The Relationship between Semantic-Episodic Cues and Retrieval Limitations in Free-and Cued-emission

The Relationship between Semantic–Episodic Cues and Retrieval Limitations in Free– and Cued–emission.[1]

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ABSTRACT

Three experiments were counducted to examine the causes that bring about retrieval limitations in free– and cued–emission. In experiment I, the subjects free–emitted only 34% of their well known flower names. This lower percent of retrieval indicates that semantic memory is not so systematic and hierachical. The introduced episodic cues earned no gain, whereas multiple semantic cues for certain items earned a 45% gain. However, 58% of well known items were not retrieved, showing a limitation of semantic cues. Finally, it is suggested that a strict distinction of semantic–episodic memory systems can not explain the result (66% of known items did not retrieve) and 5W (who, where, when, why, what) + H (how) memory that is obtained from everyday life.

Bousfield and his associates conducted a series of experiments in order to investigate retrieval processes in long–term memory using the "free emission" method. In this method, subjects are asked to recall as many items which belong to a general category as possible within a given time limit. Bousfield and Sedgewick (1944) asked the subjects to list items under the categories of animals, birds, etc. They found that the cumulative totals of the listed items (n) were closely approximated by equation (1), except during the initial phase of recall. In addition, they noticed that the cumulative curve for each subject did not show a constant rate of increase. Instead, they showed a burst of responses. Nevertheless, as Indow and Togano (1970) pointed out, the cumulative total of each subject is well approximated with equation (1). Equation (1) has an asymptote. It means that a subject cannot recall beyond a certain number of items, even if he know more items.

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$$n=c\ (1-e^{-mt}) \qquad (1)$$

There is an evidence that subjects know more items than they can recall. Lazar and Buschke (1972) reported that the subjects recalled only about 20 percent of the category items which they knew. It is likely that the percent of recallable items is too small. One of the purposes in experiment I is to estimate the percent of recallable items against estimated whole items. Another purposes in experiment I are as follows;

What kinds of retrieval cues are utilized by subjects in free emissions? What percent of items are recalled with such cues? How do these cues and items decrease with recall time?

As many memory theorists assumed, all retrieval must be cued (Jones, 1979; Tulving, 1976, 1982). On this point of view, we can think of a variety of retrieval cues like Fig. 1,in case of a flower name such as 'tulip'. These are ranged from episodic to semantic in a memory distinction of Tulving (Tulving, 1972, 1982). In Tulving's theory, semantic or episodic meanings(cues) are usually tagged with different memory traces for 'tulip'. On the view of Tulving's theory, it is expected that the semantic cues in Fig. 1 facilitate the retrieval from semantic memory and episodic memory, while episodic cues only facilitate the retrieval from episodic memory. In experiment II and III, the relationships between both cues and retrieval limitaion are explored.

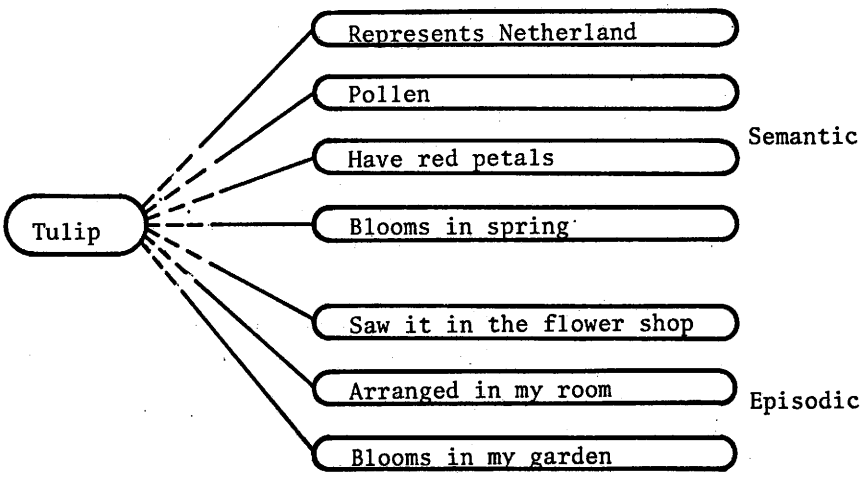

Fig. 1. A variety of semantic and episodic retrieval cues for a flower name 'Tulip'.

