

DO YOU REMEMBER THE WORDS? DUAL-CODING METHOD ON LONG-TERM MEMORY

Christ Billy Aryanto

Faculty of Psychology, Universitas Katolik Indonesia Atma Jaya
Jl. Jenderal Sudirman No. 51, Jakarta 12930

christ.billy@atmajaya.ac.id

Abstract

For students, long-term memory is required for individuals to study at various levels of education. An effective method is needed to help student to remember. This study aims to determine the dual-coding method on long-term memory in two levels of education: primary school and university. The first study was conducted on 60 primary school students and the second study was conducted on 81 university students, each divided into experimental group and control group. The two groups were shown 10 concrete nouns with the experimental group displayed along with the picture and only the word for the control group. Each word was displayed for 3 seconds. The results showed that the experimental group remembered more words in the first study, $t(58) = 4.386, p < .05$; and the control group remembered more words in the second study, $t(79) = -3.036, p < .05$. Therefore, the dual-coding method affects the long-term memory of primary school students but not on university students.

Keywords: cognitive psychology; dual-coding; long-term memory; memory

Abstrak

Bagi pelajar, ingatan jangka panjang diperlukan agar seseorang dapat mengingat pelajaran-pelajaran di berbagai jenjang pendidikan. Perlu ada metode yang efektif untuk membantu pelajar mengingat. Penelitian ini bertujuan untuk mengetahui pengaruh metode *dual-coding* terhadap ingatan jangka panjang di dua jenjang pendidikan: sekolah dasar dan universitas. Studi pertama dilakukan pada 60 siswa SD dan studi kedua dilakukan pada 81 mahasiswa, masing-masing dibagi menjadi kelompok eksperimen dan kelompok kontrol. Kedua kelompok mendapatkan tayangan berisikan 10 kata benda konkret dengan kelompok eksperimen ditayangkan bersamaan dengan gambarnya dan hanya kata saja pada kelompok kontrol. Masing-masing kata ditampilkan selama 3 detik. Hasil penelitian menunjukkan kelompok eksperimen mengingat lebih banyak kata pada studi pertama, $t(58) = 4,386, p < 0,05$; dan kelompok kontrol mengingat lebih banyak kata pada studi kedua, $t(79) = -3,036, p < 0,05$. Oleh karena itu, metode *dual-coding* memengaruhi ingatan jangka panjang siswa Sekolah Dasar tetapi tidak pada mahasiswa.

Kata kunci: *dual-coding*; ingatan jangka panjang; memori; psikologi kognitif

INTRODUCTION

Memory has a vital role in the learning process. Teaching and learning activities allow students to learn and get lessons every day. However, a learner cannot always recall the entire material that is already learned. Students need good long-term memory to remember the lesson material for a long time. In order to improve memory, it is necessary that students practice and improve their memory skills using certain techniques.

According to the cognitive dimensions of the revised Bloom's taxonomy, Kaivanpanah and Langari (2020) explain that the earliest stage in learning is remembering before being able to understand, apply, analyse, evaluate, and finally create. Each stage increases gradually from lower-level knowledge to higher-level knowledge. Learners should master the lowest level of knowledge first (remembering) to advance to the next level. The fundamental difference between revised Bloom's taxonomy compared to the old one

is that the new taxonomy uses verbs, namely remembering, whereas the old one used noun, namely knowledge (Kaivanpanah & Langari, 2020). The implication of turning a noun into a verb is that there is an emphasis that students need to use their memory to remember information actively.

Memory is a process where information or experience encounter encoding, storage, and retrieval (King, 2016). Encoding occurs when information is first translated into a form that can be used by other cognitive processes. Then, the information is brought to the storage in various forms for the retrieval process. If the information in memory fails to be recalled, forgetting occurs (Goldstein, 2019). The researchers found that a complete understanding of the memory formation process requires an appreciation of a variety of cognitive and neurobiological processes that involve three stages of memory processes, namely encoding, consolidation (modification of various representations in memory, so that the representation becomes stable), and retrieval, also the interaction between these three stages. (Ashcraft & Radvansky, 2014). There are three types of memories: sensory memory, short-term memory, and long-term memory (King, 2016). This study will focus on the discussion of long-term memory.

