et al., 1986; Berman et al., 1988) and demonstrate abnormal structure of semantic knowledge, one speculation is that the development and organization of past experience into a schematic formation may be mediated by the frontal system. Although this speculation is conceivable given that the frontal system is responsible for planning and organizing, more studies on the schema of various patients with frontal-lobe dysfunction are needed to validate this speculation.

Acknowledgements

This study was in part funded by the Chinese University of Hong Kong Direct Grant. We thank Qian-lin Chen, Maggie Ng, Issac Kwok, Mei-Chun Cheung and Jeanny Tan for assistance with data collection and management, and Dr. Twila Tardif for insightful comments on an earlier version of this article.

References

Allen, P.A., Weber, T.A., May, N., 1993. Age differences in letter and color matching: selective attention or internal noise? Journal of Gerontology: Psychological Sciences 48, 69–77.

Anderson, J.R., 1983. A spreading activation theory of memory. Journal of Verbal Learning and Verbal Behavior 22, 261–295.

Anderson, R.C., 1984. Role of the reader's schema in comprehension, learning, and memory. In: Anderson, R.C., Osborn, J., Tierney, F.J. (Eds.), Learning to Read in American Schools: Basal Readers and Content Texts. Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 243–272.

Andersen, S.M., Spielman, L.A., Bargh, J.A., 1992. Future-event schemas and certainty about the future: automaticity in depressives' future-event predictions. Journal of Personality and Social Psychology 63, 711–723.

Barr, W.B., Bilder, R.M., Goldberg, E., Kaplan, E., Mukherjee, S., 1989. The neuropsychology of schizophrenic speech. Journal of Communication Disorders 22, 327–349.

Bartlett, F.C., 1932. Remembering: A Study in Experimental and Social Psychology. Cambridge University Press, New York and London.

Berman, K.F., Illowsky, B.P., Weinberger, D.R., 1988. Physiologic dysfunction of dorsolateral prefrontal cortex in schizophrenia. IV. Further evidence for regional and behavioral specificity. Archives of General Psychiatry 45, 616–622.

Bleuler E., 1911. Dementia Praecox or the Group of Schizophrenias (translated 1950 by J. Zinkin). International Universities Press, New York.

Bower, G.H., Black, J.B., Turner, T.J., 1979. Scripts in memory for text. Cognitive Psychology 11, 177–220.

Cameron, N., 1939. Schizophrenic thinking in a problem-solving situation. Journal of Mental Science 85, 1012–1035.

Cameron, N., 1954. Experimental analysis of schizophrenic thinking. In: Kasanin, J.S. (Ed.), Language and Thought in Schizophrenia. University of California Press, Berkeley, CA, pp. 55–63.

Chen, E.Y.H., Wilkins, A.J., McKenna, P.J., 1994. Semantic memory is both impaired and anomalous in schizophrenia. Psychological Medicine 24, 193–202.

Collins, A.M., Loftus, E.F., 1975. A spreading-activation theory of semantic processing. Psychological Review 82, 407–428.

Corrigan, P.W., Nelson, D.R., 1998. Factors that affect social cue recognition in schizophrenia. Psychiatry Research 78, 189–196.

Duffy, L., O'Carroll, R., 1994. Memory impairment in schizophrenia — a comparison with that observed in the Alcoholic Korsakoff Syndrome. Psychological Medicine 24, 155–165.

Gardner, G.E., 1931. The measurement of psychotic age: a preliminary report. American Journal of Psychiatry 10, 963–975.

Goldberg, T.E., Berman, K.F., Weinberger, D.R., 1995. Neuropsychology and neurophysiology of schizophrenia. Current Opinion in Psychiatry 8, 34–40.

Goldstein, K., 1944. Methodological approach to the study of schizophrenic thought disorder. In: Kasanin, J.S. (Ed.), Language and Thought in Schizophrenia. University of California Press, Berkeley, CA, pp. 17–40.

Johnson, R.C., Weiss, R.L., Zelhart, P.F., 1964. Similarities and differences between normal and psychotic subjects in response to verbal stimuli. Journal of Abnormal and Social Psychology 58, 221–228.

Kasanin, J.S., 1944. Language and Thought in Schizophrenia. University of California Press, California.

