12-13-2014

Picture Superiority Effect and its Detrimental Effect in Memory Updating with Road Signs

Eumji Kang

Picture superiority effect and its detrimental effect in memory updating with road signs

By

EumJi Kang

A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Experimental Psychology
in the Department of Psychology

Mississippi State, Mississippi

December 2014

Picture superiority effect and its detrimental effect in memory updating with road signs

By

EumJi Kang

Approved:

Carrick C. Williams
(Major Professor)

Deborah K. Eakin
(Committee Member and Graduate Coordinator)

Lesley Strawderman
(Committee Member)

R. Gregory Dunaway
Professor and Dean
College of Arts & Sciences

Name: EumJi Kang

Date of Degree: December 13, 2014

Institution: Mississippi State University

Major Field: Experimental Psychology

Major Professor: Carrick C. Williams

Title of Study: Picture superiority effect and its detrimental effect in memory updating with road signs

Pages in Study: 63

Candidate for Degree of Master of Science

Classic studies found advantages of pictures over words in memory (picture superiority effect). This paper applied the picture superiority effect to road signs to examine whether people remembered picture road signs better than word road signs. People remembered picture road signs better than word road signs, as evidenced on a recognition test. However, in real driving situations drivers do not need to remember the meaning of one road sign for a long time; rather, they need to continuously update information from sequentially encountered road signs. Therefore, Experiment 2 explored the differences in updating memory between pictures and words. Memory for the most recently viewed road signs was different depending on the form (picture, word) of the previously encountered road sign. Previously encountered picture items impaired memory significantly more than previously encountered words. These findings demonstrate that superior picture memory sometimes can be detrimental, especially when remembering recent information.

DEDICATION

This paper is dedicated to my parents and my one and only brother.

ACKNOWLEDGEMENTS

I would like to thank Dr. Carrick Williams for all of his assistances through my graduate life. I still remember the essay test in his class. I raised my hand and asked the meaning of “ramification”. I learned this word from you and much more than just one word as your student. I appreciate your time, effort, and patience with me.

I also would like to thank my committee members, Dr. Deborah Eakin and Dr. Lesley Strawderman for providing directions and advices on my work.

I finally would like to thank all people from psychology department. All of advices and valuable times are really appreciated.

TABLE OF CONTENTS

DEDICATION ii

ACKNOWLEDGEMENTS iii

LIST OF TABLES vi

LIST OF FIGURES vii

CHAPTER

I. INTRODUCTION 1

Picture Superiority Effect 3
Road Signs 6
Road Signs and Picture Superiority Effect 8
Long-Term Memory vs. Memory Updating 10
Proactive Interference 11

II. SPECIFIC AIMS 15

Aim 1: Replicate picture superiority effect with road signs 15
Hypothesis 1 15
Hypothesis 2 16
Aim 2: Examine the picture superiority effect in memory updating task 16
Hypothesis 3 16
Hypothesis 4 16
Hypothesis 5 17

III. EXPERIMENT I 18

Method 19
Participants 19
Design 19
Materials 20
Procedure 21
Results 23
Discussion 24
Experimental condition 24
Picture superiority effect 26

Item type 27

IV. EXPERIMENT II..29

Method 32
Participants..32
Design 32
Materials 33
Procedure 33
Results..35
Discussion 39

V. GENERAL DISCUSSION 42

Limitations and Future Directions 45
Conclusions..46

REFERENCES 48

APPENDIX

A. STIMULI LIST FOR EXPERIMENT I 53

B. INFORMED CONSENT 56

C. DEMOGRAPHIC QUESTIONNAIRE 58

D. STIMULI LIST FOR EXPERIMENT II 60

E. INSTITUTIONAL REVIEW BOARD APPROVAL FORM 62

LIST OF TABLES

1 Memory accuracy for transition conditions for Experiment 2 (Standard deviation in parentheses). 36

2 Memory accuracy for normal stimuli and road signs (Standard deviation in parentheses). 38

LIST OF FIGURES

1 An example of picture (left) and word (right) road signs 1

2 An example of normal picture (left) and normal word (right) 20

3 Examples of memory test for normal items (left) and road signs (right)...........21

4 Memory accuracy (Standard error in error bars) for Experiment 1 24

5 The schematic for the Experiment 2...33

CHAPTER I

INTRODUCTION

Driving is a part of our daily life. Understanding and interpreting the meaning of road signs is an important task in driving because road signs provide information about traffic and upcoming situations. Road signs can be displayed in two formats (Figure 1): using pictures (*picture road signs*) and words (*word road signs*). Picture road signs display messages with simple icons, whereas word road signs convey messages with a couple of words. Drivers must process road signs correctly to produce proper reactions while driving (Jongen, Brijs, Mollu, Brijs, & Wets, 2011). Although they are intended to convey the same meaning, what if one form of road signs can be processed more efficiently than the other form?

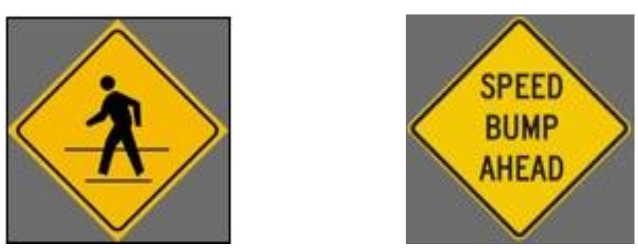

Figure 1. An example of picture (left) and word (right) road signs.

We deal with pictures and words everyday. In many situations, a simple picture or drawing effectively convey the messages to readers. Many students will agree that a simple picture or graph can enhance their memory for the reading (Koenke & Otto, 1969; Readence & Moore, 1981). More generally, previous studies have shown that people have superior memory for pictures compared to words in recognition task (e.g., Nickerson, 1965; Shepard, 1967) and in recall task (e.g., Bousfield, Esterson, & Whitmarsh, 1957; Paivio & Csapo, 1973). Those findings imply that pictures may be processed more efficiently than words, and series of experiments have shown that people remember pictures better than words. Would road signs show the same sort of picture advantage that other stimuli have shown and would this impact the effectiveness of the road signs? Anderson et al. (2007) mentioned the role of memory in driving. They said driving requires an interaction among attention, perceptuomotor skills, memory, and decision-making. Although they did not emphasize the memory for road signs solely (they emphasized the memory of relevant previous experience), they said that any component of cognitive processes is related to the risk of behavioral errors on driving. Because memory is an important factor in cognitive processing, we believe that memory will contribute to the effectiveness/processing of road signs.

Extending the concept of better memory for pictures to road signs, do picture road signs have advantages in memory like normal pictures (e.g., picture of an apple) compared to word road signs? Picture road signs seem to capture more attention from drivers and appear to be processed better/faster than word road signs (Ells & Dewar, 1979). Picture and word road signs are designed to deliver the same traffic information, but if one type of road sign is processed better than the other, we can encourage the use of that type of road sign more. Many factors affect sign effectiveness (Dewar & Olson, 2007) such as design, layout, and legibility. We think memorability of road signs also affect sign effectiveness (Anderson et al., 2007). Thus, the first study presented in this paper examined whether there is an advantage for picture road signs in their memory over word road signs.