In experiment II, the cues that were obtained from a large number of subjects are given to a different group of subjects. Most of these cues are episodic. The effects of those cues on cued emission are examined. In experiment III, the effects of semantic cues that are simular to the ones in Fig 1 on cued emission are investigated.

EXPERIMENT I

Method

Subjects. Twenty–three college students(six males, seventeen females) served as subjects. All subjects took a test together.

Instructions. "This experiment is being undertaken to investigate the limitation of retrieval in human memory. Please recall as many flower names as possible and write them in columns at the left side of your response sheets. Recall time is fourteen minutes. A recall time announcement will be given every two minutes. When you hear this announcement, turn to next page of response sheets and continue writing."

Putting into retrieval cues. After the recall session, the subjects were asked to write the retrieval cues they used during the recall session on their response sheets.

Estimated totals of flower names. For the estimation of the whole number of flower names (estimated totals), 220 flower names were given to the subjects after they finished writing retrieval cues. The subjects were then asked to grade each name on a seven–point scale of familiarity (1=unknown – 7=well known). About 120 of the names were drawn from an experiment(Ss=40) similar to Experiment I. The remainder were selected from a book of botany.

IWC, IWOC and Unit Size. The items that each subject recalled were divided into two groups. One is the items recalled with some visible retrieval cues (IWC), the other is the items without such cues (IWOC). Unit size is defined as the size of IWC. That is, if a subject recall three items consecutively with a cue, his output unit size is three.

Results

Fig.2 illustrates the relationship between the estimated totals and the recalled totals. For each subject, the total number of well–known (point 7) responses were used as an estimate of the estimated totals. The correlation coefficient (r) between both variables is .72($p<.01$). The largest ratio of recalled total /estimated total is .44, while the smallest is .22. On the average, .34 of the estimated totals were recalled. As expected, the number of recalled totals increases as a function of estimated totals. There are few items that the subjects recalled with a rating point 6 or less. The average number of such responses is only 1.0. The average ratio of IWC / the recalled totals (IWC+IWOC) is .63 (S.D.=.22). Over 70% of subjects used some retrieval cues for half or more of their recalled items.

