The Role of Hand Gesture Images in Recall of Abstract Words: Testing Memory Retention at High and Low Verbal Levels

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Abstract

This study examine d the effects of hand gesture images on verbal recall in the framework of bilingual dual coding theory. Forty subjects were divided into two groups. The first group was presented with 40 English words (20 concrete words and 20 abstract words), while the second group was presented with the same words and their images which were described through hand gestures. The hand gestures were based on signs used in American Sign Language. All the materials were presented consecutively to the subjects by means of a videotape. The subjects were required to copy the vocabulary items on a worksheet after viewing each word. Then, the subjects were given an unexpected test in which they were asked to recall the 40 English words. Both groups achieved a higher recall for the concrete words than for the abstract words. And the group which was presented with words and hand gesture images achieved higher verbal recalls than the group which was presented with words alone. The experiment indicated that gesture images based on signs used in American Sign Language facilitate Japanese students in recalling abstract words as well as concrete words. But when the same experiment was carried out with subjects with low English proficiency, the gesture image stimuli were not effective when they tried to recall abstract words.

1. Introduction

Paivio (1971, 1990) proposed a dual coding theory that cognitive activity is mediated by two independent but partly interconnected memory systems for encoding, storing, and retrieving two different kinds of information. One system is specialized for processing and generating nonverbal information, and the other is specialized for processing and generating verbal information. The independence of the two systems implies that cognitive activity is mediated in the nonverbal system or the verbal system alone, or simultaneously in the both systems. The interconnection implies that activity in one system can activate that in the other system. That means that verbal information arouses imagery, and conversely imagery can be expressed verbally. It is well known that verbal recall of items presented as pictures is generally higher than that of items presented as words. How can picture superiority in recall be well explained in the frame of the dual coding theory?

One experiment in Paivio and Csapo (1973) used pictures and words under four different conditions. Two groups of subjects were required to write the names of objects which flashed pictures refer to or copy flashed words. Another two groups were required to make a rough sketch of flashed pictures or of objects which words refer to. Then, the subjects were given an unexpected recall test. The task of drawing to pictures and that of copying words were under a single coding condition, while the task of drawing to words and that of writing the names of objects were under a dual coding condition. The mean numbers of recalls under the picture-word, the word-picture, and the picture-picture condition were more than double the mean number of recall under the word-word condition. The additive effects under the picture-word and word-picture condition support the independence and interconnection of the verbal system and nonverbal system in the dual coding theory. As for the high performance under the picture-picture condition, it was regarded that the subjects may have labeled the pictures in their mind spontaneously before they drew. If that were the case, it would support the dual coding theory.

Materials used in the above experiment were concrete words and pictures of common objects. Another experiment in Paivio and Csapo (1973) employed abstract words in addition to the same pictures and concrete words. They showed subjects slides of pictures, concrete words, and abstract words, and asked them to label the pictures and copy the words on a sheet of paper. Then, the subjects were given an unexpected recall test. Recall increased systematically from abstract words, to concrete words, to pictures. The fact can be interpreted as follows: pictures of common objects can readily evoke a verbal code as well as a nonverbal image and can be verbalized easily, while words can stimulate a verbal memory code, but coding of words into imagery is assumed to be more difficult than coding of pictures into words, especially in the case of abstract words. Paivo (1968) empirically indicated that imagery is the major psychological process underlying linguistic concreteness-abstractness. If concrete words are likely to arouse more images than abstract words, it is quite natural that coding of pictures of common objects causes highest recall, and the coding of concrete words into images causes higher recall than the coding of abstract words.