However, typical experimental conditions demonstrating a picture advantage in long-term memory are different than the demands of driving. In most studies with normal pictures (pictures of everyday objects) and words, people are usually shown sequentially presented pictures and words and tested later for their long-term memory of the pictures and words (e.g., Paivio & Csapo, 1973;Weldon & Coyote, 1996). On the other hand, drivers do not necessarily need to remember all the road signs they have encountered during their entire drive. Rather, drivers need to remember the information that is related to current traffic and driving situations from recently encountered road signs. Under this circumstance, memory for previously encountered road signs that is now irrelevant might interfere with more recently encountered road signs that are related to current driving situation. The second study introduced in the current paper explored how previously encountered picture and word items interfere with the most recently encountered picture and word items including road signs.

Picture Superiority Effect

There is an old saying: a picture is worth a thousand words. In many situations, a simple picture or drawing can effectively convey messages to readers. Pictures seem to be more effective type of visual information than words although both pictures and words are used to deliver the information visually (Koenke & Otto, 1969; Readence & Moore, 1981).

Previous studies have shown remarkable capacity, longevity, and accuracy of visual memory from pictures. People could recognize studied pictures after one year (Nickerson, 1968). Standing (1973) showed people were almost perfect at remembering about 1,200 vivid pictures and made relatively few mistakes in remembering a population of 11,000 ordinary photographs after only five seconds exposures per each item. The error rates were higher for words in recognition task (Standing, 1973). Other studies also have shown the superior memory of pictures than words (Shepard, 1967; Nickerson, 1965; Paivio & Csapo, 1973; Weldon & Coyote, 1996).

Paivio compared picture and word memory and showed that concepts were remembered better when they were represented as pictures rather than words (*picture superiority effect*; Paivio, 1969; Paivio, 1971; Paivio & Csapo, 1969; Paivio & Csapo, 1973). Many researchers have proposed theories to explain picture superiority effect in memory. Paivio and colleagues (1971; 1986; Paivio & Csapo, 1973) explained the picture superiority effect by *dual-coding theory*. According to the dual-coding theory, nonverbal information is represented in an image code and verbal information is represented in a verbal code. Those two systems are independent but interconnected. Information represented with both image code and verbal code is more likely to be remembered compared to information with only one code because the redundancy of two codes enhances the memory. According to the dual-code theory, people usually name a picture if it is not abstract, and naming something provides it with a verbal label or code. Thus, pictures evoke both an image code and a verbal code. Words directly evoke verbal code, but, under some circumstances, they also can activate an image code. The chance of a word having an image code is higher for concrete nouns than for abstract nouns. Because the verbal code to pictures is more available than imagery to words (i.e., it is easier to name a picture than evoke an image), pictures have better chance to be represented with both codes (Paivio & Csapo, 1969; 1973). Paivio and Csapo (1969, 1973) claimed that the availability of both codes is highest in the case of pictures, intermediate for the concrete words, and lowest for the abstract nouns.

Paivio and Csapo (1973) also suggested that image code by itself might be more effective cue than verbal code because pictures generate relatively more verbal elaborations than do words. People can generate more than one verbal code for pictures if there is sufficient time and that enhance the memorability of pictures. Nelson, Reed, and Walling (1976) provided further explanation from the similar point of view with their sensory-semantic model. According to their model, pictures and words provide similar semantic codes, but pictures have better sensory codes. Nelson et al. proposed that pictures provide qualitatively better sensory memory than words that can aid memory even in the absence of a secondary verbal code. As a test, Nelson et al. found that people remember pictures better than words even when participants were unable to verbalize the label of the picture by presenting stimuli fast enough to suppress verbalization (limiting the chance to use dual codes for pictures). Thus, image code itself might be a qualitatively better code compared to verbal code.

Others have insisted that perceptually distinctive aspects such as colors, shapes or perspectives of pictures provide better cues to be memorized than much less distinctive words (Bousfield, Esterson & Whitmarsh, 1957; Weldon & Coyote, 1996). Each picture has its own distinct perceptual information and this information can be served as a cue to be memorized. According to the perceptual distinctiveness theory, for example, if we see a picture of mug, its color, size, shape, the orientation of handle, and etc. can provide various perceptual distinctive cues. Each of these perceptual cues can distinguish this particular mug from other mugs. In contrast, words have less perceptual distinctiveness. Only font types, colors, sizes can provide perceptual distinctiveness of words that lead to less superior memory than pictures. According to this perceptual distinctiveness theory, more visually distinctive pictures enhance its memory.

Picture superiority effect showed people remember pictures better than words. Dual-coding theory explained that pictures are more likely to evoke both image code and verbal code than words allowing multiple cues to a picture memory. Sensory-semantic model emphasized that picture code itself is qualitatively a better cue than verbal code allowing for superior picture memory. Perceptual distinctiveness theory explained that pictures provide more perceptual information and that each perceptual information serves as a cue to be memorized.

Road Signs

Road signs are designed to convey the information regarding traffic and driving effectively by using different shapes and colors. For example, a triangle shape is used for yield signs and round shape indicates that a railroad crossing is ahead; also, the color red means stop and the color yellow implies warning (Traffic signal timing manual, 2008). Although the shapes and colors provide general traffic information such as caution, specific information is provided by either pictures or spelled out words – a picture of a pedestrian in a crosswalk or the words of speed bump ahead.

Both picture and word road signs have their own characteristics. Picture road signs use simple drawings and convey their messages effectively even to the different language users (Walker, Nicolay, & Stearns, 1965). On the other hand, word road signs consist of a couple of words that convey the specific meaning of the sign. Although different language users may have difficulties in understanding word road signs, it can clearly deliver its intended meaning without confusion.

Previous studies about picture and word road signs support the advantage of pictures over words in conveying meaning efficiently and easily. Ells and Dewar (1979) found that people reacted faster to picture road signs than word road signs when people were required to say "yes" if a presented sign matched the meaning of the referent message. Walker, Nicolay, and Stearns (1965) demonstrated that the meaning of road signs could be learned better with picture road signs than the word road signs. From these studies, we might think picture road signs are more effective type of road signs.

Although some studies have compared picture road signs and word road signs in terms of processing efficiency, to our knowledge, there has been no direct memory study about road signs. We cannot ignore the memorability of road signs in its effectiveness because drivers need to remember road signs well to process it (Anderson et al., 2007). Comparing memory for picture and word road signs would provide important information regarding sign effectiveness and picture superiority effect. The next section introduces the relationship between road signs and picture superiority effect.

Road Signs and Picture Superiority Effect

Picture and word road signs are designed to deliver the exact same meaning to drivers. A picture of a person walking should be perceived same as words "pedestrian crossing." However, if drivers remember picture road signs better, we can ask a question about the effectiveness of word road signs (Anderson et al. 2007). Although Fisher (1992) claimed that sign recall or recognition *per se* is not a true measurement of sign effectiveness, we still cannot ignore the importance of sign recall or recognition because drivers need to hold the information extracted from the road signs to adjust their driving behaviors. For example, drivers need to remember previously seen road sign such as work zone sign to adjust their driving behavior (Strawderman, Huang, & Garrison, 2013).