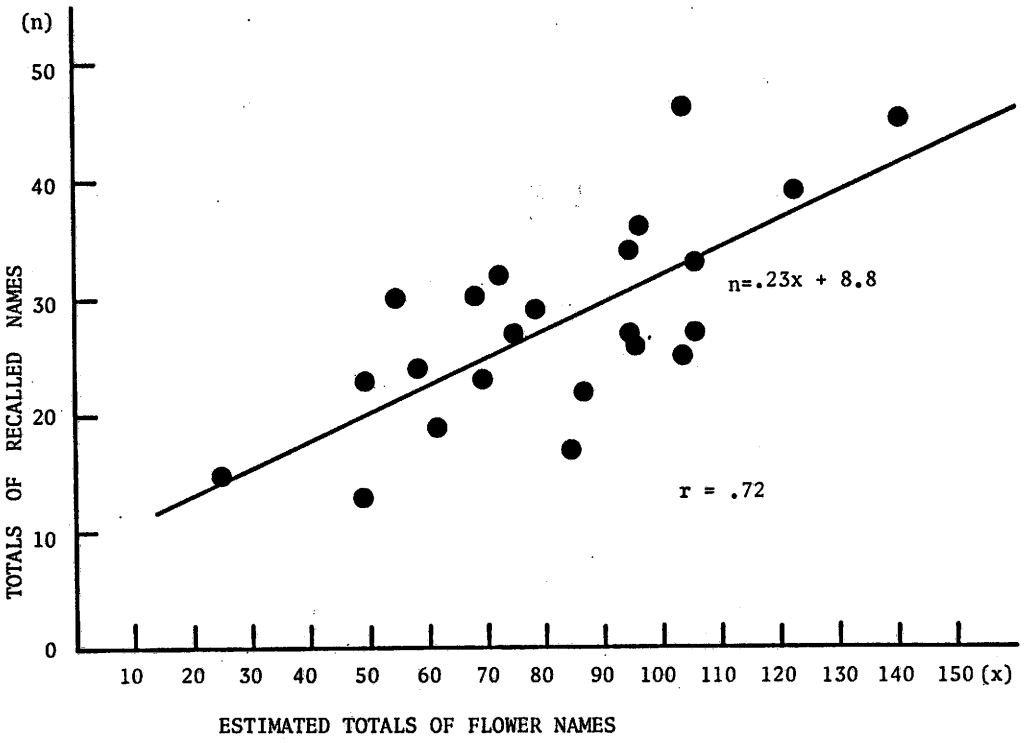

Fig. 2. The relationship between the estimated totals of flower names and the totals of recalled names.

Some of the retrieval cues that the subjects used are as follows : 1) semantic ; spring flowers, seven flowers in spring, flowers that symbolyze Japan, purple, white, blue, large, small, represents Netherland,———. 2) episodic; blooming in my garden, from a text, painting them now, recently saw them in a flower shop, from a movie, saw them in my grandmother's garden, paper flowers that were made by mother, flower arranging, TV, saw them in younger days, used to plant in my garden, memory from elementary school, flower garden in elementary school, saw them near house, from children's book, arranged in the vase, school materials in science, poem, proverb, popular song,———.

Tweleve kinds of semantic and 28 kinds of episodic retrieval cues were observed. About 70% of all cues were episodic. In order to see a tendency of appearance of each unit size items during recall time, each subject's recall sequence was equally divided into 4 blocks. It is because that recency recall sequence has usually a very few items. Each unit size observed in each block is shown in Fig.3. Larger unit size items are rapidly reduced, while smaller ones are rather constant.

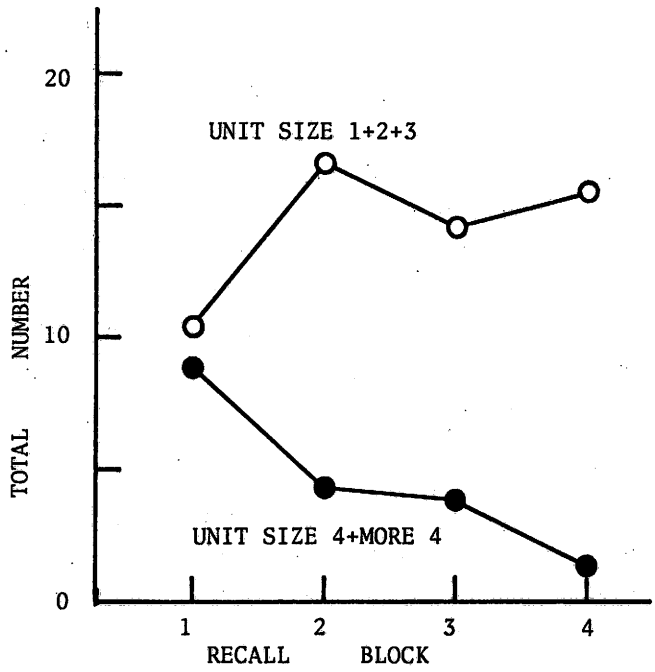

Fig. 3. The total number of different unit sizeitems as a function of recall block.

Discussion

After free–emission, each subject rated a total of 220 flower names for their familiality. As the number of flower names was large, most of the responses fell into those 220 names, except several cases. Since the number of such exceptional items are small, it is reasonable to use the total number of 'well−known' items as an approximation of each subject's estimated total.