Long-term memory has two aspects, explicit memory (declarative memory) and implicit memory (non-declarative memory) (Smith & Kosslyn, 2013). Explicit memory is a memory about an activity or task that individual consciously did or experienced before. There are two explicit memories in long-term memory: episodic memory and semantic memory. Episodic memory is memory related to an event in the past, while semantic memory contains information about knowledge about the world, both in the form of words and concepts (Smith & Kosslyn, 2013). The fundamental difference between episodic and semantic memory is not only from the type of information stored but from subjective experiences associated with

encoding and retrieval information (Eysenck & Keane, 2015). One method helping individuals to ease the forming of explicit memory is the dual-coding method.

Allan Paivio's classic study sheds light on the dual-coding hypothesis. Dual-coding is two separates but connected cognitive processes through a multimodal system (Paivio, 2010). Thus, someone will remember a concept and interpret it in two ways, through a mental image or verbal representation (Paivio, 2010). This theory originated from Pavio's research about the effect of the level of abstraction of a concept on person's memory. In his research, the researcher gave participants pairs of words. Participants can remember concrete words (fork - book) better than participants who have to remember pairs of words with a higher level of abstract words (democracy - intelligence). Furthermore, Paivio (2013) explains that cognition involves the activities of two different subsystems, namely the verbal system and the non-verbal or imagery system.

The dual-coding hypothesis can explain the results of the study, which also answer the question, why participants who was shown concrete words had higher scores than participants with abstract ones, and why concrete word pairs demonstrated the effectiveness of imagery on memory. Concrete concepts can be represented verbally or visually. Meanwhile, abstract concepts only have a verbal representation because they do not have a specific or moving visual image (Paivio, 2010).

Furthermore, Paivio (2010) also explains that verbal and mental images operate in parallel. Once they work together, memory can increase. When individuals unsuccessfully represent one concept, they will try to retrieve information from other representations. Therefore, concrete words that are easier to imagine will be better recalled and better to get retrieval cues, because these words have two

representations in memory, verbal and visual (Paivio, 2010). The concept of this dual-coding hypothesis is developed and called the picture superiority effect, which means that it is easier for someone to remember information in images form (Fink, Goodwin, Jewell, Kohn, & Pak, 2012). Baadte and Meinhardt-Injac's explanation supports this theory (2019). They state that if the information in the form of images can provide a semantic representation of the words that need to be remembered, then the image can complement the information on the object to be recalled. The image ease someone in recalling the object. The semantic representation is the harmony between words and images (e.g., the word heat and the image of sun) or between images and images (e.g., the image of key and the image of padlocks). Those representations help an individual to remember because there is an association between the two words.

The results of previous studies support the dual-coding theory. Once the displayed verbal information is followed by the visualization, then the information will be easier to be remembered (Baadte & Meinhardt-Injac, 2019). These results are also supported by research on foreign language learning where learning with words and images display (verbal-visual) leads to an easier remembering process than learning by merely displaying the translation (verbal-verbal) (Carpenter & Olson, 2011). Carpenter and Olson (2011) experimented on undergraduate students and they found that if the participant was too confident that images help them to remember, the image representation stops to help the participants in remembering the word. Even though the word displayed in the experiment was only in one syllable (e.g., an image of a dog image followed by the word dog).

Other pieces of research also finding the effectiveness of dual-coding method to learn foreign language. According to Yanasugondha's research (2017), he finds

that students with English as their native language who learn Thai using the dual-coding method have higher scores than those participants who learn Thai and remember vocabulary only with words or pictures alone. However, further analysis results show an insignificant difference between groups. That may happen because the culture in Thailand is different from the culture outside Thailand. The research result from Jared, Poh, and Paivio (2013) states that learning foreign languages with images that are congruent with the local culture will be easier to remember than images that are incongruent with the local culture. For example, if an individual wants to remember the word 'post box', it will be easier to use a picture of a post box that is commonly seen in Indonesia compared to a picture of a post box commonly seen in other countries.

In learning foreign languages, students may have different learning styles. Research on students in India who learned English shows that students have more visual and auditory learning styles than kinesthetics (Karthigeyan & Nirmala, 2013). Since the dual-coding method engages with the use of words and pictures in learning, there is an assumption that visual learner will be better than others. However, Cuevas and Dawson (2018) argue that there is no interaction effect between the dual-coding method on visual, auditory, and kinesthetics learning styles. The results of these studies confirm that regardless of the student's learning style, the dual-coding method can still be effectively implemented in the learning process.