In addition to informing us about the road sign effectiveness, studying road signs memory can tell us more about the picture superiority effect. In comparison to more usual stimuli used in picture superiority effect experiments, picture and word road signs are more similar to each other. Although a word road sign consists of a couple of words, it is still presented within the context of a sign that could easily provide an image code for the verbal information. Also, picture road signs are not as varied as normal pictures in that the shapes and colors are limited decreasing the distinctiveness of the picture road sign compared to a word road sign. Finally, picture and word road signs with same meaning share their shapes and colors and thus share their perceptual information. If there is a difference in the picture superiority effect between road signs and normal stimuli, we can use that difference to probe the theories of picture superiority effect.

With regard to the difference between road signs and other stimuli, according to dual-coding theory, we would expect a similar picture superiority effect for normal objects and road signs. When presented with a picture road signs, people should encode picture road signs with both an image and a verbal code because usually people name presented picture item. On the other hand, word road signs should only be encoded verbally. In other words, the encoding of road signs should be identical to normal pictures and words. Thus, picture superiority effect should be equivalent for both normal objects and road signs according to the dual-coding theory. However, the magnitude of the picture superiority effect may be different for normal objects and road signs from the view of sensory-semantic model and perceptual distinctiveness theory. According to sensory-semantic model, label similarity of named pictures is expected to disrupt memory performance (Nelson, Reed, and Walling, 1976). Picture road signs have high label similarity because they are all about traffic compared to normal pictures. Thus, picture road signs might not have extreme superior memory. Also, from the view of perceptual distinctiveness theory, normal words lack perceptual distinctiveness whereas word road signs have some perceptual characteristics such as colors and shapes (see Figure 1). In addition, the pictures used in picture road signs provide less perceptual information than normal pictures in that they are limited in both shapes and colors. Thus, picture and word road signs provide less perceptual difference because they share the shapes and colors. From this point of view, the picture superiority effect for road signs should be smaller than one for normal objects.

We expected studying memory for road signs to provide us more insights about the effectiveness of picture and word road signs. Also, the degree of picture superiority effect for road signs might test which theory could best explain picture superiority effect. According to dual-coding theory, the amount of picture superiority effect would be same for both normal objects and road signs. On the other hand, picture superiority effect should be smaller for road signs compared to normal objects according to sensory-semantic model and perceptual distinctiveness theory.

Long-Term Memory vs. Memory Updating

In this paper, two experiments will be presented. The first experiment tried to replicate picture superiority effect with normal objects and road signs. Similar to Paivio and Csapo (1973), pictures and words were presented sequentially followed by a memory test. This design tested long-term representation of pictures and words for both normal stimuli and road signs. Critically, this experiment established whether the picture superiority effect can be found with road signs and if the effect is similar to other, more normal stimuli.

The second experiment examined the picture superiority effect under different circumstances. In driving situations, drivers do not need to remember large number of road signs presented over several minutes for a long period of time. Instead, they need to remember which road signs were the most recently encountered because those signs are the ones relevant to the current driving environment. For example, speed limits change frequently during a drive, and drivers need to update their memory with the current speed limit and ignore or forget the previous speed limit. Thus, rather than asking to choose what sign had been seen at some indeterminate time during an experiment (like in Experiment 1), we asked people to choose the more recently encountered road signs or most recently encountered normal objects of two previously presented stimuli to more accurately simulate the memory demands of a real driving situation. In order to accomplish this goal, we tested memory frequently while presenting pictures and words sequentially. On the memory test, we asked people to choose the more recently encountered item over previously encountered item (*memory updating task*). Critically, picture superiority should play a role in this memory updating task. If the most recently encountered item were a picture, people would likely remember it better than a word (the picture superiority effect). However, if the previously encountered item were also a picture, it may make it harder to remember the current item. The next section explores how the picture superiority could affect memory updating tasks.

Proactive Interference

The second experiment in this paper asked people to choose the most recently encountered items during a sequential presentation. In this memory updating task, people's ability to discard previous memories and focus on the current memories is important, and when it becomes hard to distinguish older memory from the more recent memory, proactive interference can occur (Szmalec, Verbruggen, Vandierendonck & Kemp, 2011). Proactive interference refers to forgetting due to the events that occurred prior to the materials to be remembered (Still, 1969).

Asking one to choose the most recently encountered item can relate to long-term working memory rather than long-term memory by itself. Working memory is temporary storage of information that is being processed (Baddeley, 1986). The most recent information needs to be maintained in this working memory. However, also people need to replace this most recent information with previously encountered information in memory updating task. To do that, they need to access to long-term memory. Long-term working memory is a mechanism based on skilled use of storage in long-term memory

(Ericsson & Kintsch, 1995). Thus, the second experiment tested the long-term working memory ability rather than long-term memory itself.

Makovski and Jiang (2008) explained that lingering familiarity of previously stored information is confused with the current memory and produces proactive interference. In a memory updating task, such as that used in Experiment 2, the lingering familiarity of previously encountered road signs or normal objects could interfere with most recently encountered road signs or normal objects leading to inaccurate judgments of which item occurred more recently.

There are some previous studies that examined proactive interference between pictures and words in sequential presentation. Fozard (1970) presented pictures and words sequentially and implemented recognition questions (which of two items had been seen before) or discrimination questions (which of two previously seen items was presented more recently). He hypothesized that discrimination judgments would be superior when both previously and recently presented items were pictures than when both were words. According to Fozard (1970), pictures and words have different variability of estimates of an item's location on the continuum of remembered events. Pictures have less variability in their estimates whereas words have more variability. Thus, there would be less overlap in their variability when both previously and recently encountered items are pictures. However, if two items are words, they share their variability more and it can lead to less accurate judgment of recency (which item was presented more recently). His finding followed his prediction that recency discrimination was most difficult when both previously and recently encountered items were words. According to this explanation, the memory for the most recently encountered item in the presented study would be best when both penultimate and ultimate item were pictures and worst when both were words.

In contrast, we predicted a different pattern in that proactive interference should be strongest when previously encounter item (*penultimate*) was a picture and most recently encountered item (*ultimate*) was a word due to picture superiority. We think ultimate word would be more susceptible to proactive interference because its memory is weak compared to picture. Also, a penultimate picture would provide stronger lingering familiarity than words, and thus the weakest amount of proactive interference would be observed when penultimate item was a word and ultimate item was a picture.

In addition, when updating memory, the distance between penultimate and ultimate could affect the amount of proactive interference. The *N-back* task has been used widely to test people's working memory ability. Participants are presented with a stream of stimuli, and the task is to decide for each stimulus whether it matches the one presented *N* items before (e.g., Jaeggi, Buschkuehl, Perrig, & Meier, 2010). For example, the current item should match with the stimulus presented five items before to yield a positive response for the five-back task. With the *n-back* task, people made more errors when two letters were presented closer each other (Szmalec et al., 2011; Makovski & Jiang, 2008). Frey and Fozard (1970) presented unrelated pictures with four different presentation times (0.5, 0.9, 1.5, and 2.5 sec) and found that discrimination of recency was poorer with shorter presentation times than longer presentation time. Shorter presentation time decreases the distance between two items. In our memory updating task, we expected that the amount of proactive interference would be stronger when the distance between penultimate and ultimate was shorter because the lingering familiarity from penultimate should be stronger for shorter distance and lead to less accurate judgments.

