

ASSESSMENT OF THE CONCEPTUAL STRUCTURE THAT USES ASSOCIATION EXPERIMENTS FOR SCHIZOPHRENICS: COMPARING SCHIZOPHRENIC PATIENTS WITH HEALTHY ADULTS WHO USES THE ASSOCIATION NUMBER OF WORDS AND BETWEEN CONCEPTS

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Abstract

This research examined the conceptual structure of semantic memory in schizophrenics. The study involved nineteen schizophrenics and twenty-one normal controls and employed an associative concept dictionary. The relationship between number of words and distance between concepts was examined using the association experiment. The association concept dictionary to examine the conceptual structure in man's memory using large-scale association experiments is structuring of the associative memory. The result of the experiment suggested that the schizophrenics correctly inferred the distance between concepts and the association number of words, and that the conceptual structure was different. Using an association experiment, it is possible to research a schizophrenic patient's long-term meaning memory and its relation to the symptoms in further detail, based on a substantial amount of information on the conceptual structure. In addition, the distance between concepts was significantly high in the schizophrenic patients compared with that of the controls.

The cognitive dysfunction of schizophrenia relates to the quality of life (QOL) and the social function prognosis of the patient; in addition, in recent years, QOL has been considered as a potential endophenotype of this disease. Moreover, it is believed that higher-order acknowledgment functions such as long-term meaning memory also accomplish a key role in the maintenance of QOL (Sumiyoshi, 2006). It is based on the experimental work of Collins & Quillian (1969), that meaning memory came to be adopted as a subject area in psychology. Moreover, the technique for evaluating the QOL was developed by Chan (1993), using the verbal fluency task (VFT) based on the utterance data especially obtained through the category fluency task (CFT). The long-term meaning storage research using the abovementioned technique has been accumulated for Alzheimer's disease and schizophrenic patients since the latter half of the 1990s. However, the problem in the methodology lies in the analysis that uses the VFT. Concretely, the problems in the analysis relate to the following three points: (1) "An individual's trouble cannot be precisely measured," (2) "weakness of the algorithm," and (3) "necessity for a new index."

On the other hand, Okamoto, et al. (2001) collected a man's concept information by using the association concept dictionary technique employed by the storage model research in order to process the language with a computer. The association concept dictionary quantifies the distance of the stimulus word and the association word by linear programming, based on the parameter obtained from the association experiment. Moreover, a variety of concept information on superordinate, subordinate, the attribute, etc., is collected and used from the stimulus word. The association experiment is conducted on schizophrenic patients and normal controls in this research, against the abovementioned background so as to apply it to the

acknowledgment function research on schizophrenia. The relation of the association concept dictionary of the patients' group, the control group, and the preceding research (Okamoto & Ishizaki, 2001) is also examined based on the concept information obtained from the association of the word.

Table 1 Explanation of task of associative experiment

Task name	Task explanation	Association concept (Ex. Fish)
Superordinate concept	Broad abstract concept including features of the stimulus word Category name for stimulus word	Life Food
Subordinate concept	Detailed concept with features of stimulus word	Saury Deep-sea fish

Method

Subjects

Participants included 19 outpatients that met the DSM-IV criteria for schizophrenia (American Psychiatric Association, 1994) and 21 normal controls. The mean age of the patients was 28.3 years (SD = 4.5) and 27.1 years (SD = 4.0) for controls ($W = 390$, ns). Patients and controls had estimated IQ scores (Misawa, 1993) of 95.1 (SD = 17.2) and 106.2 (S.D. = 13.3), respectively ($W = 322$, ns). For the schizophrenia patients, the average score for the Japanese Brief Psychiatric Rating Scale was 34.7 (SD = 7.8). The patients had a mean duration of illness of 10.1 years (SD = 5.1), and the mean daily dosage of chlorpromazine equivalents was 528.6 mg (SD = 411.0).