The relationship between estimaed totals and recalled totals in Fig.2 is roughly linear. The correlation coefficient is high (r =.72). These results indicate that the subject's rating to 220 items are reliable.

The ratio of IWC/ (IWC+IWOC) is .63. This ratio may become larger if a verbal protocol method (Walker & Kintsch,1985) is used. As Yumino (1977), Walker *et al.* pointed out, this high percent of IWC reaffirms that retrieval from long-term memory involves two different processes. One is an efficient search process that occurs when a subject succeeds in finding an appropriate retrieval cue. The other is a rather random search process that may occur when he fails to find such a cue. Yumino (1977) proved that the Inter Response Time (IRT) of the former is constant during recall time, whereas one of the latter is rapidly increased with recall time. More than 50 seconds were needed to retrieve a new item of IWOC in the latest period of recall time.

The subjects could recall 34% of their well known items. In a case of Lazer & Buscke (1972), the percent is about 20%. As pointed out by Eysenck (1977), that percent seems like too small. Coversely, the subjects could not recall 66% of their well–known items. Why didn't they produce so large percent of items? Two reasons may be explained the case. a) It is difficult to output more IWC in a later period of recall time, because the number of larger unit size items decrease rapidly in an earlier period (see Fig.3). b) As stated above, IRT of IWOC increases rapidly with recall time. So in a later period, it took more time to find new IWOC. It is evident that both reasons cause the limitation of retrieval in free–emission.

The relationship between the limitation of retrieval and semantic–episodic distinction of memory will be discussed in the place of general discussion.

EXPERIMENT II

In experiment I, it became clear that the lack of appropriate retrieval cues limits retrieval. Subjects might recall more items only if they had suitable cues in any time of recall. In experiment II, the experimental group received 43 semantic and episodic cues that were used by other groups. These printed cues were given at the 8th minute from the beginning of the second recall.

Method

Subjects. Fifty–two female college students. The same number of students were alloted to cued– and non–cued conditions.

Instructions. Basically, instruction was the same as in experiment I, except it was repeated 2 times in the first and second emission, and the cued group received a sheet of retrieval cues at the time of 8th minute of the 2nd recall.

Printed retrieval cues. In order to help retrieval, a sheet of 43 printed retrieval cues was given to the cued group. These cues are similar to ones that were obtainde from experimental I. Eight were semantic, 35 were episodic.

Putting into retrieval cues. After the first 14 minutes recall, the subjects took 2 minutes rest. After second 14 minutes recall, the cued group put retrieval cues into response sheets. They marked the printed cues whatever they utilized.

Results and Discussion

Table 1 shows results. The increment between the first and second emission for the cued group is a little larger than that of non–cued group. However, there is no statistical difference between the two groups, and no interaction between the two variables. Only second recall is higher than the first ($F\ (1,50)=7.80, p<.01$).

On the other hand, interestingly enough, all subjects utilized cues. That number ranged from 3 to 7. But there is no gain in recall by means of using such retrieval cues. This result shows the weakness of introduced retrieval cues, that is, 79% of episodic cues. As Tulving

(1972, 1982) summarized,episodic memory is based on personal experiences. Hence, it is likely that introduced cues were of no use to surpass the limitation of retrieval.

Table 1
Mean number of emitted items of cued– and non–cued groups which were observed 1st and 2nd emission.

	Cued	Non–cued
1st	30.1	29.5
2nd	32.6	31.0

Experiment III

The retrieval cues introduced in experiment II were of no use. Most of those cues consisted of episodic meaning. Hence these were relatively weak as retrieval cues. In experiment III, the subjects who were approaching the limitation of retrieval received succesive semantic cues that are associated with certain flower names. The effect of these semantic cues is examined.

Method

Subjects. Six female college students. They were tested individually.