Many previous studies regarding proactive interference have used either words or pictures only to examine the working memory ability (e.g., Makovski & Jiang, 2008; Jaeggi, Buschkuehl, Perrig, & Meier, 2010; Szmalec et al., 2011). Some studies, however, have tried to compare both picture-type of stimuli and word-type of stimuli in proactive interference paradigm. Mecklinger, Weber, Gunter and Engle (2003) used both letters and abstract objects in their recent-probes task. In recent-probes paradigm, participants need to remember several target items for a couple of seconds and then indicate later whether the new cue matches one of the presented targets (Jonides & Nee, 2006). Mecklinger, et al. found that participants responded faster to letters than to abstract objects when the interference (target items were used in different previous trials) occurred. Badre and Wagner (2005) also found that participants were worse at identifying the abstract patterns than verbal items in the interference condition (target had appeared in different trials). These finding demonstrated that the effect of interference was stronger for abstract objects than for letters. It seems that current memory is more affected when the previous stimuli are in picture or abstract pattern forms than the word forms because pictures provide stronger lingering familiarity (picture superiority effect) than words. Some studies also have found no picture superiority effect when they implemented implicit memory tests such as category production and word association test (Weldon & Coyote, 1996) and when they equated visual angles across pictures and words (Amrhein, McDaniel, & Waddill, 2002). Picture superiority does not always provide better memory especially when interference occurs.

CHAPTER II

SPECIFIC AIMS

Two experiments are introduced to replicate picture superiority effect and explore the effect of this effect in memory updating task with picture and word road signs along with normal pictures and words. Specific aims and hypothesis are described below.

Aim 1: Replicate picture superiority effect with road signs

Picture superiority effect has been replicated in many experimental conditions. With Aim 1, we wanted to find whether road signs also show classic picture superiority effect along with normal pictures and words. If people remember picture road signs better than word road signs, it can be problematic because two types of road signs should yield similar responses from drivers. Also, we expect that we can evaluate some theories, which explain picture superiority effect from our predictions.

Hypothesis 1

If dual-coding theory explains picture superiority effect, the picture superiority effect would be same for both normal objects and road signs. People can use both image code and verbal code when they encode the meaning of picture road signs whereas they use only verbal code for word road signs. The redundancy of codes for both normal pictures and picture road signs would produce similar picture superiority effects.

Hypothesis 2

If sensory-semantic model and distinctiveness theory explains picture superiority effect, normal pictures and words would produce a larger picture superiority effect than road signs. Normal pictures and words have more differences in their distinctiveness than picture and word road signs, which share shapes and colors. More perceptual differences of normal pictures and words would yield a bigger memory difference.

Aim 2: Examine the picture superiority effect in memory updating task

With Aim 2, we wanted to explore the effect of superior memory of pictures in memory updating task. In the memory updating task, we asked participants to choose the more recently encountered item tested against a previously encountered item. In this task, proactive interference would be measured between two items by measuring the memory accuracy for most recent item. We hypothesized that the amount of proactive interference might be different depending on the distance between penultimate and ultimate items and the format of those two items.

Hypothesis 3

More proactive interference would be observed when previously and recently encountered items are closer each other. Closer items would share their memory more than more distant items making the judgments of recency more difficult.

Hypothesis 4

Previously encountered pictures would produce stronger proactive interference than previously encountered words. Pictures have stronger memories and they affect the later memory more than words. Thus, the judgment for the most recently encountered item would be less accurate when the penultimate item was a picture.

Hypothesis 5

Recently encountered words are more susceptible to proactive interference than recently encountered pictures. Ultimate words provide weaker memories and the judgment for the ultimate words will be less accurate compared to pictures.

CHAPTER III

EXPERIMENT I

The first experiment was designed to replicate the picture superiority effect with road signs. Both normal pictures and words and picture and word road signs were presented in random sequence with intentional memory instructions (*intentional memorization*) or without memory instructions (*incidental memorization*) along with a pleasantness rating task. In the intentional memorization, participants were told about the memory test in advance and were informed that they needed to remember all the presented items. The incidental memorization condition was used because drivers usually encounter road signs without the intention to memorize road signs. Thus, incidental memorization more accurately reflects realistic driving conditions, whereas intentional memorization is more common in previous picture superiority studies. Under the incidental memorization condition, participants were not informed about the memory test in advance. Rather, they were required to view the items and rate the pleasantness of presented items. The pleasantness rating task was used to disguise the real purpose of the experiment for the incidental group and encourage all participants to examine items thoroughly. After the sequential presentation of the items, a memory test was given to both intentional and incidental memorization groups.

Method

Participants

Seventy-eight undergraduate students from Mississippi State University participated in the experiment. Their average age was 19.65 (range = 18 years to 36 years). All participants reported they had normal or corrected-to-normal vision. Forty participants were told about the memory test before they started studying phase (intentional memorization) and thirty-eight participants were not told about the memory test (incidental memorization). One participant from intentional memorization condition and three participants from incidental memorization condition were excluded from analysis because they responded correctly less than 30% of the time on the memory test. The chance level for memory test was 25% because the participants had to choose one item from four alternatives.

Design

The design was a 2 (Experiment Condition: intentional memorization, incidental memorization) x 2 (Item Type: normal object, road sign) x 2 (Item Presentation: picture, word) mixed factorial design. Intentional and incidental experiment conditions were manipulated between participants; item type and item presentation were manipulated within participants. The first phase of the experiment was the encoding phase where all the items were presented sequentially, and the second phase was the memory test where participants were required to choose the item that they had seen from four alternatives.

Materials

Normal pictures were collected primarily from Hemera Photo Objects (2002), although some pictures were collected through web searches. They were all color pictures and resized to 150 x 150 pixels while maintaining the original proportions (the longer dimension of the image, height or width, was set to 150 pixels, 3.50 degrees of visual angle at a distance of 57cm). The background color was filled out by a neutral gray color (RGB = 128). Normal word stimuli images were made by Adobe Photoshop CS2. We used black Times New Roman font at 48 point font size to display the words. Words were centered in 150 X 150 gray backgrounds (Figure 2).

Figure 2. An example of normal picture (left) and normal word (right).

Images of picture and word road signs were collected through web search. We collected pairs of picture and word road signs that have same meaning. The road sign stimuli were resized to 150 X 150 pixels in the same manner as the normal pictures and words. E-prime software (Psychology Software Tools, Inc.) was used to run the experiment.

We collected 56 picture road signs, 56 word road signs, 360 normal pictures, and 360 normal words (total 832 items). During the encoding phase, a quarter of the stimuli (208 items) were presented in the center of the screen with gray background (Appendix A). The remaining three quarters of pictures and words served as incorrect answers (foils) in the memory test. In the memory test, four items were appeared on the screen horizontally with 25 pixel spacing (added to left and right of the items) between each (See Figure 3).