Koh, S.D., 1978. Remembering of verbal materials by schizophrenic young adults. In: Schwartz, S. (Ed.), Language and Cognition in Schizophrenia. Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 55–69.

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.

Lisman, S.A., Cohen, B.D., 1972. Self-editing deficits in schizophrenia: a word-association analogue. Journal of Abnormal Psychology 79, 181–188.

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.

McKay, A.P., McKenna, P.J., Bentham, P., Mortimer, A.M., Holbery, A., Hodges, J.R., 1996. Semantic memory is impaired in schizophrenia. Biological Psychiatry 39, 929–937.

Minsky, M., 1975. A framework for representing knowledge. In: Winston, P. (Ed.), The Psychology of Computer Vision. McGraw-Hill, New York, pp. 211–281.

Nosek, J.T., Roth, I., 1990. A comparison of formal knowledge representation schemes as communication tools: predicate logic vs. semantic network. International Journal of Man-Machine Studies 33, 227–239.

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

Overall, J.E., Beller, S.A., 1984. The Brief Psychiatric Rating Scale (BPRS) in geropsychiatric research: 1. Factor structure on an inpatient unit. Journal of Gerontology 39, 187–193.

Overall, J.E., Gorham, D.R., 1962. The Brief Psychiatric Rating Scale. Psychological Reports 10, 799–812.

Paulsen, J.S., Heaton, R.K., Jeste, D.V., 1994. Neuropsychological impairment in tardive dyskinesia. Neuropsychology 8, 227–241.

Paulsen, J.S., Heaton, R.K., Sadek, J.R., Perry, W., Delis, D.C., Braff, D., Kuck, J., Zisook, S., Jeste, D.V., 1995. The nature of learning and memory impairments in schizophrenia. Journal of the International Neuropsychological Society 1, 88–99.

Paulsen, J.S., Romero, R., Chan, A., Davis, A., Heaton, R., Jeste, D., 1996. Impairment of the semantic network in schizophrenia. Psychiatry Research 63, 109–121.

Penn, D.L., Corrigan, P.W., Bentall, R.P., Racenstein, J.M., Newman, L., 1997. Social cognition in schizophrenia. Psychological Bulletin 121, 114–132.

Rosch, E., Mervis, C.B., Gray, W., Johnson, D., Boyes-Braem, P., 1976. Basic objects in natural categories. Cognitive Psychology 8, 382–439.

Rumelhart, D.E., Ortony, A., 1977. The representation of knowledge in memory. In: Anderson, R.C., Spiro, R.J., Montague, W.E. (Eds.), Schooling and the Acquisition of Knowledge. Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 99–135.

Schank, R.C., 1975. Conceptual Information Processing. North-Holland, Amsterdam.

Schank, R.C., Abelson, R., 1977. Scripts, Plans, Goals, and Understanding. Lawrence Erlbaum Associates, Hillsdale, NJ.

Silverberg-Shalev, R., Gordon, H.W., Bentin, S., Aranson, A., 1981. Selective language deterioration in chronic schizophrenia. Journal of Neurology, Neurosurgery and Psychiatry 44, 547–551.

Spitzer, M., Braun, U., Hermle, L., Maier, S., 1993. Associa-

tive semantic network dysfunction in thought-disordered schizophrenic patients: direct evidence from indirect semantic priming. Biological Psychiatry 34, 864–877.

Tamlyn, D., McKenna, P.J., Mortimer, A.M., Lund, C.E., Hammond, S., Baddeley, A.D., 1992. Memory impairment in schizophrenia: its extent, affiliations and neuropsychological character. Psychological Medicine 22, 101–115.

Tulving, E., 1985. How many memory systems are there? American Psychologist 40, 385–393.

Von Domarus, E., 1944. The specific laws of logic in schizophrenia. In: Kasanin, J.S. (Ed.), Language and Thought in Schizophrenia. University of California Press, Berkeley, CA, pp. 104–114.

Weinberger, D.R., Berman, K.F., Zec, R.F., 1986. Physiological dysfunction of dorsolateral prefrontal cortex in schizophrenia. 1. Regional cerebral blood flow evidence. Archives of General Psychiatry 43, 114–125.