Associative experiment

We conducted interviews and administered a questionnaire. Two tasks, a Superordinate concept and a Subordinate concept, were presented to the subjects. The subjects were asked to view a stimulus word and to supply an associated word on the form.

The task was structured as follows: "Fish" was the stimulus word, in the Superordinate concept. [What is a fish? Please give a general answer and include the word.]

"Fish" was also the stimulus word in the Subordinate concept. [What kinds of fish are there? Please give a specific answer that has similar features as the word.]

Table 1 presents an explanation of the task presented during the associative experiment.

Indicator of conceptual structure

The following indices were considered as indicators of the conceptual structure in the association experiment based on the preceding research (Okamoto, Ishizaki, 2001).

The number of words

(1) "The total number of associations," (2) "Number of different associations with the words," and (3) "the decrease rate" were considered as elements that related to the number of words. The total number of associations represents the total number of words associated with each problem of the stimulus word in the association experiment. When the same association word is associated even if the stimulus word is different from the different associations with the

number of words, it is one and a counted number of totals as the same word. For instance, the total number of word associations is counted as “2” when a “living thing” is associated as a superordinate concept of stimulus words such as “dog” and “cat,” and it is counted as “1” in the different associations with a number of words. Moreover, the decrease rate is obtained by dividing the different associations with a number of words by the total number of associations.

The distance between concepts

The distance between concepts was calculated using the following calculation types based on the quantification of the distance between concepts of the stimulus word and the association word, which was the method used in the preceding research (Okamoto, Ishizaki, 2001).

$$D \text{ (The distance between concepts)} = 0.81 \times F + 0.27 \times S \quad (1)$$

The distance between concepts (D) is expressed using the linear programming method by linearly uniting the association order (S) and the association frequency (F). First, the association order (S) of the stimulus word in each problem was obtained through the following expressions, as a procedure, in each association word. The ease with which a word can be associated with a certain word can be determined from this expression. A small S value suggests that a word is easily associated.

$$S = \frac{1}{n} \sum_{i=1}^n s_i \quad (2)$$

n = Number of associations (≥ 1)

s_i = Order in which the subject associated with the association word

Next, the association frequency (F), which was the value of the degree to which the word could be associated in the ratio by using the following expressions in the subject group, was obtained. The correction value (δ) is originally calculated using $N \div 10 - 1$. However, this time, the subject group was divided into two and because the number of subjects in each group was different, the maximum value of F in the two groups was obtained using an existing association concept dictionary in the preceding research with a value that became equal. Finally, the distance between the concepts (D) and that between the stimulus word and the association word was obtained.

$$F = \frac{N}{n + \delta} \quad (3)$$

N = number of subjects, δ = correction value

Results and Discussion

Number of words

(1) The total number of associations, (2) the different associations with a number of words, and (3) the decrease rate in the superordinate and subordinate concepts of each control and schizophrenic patient were obtained. The result is shown in Table 2 along with the result of the preceding research (Okamoto, Ishizaki, 2001). The decrease rate of the difference number of words observed in both the superordinate concept as well as the subordinate concept was lower than that in the association concept dictionary of the early research in terms of the number of words in the conceptual structure of the object person of this preceding research. It seems that this result originates from the fact that the number of stimulation words in this

experiment was less than that in the preceding research, which was conducted online for many number of words.

Table 2 Results concerning the number of words

Group	Task	The number of association total	The association difference number of words	The decrease rate	Stimulus word
Schizophrenia	Superordinate	301	33	11.0%	14
	Subordinate	153	67	43.8%	14
Controls	Superordinate	528	35	6.6%	14
	Subordinate	538	190	35.3%	14
Total	Superordinate	835	53	6.3%	14
	Subordinate	691	205	29.7%	14
The precedence research	Superordinate	13342	5399	40.5%	660
	Subordinate	23114	17205	74.4%	660