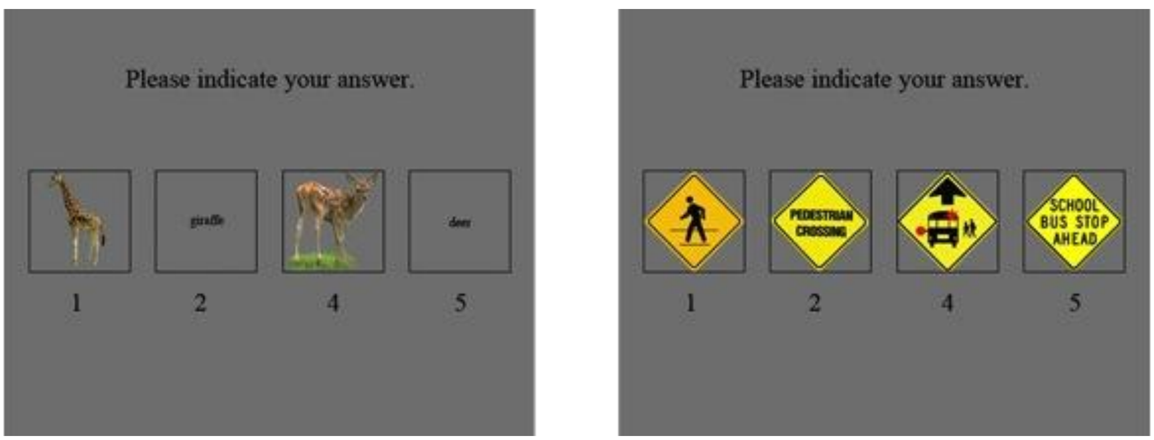

Figure 3. Examples of memory test for normal items (left) and road signs (right).

Procedure

Participants were seated in front of the computer monitor in private laboratory room. They filled out an informed consent form and demographic questionnaire (see Appendix B and C). Participants were randomly assigned to either intentional or incidental memorization group. Both groups were instructed about encoding phase of the experiment. Participants were told that a series of pictures and words would be shown for one second each and that they were to rate the pleasantness of each presented item on a 1 to 5 scale (1 for unpleasant, 3 for neutral, and 5 for pleasant) by pressing the appropriately labeled button on the button box in front of them. Only the intentional memorization group was told about the memory test by experimenter before they start the experiment. During the encoding phase, participants saw 104 pictures and 104 words of normal objects and road signs presented in a random order in the center of the screen for the pleasantness rating task.

The second phase of the experiment was the memory test. The memory test was a surprise for incidental memorization group, but participants in the intentional group had been informed that it would occur. In the memory test, participants were instructed to choose the one item that they saw during the encoding phase from among four alternatives (Figure 3) by pressing the labeled button in front of them. The three foil alternatives were selected to match the conceptual meaning, perceptual form, or neither of the presented stimuli. One foil was a *perceptual foil* that shared the conceptual meaning of the presented item. For example, if the presented item were a picture of a strawberry, the perceptual foil would be the word “strawberry”. The other two alternatives were *conceptual foils* that did not share the meaning of the presented item. For example, if the presented item were a picture of a strawberry, two conceptual foils were a picture of a watermelon (sharing the form, but not the meaning of the presented item) and the word “watermelon” (not matched on either form or meaning). Participants were tested for all 208 presented items from the encoding phase. The experiment lasted about 30 minutes and participants were told that they could have a break at any time.

Results

Memory accuracy was analyzed by mixed-design analysis of variance at .05 alpha level. There was a significant main effect of experiment condition: people remembered pictures and words better (87.07%) in intentional condition than the incidental condition (80.52%), $F(1,72) = 6.24$, $MSE = .05$, $p = .015$, $\eta^2 = .08$. The main effect of item presentation was also statistically significant, $F(1,72) = 31.06$, $MSE = .01$, $p < .001$, $\eta^2 = .30$, with picture memory (86.91%) being better than word memory (81.04%), demonstrating a picture superiority effect. Finally, the main effect of item type was statistically significant, $F\ (1,72) = 91.57$, $MSE = .01$, $p < .001$, $\eta^2 = .56$, with memory for normal stimuli (89.61%) being better than memory for road signs (78.34%).

Experiment condition (intentional memorization or incidental memorization) did not interact with either item type (normal objects or road signs), $F\ (1,72) = 2.10$, $MSE = .02$, *ns*, $\eta^2 = .03$, or item presentation type (picture or word), $F\ (1,72) = 1.62$, $MSE = .21$, *ns*, $\eta^2 = .02$. Thus, we collapsed intentional and incidental memorization conditions and the memory accuracy for Experiment 1 is summarized in Figure 4. There was an interaction, however, between item type and item presentation type, $F\ (1,72) = 9.40$, $MSE = .01$, $p = .003$, $\eta^2 = .12$. People remembered pictures better when they were normal objects than they were road signs. However, the picture superiority effect was *larger* for road signs than for normal objects. The size of picture superiority (picture memory minus word memory) was 2.55% for normal stimuli and 9.18% for road signs. The three-way interaction (Experiment condition, Item type, and Item presentations) was not significant, $F\ (1,72) = 0.03$, $MSE = .01$, *ns*, $\eta^2 = .00$.

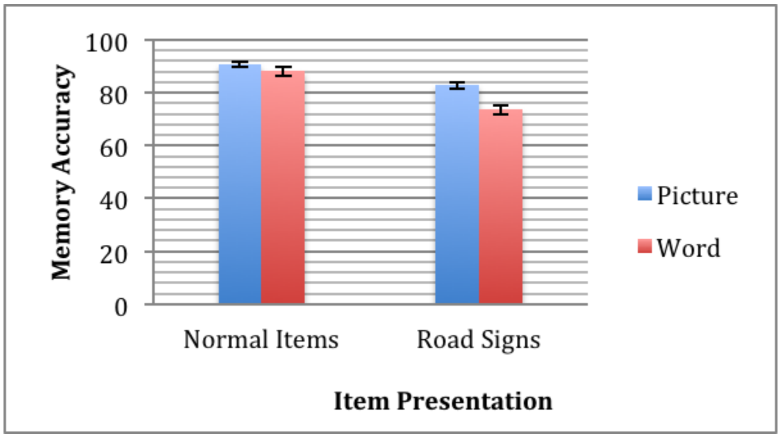

Figure 4. Memory accuracy (Standard error in error bars) for Experiment 1.

Discussion

The current study examined whether or not the picture superiority effect would be present in picture road signs compared to word road signs. Normal picture and word objects were tested to confirm the picture superiority effect for experimental materials along with picture and word road signs. Also, incidental memorization condition was introduced to describe more realistic driving situation (drivers usually do not have an intention to memorize road signs).

Experimental condition

Previous studies found that the intention to memorize items did not make a significant difference in visual memory tests (Castelhano & Henderson, 2005; Williams, 2010). However, there was a main effect of the experimental condition in the current study. Intentional memorization condition (87.07%) yielded better memory performance than incidental memorization condition (80.52%). Previous studies found no difference between intentional and incidental memorization used a different incidental task such as visual search task and used picture stimuli only (Castelhano & Henderson, 2005; Williams, 2010). Visual search task requires participants to find a target among distractors that share some aspects with a target such as categories or colors (Williams, 2010). People can immediately distinguish distractors (white cup) from a target (red apple) especially when they do not share any aspects with a target. This strategy prevents people from processing all the presented items deeply. Compared to visual search task, the current study made participants view the items and rate the pleasantness of presented items. To rate the pleasantness of items, people need to examine and evaluate presented items more carefully. This different type of task might result different effect of the instruction.