Clark and Paivio (1991) proposed the dual coding theory as a general framework for educational experiments and methods by stating that memory is enhanced by presenting information in both verbal and nonverbal forms. Surprising effects of imagery on memory for educational material have been reported, and the results are clearly explained in the framework of the dual coding theory. One example is Total Physical Response (Asher, 1965). TPR is a well known second language learning technique based on how children learn their first language. TPR insists that listening should be developed in advance of speaking, and understanding should be mediated by physical movement drills in the imperative form, and then comprehension facilitates learn-

ers in speaking a second language spontaneously. TPR is closely linked with the theory that memory is enhanced through association with physical movement. Asher (2000, 1-35) stated that "the intact kinesthetic event, when the person performs, is important." The effect of the coordination of speech and action on comprehension of a second language is consistent with the additive effects of verbal and nonverbal information which the bilingual dual coding theory has hypothesized, although pictures and physical movement are different types of nonverbal stimuli.

Kohno (1984) reported that kinesthetic information as well as pictures helped the listening comprehension of Japanese learners of English even though subjects were not familiar with the gestural system of an American speaker. He showed three groups of high school students three videotaped stories of different kinds of materials. In one experiment, the first stimulus is a 'sound only' tape, the second is a 'sound + a picture describing a scene' tape, and the third is a 'sound + an American instructor's facial expression' tape. Then, each group was asked to answer questions about the content of the story they were presented with. There was a statistically significant difference between 'sound only' and 'sound + a picture', and between 'sound only' and 'sound + facial expression.' In the other experiment, he tested the difference between a 'sound + facial expression' tape and a 'sound + body expression' tape, and found a significant difference. The results of those experiments showed the role of kinesthetic information in listening comprehension.

Riseborough (1981) investigated the role of hand gestures in a story-retelling test. She showed British subjects a videotaped story under three conditions: the first involved 'sound only', the second contained 'sound + a speaker's face', the third provided 'sound + a speaker's vague gestures', and the fourth provided 'sound + gestures describing shape, size, and action'. The subjects' recall was superior in the fourth condition. Many subjects reported that gestures evoked visual images, but they were not aware of most gestures consciously. That suggests that both verbal information and information contained in gestures are processed simultaneously and unintentionally, and are joined together. As for the functions of hand gestures, McNeill (1985) observed that a speaker may divide a cognitive representation into two parts, one conveyed by verbal means, and the other by hand gestures. And, McNeill (1992, 23) assumed that "gesture and speech are semantically and pragmatically coexpressive" and "the gestures that accompany utterances also present the same or closely related meanings semantically and perform the same functions pragmatically."

The significance of nonverbal information, especially kinesthetic behavior like hand gestures, in verbal communication is evident in the above research and observation. It is clearly recognized that hand gestures contribute to listening comprehension and vocabulary retention in second language learning. It should be noted that language teachers and researchers should consider the role of hand gestures in second language learning. How, then can they bring hand gestures as a strategy into the Japanese classroom setting? The hand gestures utilized in Kohno (1984), Riseborough (1981), and observed in McNeill (1985, 1992) were all natural hand gestures performed by native speakers of English. So, one clue to the challenge is sign language. Sign language is not just a set of pantomimes or natural gestures nor universal. American Sign Language (ASL), for example, is one fully conventional language system. But at the same time, ASL is, as a sign language, highly iconic or pictorial, and related to natural gestures in interesting ways. The sign 'house', for instance, is represented by an iconic gesture of outlining a roof and walls of an imagined house with both hands. What iconic signs such as 'house' refer to seems quite transparent to most people. If those iconic signs in ASL are useful as hand gesture stimuli to enhance retention of their English equivalents, we will be able to develop a systematic hand gesture technique to facilitate Japanese learners of English in strengthening their vocabulary power. In fact, Kawamura (2004) showed an empirical proof that hand gestures based on ASL signs were effective in recalling English concrete words. Therefore, the next issue is how to do with abstract words. Is it possible to describe abstract words with hand gestures?

The present study was designed to examine the effects of hand gesture images based on ASL signs on recall of English abstract words. The following experiment required subjects to encode a mixed presentation of concrete words and abstract words with and without hand gesture images by copying the words on a worksheet. Then, the experiment surveyed the recall of the words under high and low verbal proficiency conditions. Based on the dual coding theory, it was hypothesized that recall of abstract words as well as concrete words is facilitated by hand gesture images if those words are well gesticulated and visualized as nonverbal stimuli.