The children book is an excellent example of the application of the dual-coding method. In children's dictionaries, alphabet learning books, and other children's textbooks, the words are usually followed by pictures to simplify the learning process by associate the pictures with these words. Guo, McTigue, Matthews, and Zimmer (2020) state that images accompanying text makes material learning easier. Nevertheless, Defeyter,

Russo, and McPartlin (2009) find that the use of dual-coding was more effective in students over 18 than in children under 11 years. Different findings were put forward by Baadte and Meinhardt-Injac (2019). They state that children aged 11-13 years could remember pictures that either semantically related or not, while adults aged 18-30 could only remember those that were semantically related. From the results of this study, it can be argued that as long as words and pictures are shown simultaneously, children will more easily remember information because they make associations with both information shown.

The inconsistent results between the child and adult participants regarding the effectiveness of the dual-coding method remain the question of whether dual-coding is effective for all ages or only effective for a certain age? Defeyter, Russo, and McPartlin (2009) prove the effectiveness in student participants, but Carpenter and Olson (2011) state that if students are confident of the effectiveness, image representation would no longer help. On the other hand, Baadte and Meinhardt-Injac (2019) show that it is easier for children to associate with information in the form of words and pictures even though they are not semantically related. Therefore, this study aims to determine whether the dual-coding method has an effect on long-term memory in elementary school students and college students. The results of this study can deepen the understanding of the effectiveness of the dual-coding method in students at various levels and the development of cognitive psychology, especially the study of memory, in the Indonesian context. In order to be able to answer research questions, two studies at two different levels of education are conducted. Therefore, the researcher proposes two hypotheses to answer the research question:

1. There is a significant effect of the dual-coding method on the long-term memory of elementary school students.

2. There is a significant effect of the dual-coding method on university students' long-term memory.

METHOD

This study uses an experimental method which is divided into two groups of age. First experiment is conducted on elementary school students, and the second is on university students.

Participants

Participants in the first study were 60 primary school students. Participants were assigned into two groups using randomization technique to divide them into the first and second group. According to the random lottery, thirty students were in the experimental group and thirty students were in the control group. Thirty-eight participants were female and ranged in age from 7 to 10 years (mean age = 8.18; *SD* age = .50).

Participants in the second study were students of the Experimental Psychology class totalling 81 students. One group consisting of 41 students was the experimental group and another group consisting of 40 students was the control group. Seventy-four participants were women and ranged in age from 18 to 21 years (mean age = 19.51; *SD* age = .84).

Research Instruments

This study used two slides of a display screen and blank paper as the instrument. For the experimental group, the slide contains pictures and words, and for the control group contains only words. The blank paper was distributed for each participant and used the paper for writing down the words they can recall. The total score for long-term memory was calculated by adding up the correct words answers. The maximum score for each participant is 10, while the minimum score is zero.

The word materials displayed in the first and second studies were concrete nouns based on Allan Paivio's research in 1968, which was later developed by Clark and Paivio (2004). Previously, they researched 925 concrete words and determined whether those words non-verbally easy to imagine and familiar. Later, Clark and Paivio (2004) re-examined them with more than 1300 words added. In Indonesia, Hastjarjo (2004) developed the concreteness of words, especially for the Javanese, Sundanese and Balinese participants. However, he did not examine the level of imagery and familiarity. Therefore, in this study, the researcher decided to use the noun words from Clark and Paivio (2004), because the concreteness, imagery, and familiarity were examined and they have average scores above 6, from a range of 0-7. The words were translated into Indonesian, and the words having the same number of syllables were selected. Thus, two syllables words were used in the first study and three syllables words were used in the second study. The ten words selected in the first study were *apel* (apple), *meja* (table), *mobil* (car), *tiket* (ticket), *kulkas* (refrigerator), *pensil* (pencil), *panah* (arrow), *kucing* (cat), *pintu* (door), dan *pohon* (tree). The ten words selected in the second study were *terompet* (trumpet), *ambulans* (ambulance), *stroberi* (strawberry), *berlian* (diamond), *mentega* (butter), *boneka* (doll), *sepatu* (shoe), *mikroskop* (microscope), *jendela* (window) and *bendera* (flag).