Noldy, Stelmack, & Campbell (1990) introduced incidental learning task with pictures and words along with intentional learning task. In their experiments, memory score was highest for an intentional picture group followed by the intentional word group, the incidental picture group, and lowest for an incidental word group. According to Noldy, Stelmack, & Campbell (1990), lexical and phonological access is automatic for words but pictures require additional resources for verbal elaboration. Incidental learning task involves automatic processing whereas intentional learning task requires both automatic and effortful processing. Thus, pictures benefits from extra intention that lead to overall better memory performance in intentional condition. The finding from this current study with both pictures and words followed this pattern in comparison to previous studies with only pictures.

Picture superiority effect

The experimental materials showed a clear picture superiority effect that is consistent with previous studies (e.g., Paivio & Csapo, 1973). Pictures were remembered 86.91% and words were remembered 81.04% overall. More importantly, the picture superiority effect was found for both normal objects and road signs. People remembered picture road signs better than word road signs like normal pictures and words. Surprisingly, the picture superiority effect was in fact larger for road signs (9.18%) compared to normal objects (2.55%). This finding did not follow predictions of either the dual-coding theory (same amount of picture superiority effect for normal objects and road signs) or semantic-sensory/distinctiveness theory (stronger picture superiority effect for normal objects than road signs).

There are possible explanations for larger picture superiority effect for road signs. Participants might use the process of elimination on the memory test. If people are not sure about the answer, they could eliminate the possible incorrect answers first. We examined what kinds of errors participants made on the memory test. For both normal objects and road signs, participants selected perceptual foils that share the same meaning with answers most often as incorrect answers. However, when participants chose conceptual foils as their incorrect answers, the patterns were different for normal objects and road signs. For normal objects, participants chose words (33% of the errors) more than pictures (10.5% of the errors) likely because they could exclude the unseen pictures on the memory tests. This process on memory test increased the overall memory accuracy for normal objects by providing the opportunity to discriminate distinct incorrect answers. Overall good performance for normal objects led to less memory difference between normal pictures and words. On the other hand, people were more likely to choose pictures (29% of the errors) than words (23.5% of the errors) for the incorrect answers for road signs. First, people could not exclude the unseen picture road signs perhaps because they are less distinctive than normal pictures. Because picture and word road signs look more similar than normal pictures and words, people could not use the process of elimination for the road signs based on distinctiveness on memory tests. Second, people were more likely to choose picture road signs when they were not sure of the correct answer because participants might be more familiar to picture road signs than word road signs. All participants were university students who, because of the increased prevalence of picture road signs in the last few decades, may be biased to choose the more familiar picture road signs. Thus, people made more errors to picture road signs that generally increase the memory for picture road signs. This led to significant memory difference between picture and word road signs resulted in larger picture superiority effect for road signs than normal objects.

Item type

Normal objects (89.61%) were remembered significantly better than road signs (78.34%). Word normal objects were even remembered better than picture road signs. We used concrete pictures of normal objects rather than picture of abstract concepts. People could remember concrete normal pictures well. Also, not encountered concrete pictures were excluded well as incorrect answers on the memory. Because normal pictures are distinctive, people could recognize those as unseen objects and exclude on memory test. This elimination limits the chance of choosing not encountered pictures as answers, and potentially provides another chance to pick correct answer for a presented word even though participants did not remember the correct answer exactly. Compared to normal objects, however, both picture and word road signs look more similar because they share perceptual information such as shapes and colors. Also, road signs are strongly semantically related that they are all about traffic or driving information. Thus, there could be perceptual and semantic interference while remembering road signs. Also, people could not use the process of elimination for road signs on memory test. Because picture road signs are not that much more distinctive than word road signs, participants could not exclude unseen picture road signs efficiently like normal pictures. It would be harder to discriminate incorrect answers from correct answers and participants could make more errors on the memory test for road signs. That might lead to less accurate memory for road signs compared to normal objects.

CHAPTER IV

EXPERIMENT II

The first experiment replicated picture superiority effect for both normal objects and road signs. Moreover, picture superiority effect was larger for road signs than normal objects. In terms of long-term memory, people seem to remember pictures better than words. However, in real driving situations, drivers are required to remember recently encountered road signs, not every road sign they have encountered. For remembering recently encountered road signs, previously encountered information can interfere with the current information. The second experiment tried to examine whether picture superiority from previously encountered item produces more interference than words in memory updating task.

The second experiment asked participants to choose the more recently encountered item of two previously presented items from the same category. The central question was whether an older item (the *penultimate* item from a category) would interfere with the most recently encountered item (the *ultimate* item) producing proactive interference. Critically, the penultimate and ultimate items could be either a picture or a word yielding four possible transition conditions: picture-to-picture, picture-to-word, word-to-picture, word-to-word. We expected that the amount of proactive interference would be different for the four different transition conditions. Because pictures have superior memory than words, we hypothesized that pictures' more durable memories would interfere more with the current memory when it comes to the memory updating performance. Thus, when the penultimate item was a picture, there would be a more proactive interference due to the superior memory from the penultimate item. However, if the ultimate item were a picture, superior memory of most recent picture would be less susceptible to the interference from the previous item. We also predicted that compared to ultimate pictures, there would be more interference when the ultimate item was a word. Thus, we expected there would be the strongest proactive interference (as evidenced by the worst memory updating performance) when the penultimate item was a picture and the ultimate item was a word (picture-to-word). On the other hand, the least amount of proactive interference would be observed when the penultimate item was a word and the ultimate item was a picture (word-to-picture). The other two transitions (picture-to-picture and word-to-word) were expected to produce intermediate amount of proactive interference.

We also manipulated the distances between the penultimate and the ultimate items (Fozard & Weinert, 1972) because drivers encounter other visual information in between previously and recently encountered road signs. Compared to Fozard and Weinert, we used shorter distances between the penultimate and ultimate items because we wanted to measure interference both from and on recently encountered items. Two lag conditions were created along with four transition conditions (*n*-11, *n*-5). For the longer distance, ten additional items were presented between the penultimate and the ultimate items of a particular category (*n*-11). We hypothesized that the longer the distance between the two items, the less proactive interference would occur. In the shorter distance condition, only four items were presented between the penultimate and the ultimate items in the *n*-5 condition. We expected that the proactive interference would be stronger for this condition due to the more overlap in their memory.