Retrieval cues. A hundred of familiar items which were obtained in experiment I were used in this experiment. Semantic retrieval cues for certain items were prepared by three female college students and the author. Some examples of those cues are as follows ; lily : white, bulbed, perfumed, pollen, first sound is 'yu'; cosmos : autumn, small leaved, a song of a famous singer, first sound is 'ko' ; tulip : spring, Netherland, song, bulbed, red petal, first sound is 'chi'. The number of cues per single item ranged from 3 to 6. The cues associated with a certain item were written on a small card. The first sound of the item was given as a final cue. Based on the frequency of occurence of the items, these cards were clored in different tints with crayons. During the experiment, those were arranged on a table behind a subject. In the first free emission session, one of the experimenters removed the cards the subject had recalled. In the second cued emission session, the contents of the cards were orally presented to the subject. An experimenter chose the cards based on the frequency of occurrence.

Instructions. "This experiment consisted of 2 sessions. The first is a 12–minute free emission of flower names. The second is a 14–minute cued emission of flower names that you could not recall during the first session. In the first session, you cannot repeat the same name you have already recalled. In the second session, you may repeat the same name. I'll give you some useful hints that will make it easy to retrieve some names. Please recall as many flower

names as possible."

In the second session, each subject received retrieval cues at 3–second intervals. Untill the end of 26 minutes, the subject received all cues that are associated with 100 items, except the items the subject could recall in the first session. All responses were tape–recorded.

Results & Discussion

There were many repetitions of the same names in the second session. But these repeated names were excluded from the totals.

Averaged cumulative totals in the first and second session are presented in Fig.4. By fitting equation (1) to the data of the first session, c=44, m=.19 were obtained. Using these estimates, cumulative total (n_1) at the 26th minute is extrapolated. This valve is almost an asymtote of cumulative total. In this case, n_1 is 43.1.

$$n=c(1-e^{-mt})+b \qquad (2)$$

In order to apply an equation to the second session data, let us introduce another equation (2). This is an equation in which equation (1) has a constant. By fitting equation (2) to the data of the second session, c=76,m=.05, b=7.4 were obtained. The cumulative total (n_2) at the 26th minute in equation (2) is 62.6. The difference n_2-n_1 (=19.5) represents the gain of introduced cues. The difference corresponds to a 45% gain against n_1. On the other hand, 37.4 of the prepared items remained not to be retrieved.

The semantic cues used in this study were useful to retieve more items beyond the limitation of retrieval in the first session. Because each cue is particular to access a new item that is not produced so far. Especially, last cue (first sound of the name) is very so .In addition, 3 to 6 cues are succesively given to an item. The multiplicity of the cues make it easy to retrieve a target item.

A 37.4% of items the experimenter prepared were not retrieved. But the percent doesn't mean that subjects could not retrieve the percent of items which they know. Because all subjects' well known items are expected to be larger than a hundred. In order to estimate the size of well known items, let us compute a mean of estimated totals of all subjects, using the relationship specified in Fig.2 (n=.23x + 8.8). The estimate is 149.1. The n_2 corresponds to only 42% of the estimate. Subjects could not retrieve more than half of their well known items in 26 minutes, even though they got a lot of semantic cues. If we use 150 or more items, think out more suitable cues to each item, and prolong cued emission time, the cumulative total may increase. However, as expected by the shape of curve in the second session, there is a limitation to such retrieval. Why does such a limitation exist in cued–emission? This limitation is strongly correlated with characteristics of semantic cues, that is, conceptual, universal, and social agreement. Some of these characteristics are helpful for retrieval of some items. In the case of the cue 'has thorns', the subject may easily specify items. Because there are few flowers which have thorns. On the other hand, for the cue 'bulbd', there are many items

which have bulbes. So the cue is weak to specify some items. Unfortunately, the former kinds of cues are very restricted. In such reason, the retrieval limitation might be occured. If we want to elicit more items from a subject, we have to prepare more specific cues for these items. As such cues are fundamentally episodic, we cannot get these so easily.