2. EXPERIMENT 1

2.1 Purpose

The present experiment had three purposes. The first was to test the effects of hand gesture images on recall of English abstract words by comparing the recalls of concrete words and abstract words with and without hand gesture images. The next was to test the validity of hand gestures images based on ASL signs as nonverbal stimuli in recalling abstract words. The last was to test if the sign gesture technique would be effective with subjects with both high and low verbal proficiency.

2.2 Subjects

Subjects were 20 undergraduate students who majored in pharmacy. As mentioned later, a translation test after the experiment proved that they were subjects with high verbal proficiency.

2.3Design

A 2 × 2 factorial design was used in the study. The first factor was either presenting hand gesture images or not, which was the between-subjects variable. The second factor was either copying concrete words or abstract words, which was the within-subjects variable.

2.4Material

The author selected 40 target words (20 concrete words and 20 abstract words) on the basis of their imagery and concreteness ratings (Paivio, Yuille, and Madigan, 1968). They defined imagery in terms of a word's capacity to arouse nonverbal images and concreteness in terms of directness of reference to sense experience, and measured 925 nouns along a 7-point scale. The 20 concrete words had an imagery rating which was more than 6.40(1 = low imagery value, 7 = high imagery value), and had a concreteness rating which was more than 6.90 (1 = low concrete value, 7 = high concrete value). On the other hand, the 20 abstract words had an imagery rating which was less than 5.00 and had a concreteness rating which was less than 4.00. The performance of 40 hand gestures based on ASL signs was digitally videotaped, and synchronized with the 40 words on a computer. Then, the author created two different VHS videotapes of the 20 concrete words and 20 abstract words with and without the hand gesture images.

2.5Procedure

One group of subjects viewed the 20 concrete words and 20 abstract words on the TV screen, and the other group viewed the same words together with their hand gesture images. All the subjects were asked to copy the words on a worksheet after viewing every word. Each word remained on the screen for 5 seconds, and the words were presented at 5 second intervals. The presentation time and the interval time were already edited by the computer. Before the experiment, two sample words (a concrete word and an abstract word) were given to the subjects as a chance to become familiar with the task.

5 minutes after the task, the subjects were unexpectedly given a 5 minute recall test. They were asked to recall as many of the words as possible in any order. In the end, a vocabulary test was given to them. In the end, the subjects were asked to translate the abstract words into Japanese in another 5 minutes to test if they would have enough vocabulary.

3 Results

Figure 1 shows the mean numbers of the recalled English words under all the conditions. Table 1 shows all the means and standard deviations in the test, and Table 2 shows t test scores. An analysis of variance revealed that there was a large and significant main effect for hand gesture image presentation, $F(1, 76) = 67.86$, $p < 0.05$. The main effect for word concreteness-abstractness was also significant, $F(1, 76) = 11.71$, $p < 0.05$. The effect of interaction of the image presentation and the word concreteness-abstractness was not significant, $F(1, 76) = 0.40$, $p < 0.05$. T test scores in Table 2 revealed that there was a significant difference between the recalls of the concrete words and abstract words, $t(38) = 2.94$, $p < 0.01$, and there was a large and significant difference between the recalls with and without hand gesture images: $t(38) = 5.96$, $p < 0.01$ between the recall of the concrete words with and without the gesture images, and $t(38) = 5.69$, $p < 0.01$ between the recalls of the abstract words with and without the hand gesture images.