Because drivers are exposed to the various types of visual information between the previous road sign and the current road sign, we added other categories of stimuli in addition to road signs. Participants were required to choose the most recently encountered item for each of eight different categories (animals, musical instruments, fruits, road signs, etc.). We assumed that only the items from the same category would interfere with each other. People tend to encode visual information according to the category and subordinate structure. Konkle, Brady, Alvarez, & Oliva (2010) revealed that conceptual distinctiveness, rather than perceptual distinctiveness, supports visual long-term memory. Costa, Alario & Caramazza (2005) also demonstrated that semantically related stimuli interfere with each other more than the unrelated stimuli. They used picture-word interference paradigm that participants were required to name the pictures while ignoring distractor words presented along with the pictures. The naming latencies were longer when the pictures and words were semantically related whereas there was less interference of distractors when the pictures and words were semantically unrelated. Thus, memory for the most recently encountered road sign would interfere only with the memory for the previously encountered road signs whereas memory for encountered animals, for example, would interfere with the other animal stimuli.

Method

Participants

Sixty-two undergraduate students (44 females) from Mississippi State University participated the experiment for the course credit. Their average age was 19.52 (Range = 18–25 years, SD = 1.39 years). One participant reported having abnormal color vision, but we did not exclude these data.

Design

The experimental design is a 2 (Lag: *n*-11, *n*-5) x 2 (Penultimate: picture, word) x 2 (Ultimate: picture, word) x 2 (Item Type: normal items, road signs) within-subjects design. Stimuli were presented sequentially and occasionally interrupted by a two-alternative memory test. Every ultimate item that served as most recently encountered items appeared at *n*-point in the sequence. A recognition memory test for the ultimate items occurred at *n*+5 position (after four other items from different categories had been presented). The items presented between the penultimate and the ultimate items were from the other seven categories. The schematic for the experimental design is described in Figure 5.

A pilot study was conducted to evaluate the lag conditions. A quarter portion of the experiment was presented to see whether *n*-11 and *n*-5 lag condition yielded significant differences on the recognition memory test. The pilot study confirmed that this lag manipulation could show significant differences regarding the effect of the lag manipulation.

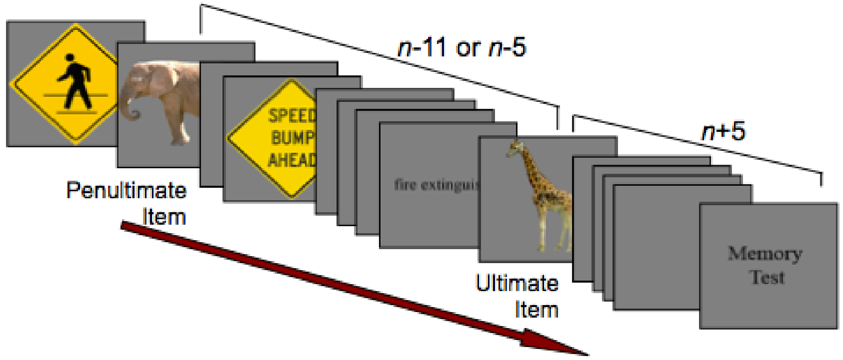

Figure 5. The schematic for the Experiment 2.

Materials

Pictures and words were exemplars of eight different categories (animals, musical instruments, fruit, kitchen appliances, clothes, stationery, sporting goods, and road signs). Sixteen pictures of typical exemplars of each category were collected mostly from Hemera Photo Objects (2002) and Experiment 1. Some pictures and road sign images were collected through the web search. Each picture object was resized into 150 x 150 pixels (as in Experiment 1) and the background was filled by gray color (RGB = 128). Sixteen words that corresponding to the name of the 16 pictures were created in Times New Roman font with font size of 48. The words were in black with gray backgrounds. Total 256 items (128 pictures and 128 words) were generated (Appendix D).

Procedure

Upon their arrivals, participants were seated in front of the computer monitor in separate rooms. They filled out informed consent and demographic questionnaire before they started the experiment. They were instructed that pictures and words would be presented one at a time for 500ms each. A fixation cross was inserted for 500ms between each item presentation. A total of 256 items were presented. After the first 256 item presentations, items were presented three times more in different orders to increase the number of memory tests. Thus, each item was presented four times and appeared only once within each quarter of total presentation. Each quarter consisted of 32 blocks of items. Within each block, eight exemplars from each category were presented. Except for the first block, there were always two memory tests in each block. *n*-5 memory tests were always presented before the *n*-11 memory tests to keep the distance between penultimate and ultimate items consistent. All items were tested once for each lag and transition combination. Thus, there were total 256 recognition memory tests. Half of the tests were *n*-11 conditions and the other half of the tests was *n*-5 lag conditions.

The task was to keep track of what was the most recently presented item for each category regardless whether it was a picture or a word. Also, participants were informed that recognition memory tests would be introduced at multiple points during the entire item presentation. The recognition memory tests were two-alternative forced choice memory tests. Participants were required to indicate which one of the two items (one was the most recently encountered item and the other was the previously encountered item) from a category was more recently encountered using the button box in front of them. The recognition memory tests were terminated when the participants entered their responses by pressing the proper answers. The entire experimental procedure lasted about 20 minutes. After their final recognition memory test, they were debriefed.

Results

We excluded about 1% of data based on the reaction time on the memory test. We excluded data when participants responded too quickly (RT < 300 ms) or too slowly (RT > 10,000 ms) from our analysis. We conducted 2 (Lag: *n*-11, *n*-5) x 2 (Penultimate: picture, word) x 2 (Ultimate: picture, word) x 2 (Item Type: normal items, road signs) repeated-measures analysis. The overall memory accuracy for lag and transition condition (penultimate x ultimate) is presented in Table 1.

We analyzed all of the categories first and then break it down by item type later. There was a significant main effect of lag, $F(1,61) = 24.64$, $MSE = .01$, $p < .001$, $\eta^2 = .29$. However, the effect went in the opposite direction than the one predicted: participants remembered the most recently encountered item in the *n*-5 lag condition (60.89%) better than in the *n*-11 condition (56.46%). This finding was unexpected in that we expected better memory accuracy for *n*-11 condition. Lag did not interact with penultimate item, $F(1,61) = 2.49$, $MSE = .02$, $p = .12$, $\eta^2 = .04$, but there was an interaction between lag and ultimate item, $F(1,61) = 13.32$, $MSE = .08$, $p = .001$, $\eta^2 = .18$. Ultimate pictures did not show memory differences (62.9% for *n*-11, 64.7% for *n*-5) for lag manipulation whereas ultimate words were remembered better in *n*-5 condition (57%) than *n*-11 condition (50.1%). We will return to this point in the discussion for this experiment.

The critical analysis for the current experiment, however, was the comparison of the penultimate and ultimate forms on memory accuracy. The main effect of penultimate item was statistically significant, $F(1,61) = 155.14$, $MSE = .02$, $p < .001$, $\eta^2 = .72$. When the penultimate item was a picture, memory accuracy was worse (51.49%) compared to when the penultimate item was a word (65.86%). Also, the main effect of the ultimate item was statistically significant, $F(1,61) = 51.58$, $MSE = .03$, $p < .001$, $\eta^2 = .46$. When the ultimate item was a picture, memory accuracy was better (63.79%) than when the ultimate item was a word (53.56%). Both of these effects were in the predicted direction. However, there was no significant interaction between penultimate and ultimate, $F(1,61) = 1.75$, $MSE = .01$, $p = .191$, $\eta^2 = .03$.

Table 1

Memory accuracy for transition conditions for Experiment 2 (Standard deviation in parentheses).