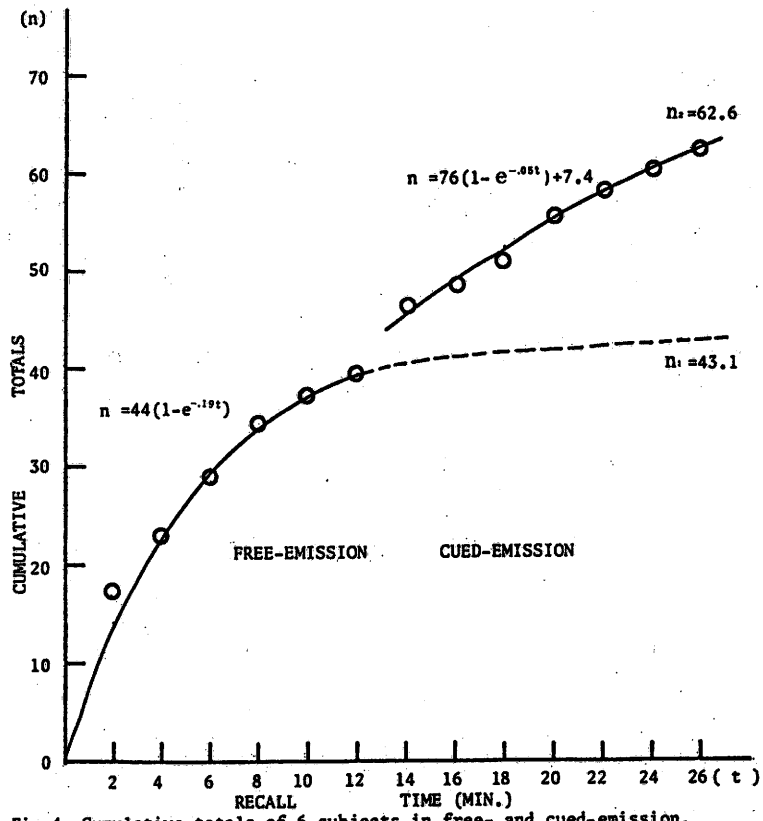

Fig 4. Cumulative totals of 6 subjects in free- and cued-emission.

n_1 shows extrapolated cumulative totals at 26 minutes.

GENERAL DISCUSSION

In experiment I, the mechanism that gives rise a limitation of retrieval was inferred. But the relationship between the limitation of retrieval and semantic–episodic distinction of memory was not discussed. Let us begin to discuss with the point.

The items required here are flower names. They are all concepts, that is, all belong to semantic memory. Semantic memory is hypothesized to be hierachical and structural (Anderson & Bower, 1973 ; Collins & Loftus, 1975 ; Collins & Quillian, 1969, 1970). If all items are stored in long term memory in a such way, we could expect that subjects are able to output most of their well known items. However, as shown in experiment I, the subjects could

output only 34% of their well known items.This indicates that the items which were learned in subject' every day life are stored rather loosely. This finding accords with a view of several theorists (Van Dijk & Kintsch,1983; Walker & Kintsch, 1985). It is unlikely that all categorical items are subsumed together by a higher category and stored in a closer memory area. Therefore, subjects have to adopt many useful strategies to retrieve categorical items. This view seems to be very similar to the models of Kolodner (1983), or Strube (1984) who emphasize reconstructive and context–dependant processes, accordingly the importance of retrieval cues. The cues are closely associated with the required items but are not the required items themselves.

In experiment III, the author used a variety of semantic features that characterize each item. We can easily identify such features. Yet the subjects who were approaching retrieval limitation seldom utilized such features as retrieval cues. Why didn't they utilize such features? The limited use of such cues may be caused by the nature of human memory. As mentioned above, human memory may not be stored in a systematic and hierachical way. That is,the network among items is not connected so closely by such semantic features, 'have thorns', or 'have small leaves', etc. If we want to use efficiently limited information that stored in memory, we have to create an intimate network among these items and features.