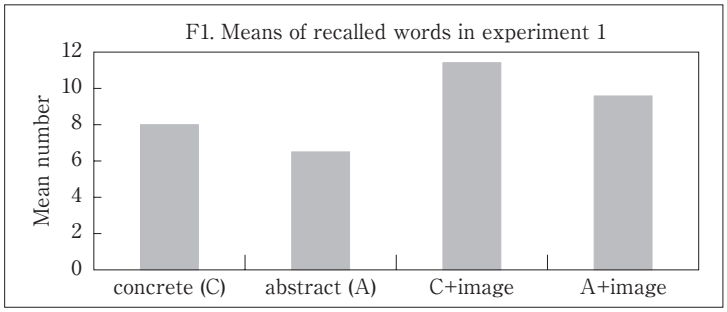

Table 1. Means and standard deviations in experiment 1

stimuli	M	SD
concrete	7.85	1.67
abstract	6.75	1.71
C+image	11.35	2.01
A+image	9.75	1.62

C. concrete, A: abstract

Table 2. T test scores in the experiment 1

	A+image	C+image	abstract	concrete
concrete	3.63 **	5.96 **	2.04 *	—
abstract	5.69 **	7.80 **	—	
C+image	2.76 **	—		
A+image	—			

C : concrete, A : abstract
** : 1%level of significance, * : 5% level of significance

4 Discussion

The present study examined the effects of hand gesture images based on ASL signs on the recall of English words in the framework of bilingual dual coding theory. The experiment 1 revealed that subjects presented with concrete words recalled more words than subjects presented with abstract words, and subjects presented with verbal information and gesture images recalled much more words than subjects presented with verbal information only. Those tendencies are consistent with the bilingual dual coding theory which emphasizes the additive effects of two verbal systems and one common nonverbal system. The experiment proved that memory is enhanced by presenting information in both verbal and nonverbal forms, and that hand gesture images based on ASL signs are very effective as nonverbal stimuli for Japanese learners of English.

The main effect of the linguistic concreteness-abstractness difference was significant, $F(1, 76) = 11.71$, $p < 0.05$. The significant difference between recalls of concrete words and abstract words was predicted. As previously mentioned, if the major psychological process underlying linguistic concreteness-abstractness is imagery, it is natural that concrete words arouse more images than abstract words, and as a result, the images facilitate the recall of concrete words more effectively than that of abstract words. The main effect of the hand gesture image presentation was very large and significant, $F(1, 76) = 67.86$, $p < 0.05$. It was also predicted that the hand gesture images as motor and visual imagery would help recall both concrete and abstract words. The t test score between the recalls of the abstract words with and without the hand gesture images, $t(38) = 5.96$, $p < 0.01$, showed the hand gesture images were very effective with the recall of abstract words as well as that of concrete words, $t(38) = 5.69$, $p < 0.01$. Reversely, abstract words are less recalled than concrete words due to the difficulty of imaging to them, but it was indicated in the experiment 1 that abstract words are well recalled when they are presented with semantically equivalent hand gesture images.

It is thought that abstract concepts are very difficult to gesticulate visualize. But Taub (2001) observed that English and ASL languages share many common cognitive structures in terms of metaphor and metonymy. The concept of time, for example, is metaphorically understood from the viewpoint of space: future is located in front of a language user and past is behind. The English word foresee etymologically means 'to see ahead', and the corresponding ASL sign is represented by moving one hand forward under the arm of the other hand to see into the future. In ASL, metaphor and iconicity often occur in combination to gesticulate abstract concepts. Based on iconic and metaphorical signs, the hand gesture images to the abstract English words used in the present study are also iconic and metaphorical. Those iconic and metaphorical qualities may have helped the subjects image the concepts of the abstract words.

5. Experiment 2

It was indicated in the experiment 1 that the hand gesture images based on ASL signs can facilitate the recall of both concrete words and abstract words, but it is unclear whether the gesture images equally benefit all students of different verbal proficiencies, especially in the recall of abstract words. It is regarded that individual differences in verbal ability are mainly based on individual knowledge and the processing capacity of information encoding, storage, and retrieval (Hunt, 1985). If that were the case, students with low second language proficiency might react to gesture images in different manners.