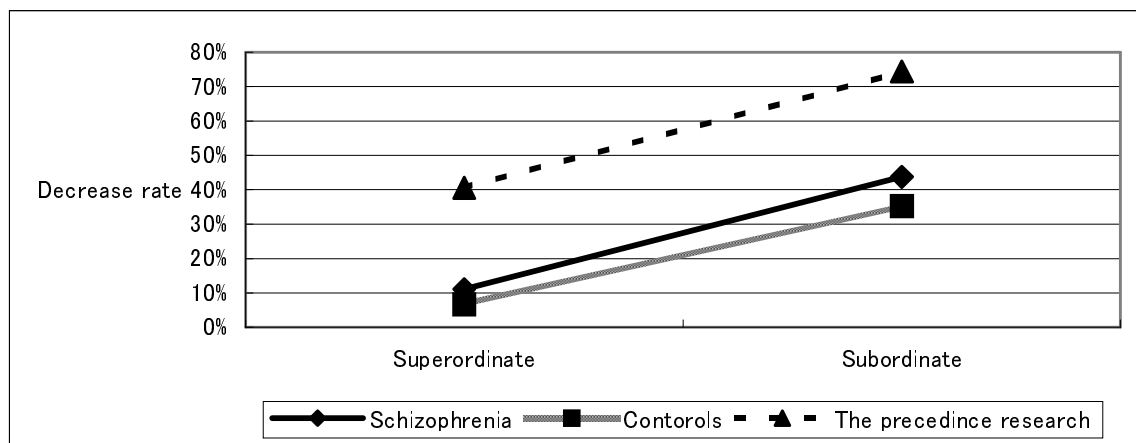


Figure 1 Each group's difference word decrease rate

However, it is believed that there is no significant influence on the result due to data shortage because the average amount of data collected with respect to one stimulation word is large. Moreover, the subordinate concepts of each conceptual structure were compared with the decrease rate of the superordinate concept. As a result, the subordinate concept could be perceived and employed to similarly perceive that its decrease rate is lower than that of the superordinate concept. This tendency is the same as observed in this experiment and in the preceding research (Figure 1). Moreover, the number of descriptions and schizophrenic patient's different number of words for the subordinate concept were especially few compared with that of the controls. However, the possibility of reflecting on a few of the schizophrenic patients with a low IQ level and rather small concrete knowledge is considered because they were requested to answer a more detailed kind information to the stimulus word as for the concept of the subordinate.

Distance between concepts

The correlation coefficient of the distance between the concepts of schizophrenic patients and controls obtained from the preceding research (Okamoto, Ishizaki, 2001) of the stimulus word, the problem, and the association word that was common to everything.

Table 3 A part of the distance between concepts wherein the stimulus word, task, and association word are common

Stimulus word	Task	Association word	Schizophrenia	Controls	The precedence research
Fruit	Subordinate	Orange	1.689	1.432	1.650
Fruit	Subordinate	Grape	3.333	2.884	2.810
Animal	Subordinate	Dog	4.654	2.164	3.116
Animal	Subordinate	Cat	3.225	2.234	3.459

Table 4 Correlation coefficient of the distance between concepts (***) $p < 0.001$

	Schizophrenia	Controls	The precedence research
Schizophrenia	1.00	0.84***	0.80***
Controls	—	1.00	0.96***
The precedence research	—	—	1.00

The number of associations that were common to all was 21. A part of the distance between concepts is shown in Table 3, though it is common. In addition, the Pearson's correlation coefficient of the distance between concepts was obtained, although it was common (Table 4). The correlation coefficient of the distance between concepts of schizophrenic patients was 0.96 and that of the controls was 0.84 in relation to the preceding research wherein the correlation coefficient of the distance between concepts for controls was 0.80 in the correlation coefficient of the distance between concepts of the schizophrenia patients. All the correlation coefficients were obtained and an intentionally positive correlation was obtained at the 0.1% level. Moreover, the strength of the correlations revealed that all correlation coefficients were 0.8 or more, and a strong correlation was observed. It is believed that a similar result was obtained with the association experiment intended for many numbers in the online test conducted in the preceding research, using the association experiment of this research, though it is a limited indicator of the distance between the concepts. It is believed that almost the same conceptual structure as that of the preceding research succeeded in being formed in the association experiment in this research if it is considered to obtain the distance between concepts from the indices of the association order and the association frequency, etc. In addition, to examine the difference between schizophrenics and controls, the distance between the concepts was examined. The statistic difference was determined by a t test. As a result, the distance between concepts was significantly high in the schizophrenic patients (average = 2.7, SD = 1.8) compared with that of the controls (average = 2.0, SD = 1.0) ($t = 3.2, p = 0.004$).