The cues used in experiment III hepled the subjects surpass the limitations of retrieval. This result is in contrast with the one obtained from experiment II, showing no gain of introduced semantic and episodic cues. On the other hand, semantic cues used in experiment III could earn a gain. The contrast between the two results shows the different nature of the two types of cues, episodic or semantic. The former is concerned with personal experiences. So the former is of no use for other person. The latter is concerned with public knowlege. Hence the latter is available for the subjects. But the latter has also a limitation. As shown in experiment III, the subjects could output only 42% of their estimated valve of well known items. If we want the subjects to output more items, we have to prepare semantic cues and simultaneously very specific episodic cues for certain items. Unfortunately, we can not know such specific cues. So it is difficult to examine their role.

Tulving (1972, 1982) made a distinction between episodic and semantic memory. The results obtained experiment II and III are in the same direction of Tulving's theory. He distinguished two memories using the following points ; 1) heuristic distinction, 2) different information (contents distinction), 3) functional distinction, 4) different systems. For the first two points, most students of memory agree with him. For the latter two points, many theorists disagree (Anderson & Ross, 1980 ; Craik, 1979 ; Jacoby & Craik, 1979 ; Naus & Halasz, 1979 ; Kintsch, 1980). Based on the data obtained here, we discuss the distinction of two memories. The cues introduced in experiment II were of no use, whereas the cues obtained from experiment III were very benificial. These facts accord with the first three distinctions of Tulving's. But for the last point, different systems, our results tell no story.

Tulving insisted that the two memory systems is separated sharply but work interdependently. When we think about typical semantic and episodic memory, his claim is

right. However, there is much memory (knowledge) that may belong to the middle of both memories. As an example, let us consider about a scientfic article that appeared in a news paper. Ususally an article consists of 6 components, 5W(who, when, where, what, why) + 1H (how). A person who reads the article makes an episodic memory about the components. Consequently he can answer all 5W + 1H questions that include 'what' type questions that are peculiar to semantic memory. He also can answer other type questions, e. g. how the content of the article reliable, depending on the knowledge just before he got. If he is very confident, he seems to be using an already stored semantic memory. On the other hand, he can answer 'when', 'where' questions that are peculiar to episodic memory. In addition, troublesome enough, he can answer another type of 5W + 1H quesions. 'Where did he read', 'When did he read',———. These kinds of memory belong to episodic memory. Nevertheless, there are differences between two kinds of 'when' and 'where'. Everyday' knowledge from a lot of media is so vast that it cannot always become semantic memory. But we can use it as it semantic memory, and simultaneously use it as if episodic memory. Thus, it is hard to make strict distinction between two memories. Hardness of distinction between the two memories is found in data. Let's see an evidence.

A distinction between semantic and episodic meanings (cues) is illustrated in Fig.1. Based on such distinction, the cues observed in experiment I were distinguished conveniently into two groups. But this distinction was not always easy. For example, the meanings 'the flower that represents Netherland', 'the flowers that symbolyze Japan', 'yellow flowers' are very abstract and non–self–experienced. Therefore, they were distinguished to semantic cues. Annoying enough, these cues have another aspects of meaning. That is, the subjects reported that they imaged some places or some features of flowers whenever they retrieved items associated with the above cues. Imagery is a personal experience. So it may belong to episodic memory. For this reason, it is difficult to distingush two memories strictly.

There is another reason that the author cannot accept the strict distinction between two memories. As has been stated, the subjects could output only 34% of their well known items. This means that semantic memory is not so conceptual. Same claim is seen Walker & Kintsch (1985). In their experiment, the subjects constructed a 'script' of restaurant from very personal recent experiences. This construction is an essential characteristic of human memory. Human memory can easily abstract a higher scheme, like a script, from very concrete memory. Simultaneously it can easily put an abstract memory into concrete one. The cues cited above are some examples. When we refer to the distinction of memory, we should remember this point.

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