Table 3. Means of correctly translated abstract words by each group

group	SH		SL	
task	word only	word + image	word only	word + image
Means	18.85	18.90	7.30	7.55

SH: students with high English proficiency
SL: students with low English proficiency

Assessment of second language proficiency needs a comprehensive survey. But in this study, based on daily teaching experiences, the author regarded the subjects in the experiment 1 as students with high English proficiency and subjects in the present experiment as students with low English proficiency. Both groups were given a translation test, and the results in Table 3 proved that the student categorization was correct at least in terms of knowledge of the 20 abstract vocabulary items. It is evident that the subjects in the experiment 1 and the subjects in the experiment 2 greatly differed in the ability to acquire abstract words in the predicted direction.

The purpose of the experiment 2 was to test whether the sign gesture technique would be effective with subjects with low verbal proficiency. Subjects were 20 undergraduate students who specialized in economy. Materials, experiment design, and procedure were the same with experiment 1.

6 Results

Figure 2 shows the mean numbers of the recalled English words under all the conditions. Table 4 shows all the means and standard deviations in the test, and Table 5 shows t test scores. An analysis of variance revealed that there was a significant main effect for hand gesture image presentation, $F(1, 76) = 47.10$, $p < 0.05$. The main effect for word concreteness-abstractness

was also significant, F (1, 76) = 16.11, p < 0.05. The effect of interaction of the image presentation and the word concreteness-abstractness was not significant, F (1, 76) = 5.64, p < 0.05. T test scores in Table 5 revealed that there was a significant difference between the recalls of the concrete words and abstract words, t(38) = 4.00, p < 0.01. There was also a significant difference between the recall of the concrete words with and without the gesture images, t(38) = 4.17, p < 0.01, but the recalls of the abstract words with and without the gesture images had no significant difference, t(38) = 1.23, p < 0.05.

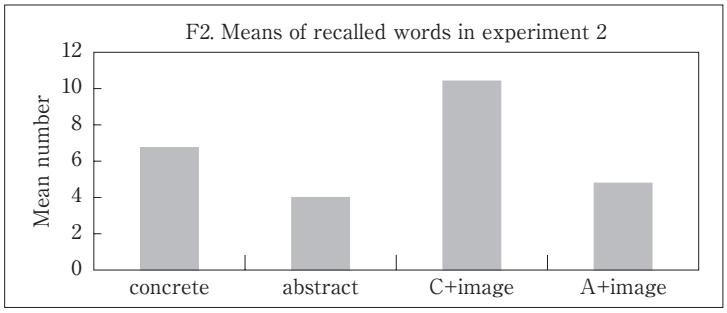

Table 4. Means and standard deviations in experiment 2

stimuli	M	SD
concrete	6.60	2.39
abstract	4.00	1.69
C+image	10.30	3.15
A+image	4.95	2.89

C. concrete, A: abstract

Table 5. T test scores in the experiment 2

	A+image	C+image	abstract	concrete
concrete	1.97	4.17 **	4.00 **	—
abstract	1.25	7.80 **	—	
C+image	5.65 **	—		
A+image	—			

C : concrete, A : abstract
** : 1%level of significance, * : 5% level of significance

7 General Discussion

A number of studies have demonstrated the effect of word concreteness on verbal recall (Paivio, 1971; Paivio and Csapo, 1973; Pavio and Desrochers,1980, Paivio and Lambert, 1981; Kawamura, 2004). Paivio, Yuille, and Madigan (1968) already indicated that concrete nouns exceed abstract nouns in imagery capacity, so the concreteness effect is attributed to concrete words' quality to evoke rich imagery. In the present study, too, concrete nouns were more recalled than abstract nouns at a significant level.

The first experiment showed that the hand gesture images based on ASL signs had a great effect on subjects with high English proficiency when they recalled abstract words as well as concrete words. On the other hand, the second experiment showed that the hand gesture images were an effective stimuli for students with low English proficiency to recall concrete words, but the images did not work well when the students tried to recall abstract words.