General discussion

The effectiveness of the evaluation of the conceptual structure by using the association experiment with the aim of applying it to the acknowledgment function research on the schizophrenic patients was examined. In this research, to conduct the association experiment in the preceding research on schizophrenic patients, the content and the execution methods of the stimulus word and the task, etc., were examined. Moreover, the distance between the number of words and the concept was examined from the obtained concept information and the relation was examined with the original results and the results of the schizophrenic patients, healthy controls, and the preceding research. As a result, the tendency similar to the preceding research was confirmed by all the elements with regard to the number of words, although the numerical value was low. Moreover, the total number of and different number of

words in the subordinate concept task were lower than in the case of the controls, and it was suggested that there be limited and overspecialized knowledge with regard to the schizophrenic patients. Further, it is believed that in the preceding research, a strong correlation is observed for both schizophrenic patients and controls, and the validity of the experiment of the association in this research was suggested with regard to the association frequency and the distance between concepts including information on the association order. An obviously low tendency was seen compared with 0.96 for the controls and preceding researches, though 0.80 and a strong correlation were obtained for the correlation of the schizophrenic patients and the preceding research. It is suggested that abnormalities are found in any way in the conceptual structure in the integrated malfunction syndrome though the association experiments reflect the conceptual structure in the memory in both schizophrenia patients and controls. The statistic difference was determined using a t test. As a result, the distance between the concepts was significantly high in the schizophrenic patients as compared with that for the controls. For instance, in Sumiyoshi, et al. (2001), the semantic structure in the animal category in the VFT reports the meaning to be indefinite in the integrated schizophrenic patients as compared with that in the normal controls.

The result of this research corresponds to the result of the preceding research in terms of the possibility of abnormality of the conceptual structure in schizophrenics. In addition, the task of this research contains information on the directionality of the superordinate and subordinate positions. There remains the possibility of examining an integrated malfunction syndrome patient's conceptual structure in further detail by using this association experiment problem. Therefore, it seems that there is significant scope to empirically research the relation between symptoms and the cognitive function, and the effectiveness can be expected to reveal the conceptual structure, using an association experiment with integrated schizophrenic patients.

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References

- American Psychiatric Association.(1994).*Siagnostic and statistical manual of mental disorders.4th ed.(DSM- IV)*.Washington,DC.American Psychiatric Press.
- Chan AS,Butters N,Salmon DP,et al.(1993).An assessment of the semantic network in patients with Alzheimer's Disease.*J CognNeurosci*,5,254-261
- Okamoto J,Ishizaki S.(2001)Construction of associative concept dictionary with distance information,and comparison with electronic concept dictionary. *Natural Language Processing*,8(4),37-54.(in japanese)
- Collins AM, Quillian MR.(1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, 8, 240-247
- Sumiyoshi C,Sumiyoshi T,Roy A,et al.(2006).Atypical antipsychotic drugs and organization of long-term semantic memory:multidimensional scaling and cluster analyses of category fluency performance in schizophrenia.*Int J Neuropsychopharmacol*,9,677-683
- Sumiyoshi,C.,Matsui,M.,Sumiyoshi,T.,Yamashita,I.,Sumiyoshi,S.&Kurachi,M.(2001).Semantic structure in schizophrenia as assessed by the category fluency test: Effect of verbal intelligence and age of onset.*Psychiatry Research*,105, 187-199.