Research Procedure

This study used the same procedure for both studies. Before conducting the first study, the researcher gave the informed consent to the school and the consent for conducting the experiment was administrated by the school. Whereas in the second study, informed consent was given to all participants before the experiment begin. The control variable for both studies was the constancy of conditions by ensuring that the two groups in each study received the same treatment (Seniati, Yulianto, & Setiadi, 2017). The study used the same instruction for each

group in both studies and use the similar characteristic classroom between studies to achieve persistence condition.

The experiment administrator displayed ten concrete nouns for the participants in the experimental group and the control group. The words are only displayed for 3 seconds each. The display screens for the experimental group contained texts and pictures of objects, while for the control group contained only texts. The two groups in both studies did the task at the same time but in different rooms. After the administrator displayed all the noun, the administrator asked the participants to write down the words they can recall on a blank paper, which were previously distributed.

The answers were not necessary to be in a sequence. As long as the participants can remember and wrote down the displayed words on a paper, the answer was correct. After completing the task, the participants returned the paper to the administrator and the classical debriefing was conducted after the experiment.

Data analysis

Both of the studies were analysed using descriptive statistical analysis to determine the number of successfully recalled words, mean, standard deviation, and standard error. Independent sample *t*-test was also used to examine whether there is a significant difference between the experimental group and the control group.

RESULTS AND DISCUSSION

Table 1 shows the number of participants who can remember each word displayed, both in the experimental group and the control group. The word apple was the most remembered word by participants in both experimental and control group, that is 28 and 30 participants respectively. The words ticket was the least remembered word in the experimental group with only 15 participants can recall this word. The word pencil was the

least remembered word in the control group as only 7 participants can remember this word.

Table 1.
Comparison of Memorized Words of The Experimental and the Control Group in Study 1

No. Item	Word ^a	Group	Total
1	Apple	EG	28
		CG	30
2	Arrow	EG	18
		CG	18
3	Car	EG	28
		CG	25
4	Cat	EG	25
		CG	20
5	Table	EG	24
		CG	16
6	Door	EG	16
		CG	8
7	Pencil	EG	17
		CG	7
8	Fridge	EG	23
		CG	18
9	Ticket	EG	15
		CG	10
10	Tree	EG	23
		CG	16

Notes. EG = Experimental Group. CG = Control Group. ^aThe words were presented in Bahasa Indonesia.

Table 2.
Score Summary in Study 1

Variable	Group	<i>M</i>	<i>SD</i>	<i>SE</i>
Total recalled words	Experimental	7.4	1.589	.268
	Control	5.67	1.47	.290

Note. SE = Standard Error.

Table 2 shows the mean, standard deviation, and standard error of the experimental and control groups. The results show that the experimental group has a higher score than the control group. The result of the independent sample *t*-test shows that there was a significant difference between the experimental group and the control group

with $t(58) = 4.386, p < .05$. This result indicates that in primary school students, the group who was shown picture and text has a significantly better score than the group who was shown only text. Therefore, the group with picture and text can remember more the noun words than the group with only text.

Table 3 shows the number of participants remembering each word displayed in the experimental and the control group in the second study. The word trumpet is the word most remembered by participants in both the experimental and control groups. It was remembered by 41 participants and 38 participants, respectively. Shoes were the least word participant can recall in the experimental group with only 13 participants can remember this word and only 27 participants in the control group can remember the word microscope.

Table 3.
Comparison of Memorized Words of The Experimental and The Control Group in Study 2

No. Item	Word ^a	Group	Total
1	Trumpet	EG	41
		CG	38
2	Ambulance	EG	37
		CG	38
3	Strawberry	EG	41
		CG	36
4	Diamond	EG	28
		CG	28
5	Butter	EG	26
		CG	31
6	Doll	EG	30
		CG	34
7	Shoes	EG	13
		CG	34
8	Microscope	EG	28
		CG	27
9	Window	EG	35
		CG	34
10	Flag	EG	21
		CG	28

Notes. EG = Experimental Group. CG = Control Group. ^aThe words were presented in Bahasa Indonesia.