The bilingual dual coding theory, the dual coding theory applied to bilinguals, explains the retention of second language vocabulary in terms of associative processes that operate on a network of verbal and nonverbal information. Some scholars such as I. A. Richards who created the English Through Pictures series, and J.J. Asher who originated TPR knew that nonverbal stimuli like visual images and physical movements are effective in second language acquisition. Clark and Paivio (1991, 151-152) described nonverbal information as "modality-specific images for shapes, environmental sounds, actions, skeletal or visceral sensations related to emotion, and other nonlinguistic objects and events." Pictures (Arnedt and Gentile, 1986) and mental imagery (Matsumi, 1994) were shown as good nonverbal stimuli for second language vocabulary recall. Krauss, Chen, and Chawla (1996), and Frick-Horbury and Guttentag (1998) demonstrated the role of hand gestures in lexical retrieval. In fact, hand gestures can describe images of shapes, actions, sensations, events, and even images of sounds.

So far, two things are clear: word concreteness has an effect on vocabulary learning, and nonverbal stimuli such as pictures and gestures are an effective cue for word recall. Then, how is it possible to enhance the recall of abstract words? Abstract words, for example, ability, agreement, anger, development, effort, etc. which were employed in the present study are all indispensable vocabulary items for leaning English. Theoretically abstract words can be easily recalled when they are linked with vivid imagery. One well known example is the keyword technique (Atkinson, 1975) for learning vocabulary items of a second language. The mnemonic technique uses a familiar word in a first language as a keyword to establish an acoustic and semantic link between the word and a target word in a second language. The acoustic link is established by similarity in sound between the keyword and the target word, and the semantic link by some interactive images of the referents of the words. The technique proved to be an effective way of learning second language vocabulary items. But imaging to words depends on individuals' mental capacity, and images individuals evoke are likely to be idiosyncratic, and hard to share. What is necessary is images, visual or gestural, which are semantically related with the contents of target words and systematically linked with a target second language.

The present study proposed that the hand gesture images based on ASL signs are effective as nonverbal stimuli to enhance word recall. But, generally languages (spoken or signed) are culture-specific. The ASL sign for flower, for example, is represented by smelling an imaginable flower in the hand, while Japanese are likely to represent flowers by opening clinched hands. In the present study, the signs for flower and water were replaced by gestures which are familiar to Japanese students, but the other 38 words were represented by gestures based on ASL signs. As a sign language, ASL is different from English in using the manual-visual channel, not the vocal-auditory channel. Many signs, therefore, have a physical resemblance to objects they represent. This is the linguistic quality called iconicity which characterizes sign languages. It is those iconic signs that functioned as effective gestural stimuli in the recall tests of English words, especially concrete words. This means that ASL's iconic signs may have a vast potentiality as nonverbal stimuli in order to aid Japanese students to learn English vocabulary.

The present study tested the effects of the hand gestures on the recall of abstract words as well as concrete words with students with high and low English proficiency. The gesture images benefited the former when they recalled both concrete and abstract words, but did not work well with the latter when they tried to recall abstract words. Based on the dual coding theory, it was hypothesized that the recall of abstract words as well as concrete words was facilitated by hand gesture images if those words are well gesticulated and visualized. The significant difference between the recalls of abstract words with and without hand gesture images in the experiment 1, $t(38) = 5.69$, $p < 0.01$, indicated that the hand gesture stimuli for the abstract words were efficient in the case of the subjects with high English proficiency. The same stimuli were effective also with the concrete words, but not with the abstract words in the case of the subjects with low English proficiency.

Even if imagery is the major psychological process underlying linguistic concreteness-abstractness (Paivo, 1968), the cause of its inefficiency with the low English proficiency students is not supposed to be a matter of imagery, but the interaction between imagery and vocabulary knowledge. The present study suggests that imagery, motor or visual, does not work well in recalling abstract words without their conceptual knowledge. Accordingly, the next study will test whether the hand gesture technique will work well when students with low English proficiency try to comprehend abstract words. The focus of that study will shift from word recall to word comprehension.

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