Table 4 shows the mean, standard deviation, and standard error of the experimental and control groups in the second study. The results show that the control group has a more average recalled words than the experimental group. The results of the independent sample t-test showed a significant difference between the experimental and the control group with $t(79) = -3.036, p < .05$. This result indicates that for undergraduate university students, the group who was shown only text can significantly remembered more words than the group with picture and text.

Table 4.
Score Summary in Study 2

Variable	Group	<i>M</i>	<i>SD</i>	<i>SE</i>
Total recalled words	Experimental	7.32	1.507	.235
	Control	8.20	1.067	.169

Note. SE = Standard Error.

The results of this study indicate that elementary school students can remember more information displayed in the form of words and pictures, while university students can remember more information displayed in text only. The results of research on elementary school students are in line with research relating to dual-coding and are consistent with previous studies because memory can be improved if verbal representations and mental images operate in parallel and both work together. So, when one representation of a concept cannot be remembered, participants can try to obtain information through other representations (Paivio, 2010). Therefore, participants in the experimental group in the first study can remember more words than the control group.

The result of the second study disproves the dual-coding approach. The results of the second study show that displaying words and pictures does not make the process of remembering easier. The results of this study differ from research from Defeyter, Russo, and McPartlin (2009) where university

students aged 18 to 23 years can remember better when the words are presented with an image stimulus compared to participants aged 7-9 years. The same effect may not occur because when participants are in the encoding process, they must share their attention on two objects, namely words and pictures. Plebanek and Sloutsky (2017) compare the ability of selective attention of adolescents aged 18-20 years and children aged 4-5 years. According to their research result, adolescents can focus on one information easier and tend to ignore other information. In contrast, children will give attention to all the delivering information, even they were asked to focus on just one information. Difficulty in paying attention to words and images at the same time causes encoding failure in adolescent. It also leads to the occurring of improperly dual-coding process. Therefore, the adolescents tend to face difficulties in remembering the displayed words (Smith & Kosslyn, 2013). Failure in this encoding stage makes a person unable to associate between words and images, so they cannot recall the displayed information because the associative memory is not well formed (Baadte & Meinhardt-Injac, 2019).

Fewer university students remembered the displayed information in the form of words and pictures compared to children may happen because students believe too much that images can help them remember, as occurred in Carpenter and Olson's research (2011). This was possible since the participants in the second study were students from the Experimental Psychology, and they have probably guessed the research hypotheses. If so, it indicated a participant bias which made the results of the study different from previous studies. This study conducts no manipulation checks, so the researcher cannot confirm whether the participants could predict the research hypothesis during the experiment or not.

This study used images that match the displayed words as done in previous studies

(Baadte & Meinhardt-Injac, 2019); for example, the 'apple' text was accompanied by 'red apple' image. The chosen words were controlled using concrete words that are easy to imagine with visual representations and were familiar according to the glossary of Clark and Paivio (2004). The difference in the words used in the first study and the second study did not affect the results of the study because each study consistently used the same number of syllables, namely two syllables in the first study and three syllables in the second study. Based on the research results of Jalbert, Neath, Bireta, and Suprenant (2011), in a study of mixing words with short syllables (one syllable) and words with long syllables (three to five syllables) participants found it easier to remember words with short syllables. The consistency of using concrete words with the same number of syllables for each study became a strong control for the study, namely the constancy of condition.

There were similarities in the first and second study in term of the order of the words. Participants tend to remember the words at the beginning and the end of the display. Whereas words in the middle are more often forgotten. This phenomenon is called the serial position effect. It is a tendency to recall items at the beginning and end of a list compared to those in the middle (King, 2016). That is also a primacy effect, which refers to the accuracy of recalling an item in the initial position (Goldstein, 2019). This study also supports the phenomenon of serial position effect and the primacy effect, that the very first word is the word most remembered by participants in both studies.

CONCLUSION

The results of this study indicate that the dual-coding method is an effective learning method for elementary school children, but not necessarily beneficial for university students. This may happen because the university students' attention was split into two when two different stimuli were

displayed, and it can disrupt the process of remembering. Manipulation checks on participants are necessary because the researcher can identify whether participants can predict the purpose of the study or not during the experiment. Because knowing the purpose of the study can affect participants' confidence to the effect of the picture to the memory and can reduce the number of memorized words.

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