Lag \ Transition	**Picture-to-picture**	**Picture-to-word**	**Word-to-picture**	**Word-to-word**	**Average**
***n*-11**	.55(.11)	.42(.13)	.71(.13)	.58(.11)	.57(.01)
***n*-5**	.57(.10)	.51(.17)	.72(.12)	.63(.10)	.61(.01)
Average	.56(.01)	.47(.02)	.72(.01)	.60(.01)	

We further analyzed data by looking at the effect of transition (penultimate x ultimate). The transition effect was also significant, $F(3,183) = 79.98$, $MSE = .02$, $p < .001$, $\eta^2 = .57$. Pairwise comparisons indicated that all four transition conditions yielded significantly different memory accuracies. We compared the memory accuracies in the matching cases (picture-to-picture; word-to-word transition) to the mis-matching conditions (picture-to-word, word-to-picture) with those of pure conditions. Picture-to-word condition (46.86%) yielded worse memory than word-to-word condition (60.25%)

indicating stronger proactive interference, $t(61) = 8.91$, $p < .001$. Picture-to-picture condition (56.12%) also yielded worse memory than word-to-picture condition (71.46%), $t(61) = 12.59$, $p < .001$. Consistent with our predictions, proactive interference was strongest for the picture-to-word transition that yielding the worst memory performance (46.86%). The proactive interference was the least in the word-to-picture transition and produced the best memory accuracy (71.46%).

Because of our interest in road sign memory specifically, we further analyzed the memory accuracies contrasting normal stimuli and road signs (Table 2). We averaged the results of seven normal stimuli and compared with the memory accuracy of road signs. The main effect of the item type was statistically significant, $F(1,61) = 6.27$, $MSE = .05$, $p = .015$, $\eta^2 = .09$, with better memory accuracy was better for the normal picture and word stimuli (58.99%) compared to picture and word road signs (55.54%). The results are summarized in Table 2. Item type did not interact with lag manipulation, $F(1,61) = 1.00$, $MSE = .04$, $p = .321$, $\eta^2 = .02$. However, item type significantly interacted with both penultimate, $F(1,61) = 5.44$, $MSE = .04$, $p = .023$, $\eta^2 = .08$, and ultimate conditions, $F(1,61) = 19.25$, $MSE = .04$, $p < .001$, $\eta^2 = .24$. The effect of penultimate item was greater for normal objects (penultimate pictures produced 14.76% more memory impairment than penultimate words) than for road signs (penultimate picture signs produced 9.07% more memory impairment than penultimate word signs). The effect of the ultimate item was nonexistant for road signs (.81% memory difference between ultimate picture and word signs) but significant for normal objects (ultimate picture memory was 11.48% better than ultimate word memory).

Table 2

Memory accuracy for normal stimuli and road signs (Standard deviation in parentheses).

Lag \ Transition		**Picture-to-picture**	**Picture-to-word**	**Word-to-picture**	**Word-to-word**	**Average**
Normal stimuli	*n*-11	.55 (.12)	.42 (.14)	.72 (.13)	.58 (.12)	.57 (.01)
	n-5	.59 (.11)	.51 (.18)	.72 (.12)	.63 (.11)	.61 (.01)
	Average	.57 (.01)	.46 (.02)	.72 (.01)	.61 (.01)	
Road signs	*n*-11	.56 (.24)	.49 (.25)	.56 (.29)	.57 (.25)	.54 (.02)
	n-5	.41 (.24)	.58 (.27)	.71 (.26)	.57 (.25)	.57 (.02)
	Average	.48 (.02)	.53 (.02)	.63 (.03)	.57 (.02)	

When we only analyzed road signs data, there was a main effect of penultimate, $F(1,61) = 15.17$, $MSE = .03$, $p < .001$, $\eta^2 = .20$. Previously encountered picture road signs were more detrimental to current memory (51.01%) than previously encountered word road signs (60.08%). However, the main effect of ultimate item was not statistically significant $F(1,61) = .16$, $MSE = .03$, $p = .693$, $\eta^2 = .003$. The interaction between penultimate and ultimate items for road signs was statistically significant, $F(1,61) = 6.81$, $MSE = .03$, $p = .011$, $\eta^2 = .10$. In terms of transition effect, the worst memory performance was observed in both picture-to-picture condition (48.59%) and picture-to-word condition (53.43%) for road signs (two transition conditions were not statistically different, $t(61) = -1.50$, $p = .14$. However, the best memory performance was observed in word-to-picture condition (63.31%) like normal objects.

Discussion

Although we found a picture superiority effect for road signs in Experiment 1, drivers need to remember several recently encountered road signs rather than holding the entire road signs they have encountered in their memory. Thus in Experiment 2, we asked participants to indicate the most recently encountered item for a specific category. During this memory updating task, we expected that previously encountered items could interfere with the most recently encountered item within the same category (proactive interference). More critically, we were interested in the form (picture or word) of the previously encountered item and how it would affect differently to the current memory.

Memory accuracies indicated that the amount of proactive interference was different depending on the form of the penultimate and ultimate item. When the penultimate item was in a picture form, there was more proactive interference as evidenced by worse memory. Picture stimuli provided stronger memory, and this superior memory lingered longer interfering with the more recent memory regardless the form of the current stimuli.

The amount of proactive interference was also different depending on the form of the ultimate item. When the ultimate item was a word, memory performance was worse indicating that memory of the words was more susceptible to the interference from the previous memory. On the other hand, a superior memory of current picture item limits the interference better than current word item. Thus, the strongest proactive interference was observed in picture-to-word condition and the least proactive interference was found in word-to-picture condition. This finding indicates that superior picture memory from older items is detrimental to memory updating.

Although the transition conditions followed our predicted pattern, the lag conditions did not. We expected stronger proactive interference from the shorter lag condition (*n*-5) because there would be more overlap in memory between penultimate and ultimate that lead to inaccurate judgment. However, this condition resulted in better memory performance than longer lag condition (*n*-11). In other words, it appears that when the previous and most recently encountered items were closer together, less proactive interference occurred. This deviation from expectation could be the result of a design issue. The memory tests for *n*-5 condition always occurred before the memory tests for *n*-11 condition in each block for experimental design. We suspect that this design might produce unexpected outcome for the lag manipulation. Answering memory test for *n*-5 required another thought process and paused experiment for a while. This interruption was more detrimental to ultimate words than ultimate pictures, indicating that word memory was more susceptible interference. This might produce extra interruption or interference on memory test for *n*-11 condition that yielded the unexpected result.

When we separately analyzed the memory performance of road signs from the normal pictures and words, a little bit different pattern was observed. The type of ultimate item for road signs did not make significant difference on memory. Both recently encountered picture road signs (55.95%) and word road signs (55.14%) were remembered equally. This result was different from the normal items data, which found the main effect of ultimate item. However, the type of penultimate item made difference on the current road signs memory. When picture road signs were encountered previously, it caused more proactive interference that detrimental to current memory (51.01%) than word road signs (60.08%). Although there was no main effect of ultimate item, previously encountered picture road signs impaired recent memory compared to word road signs. Compared to normal objects, the magnitude of proactive interference was reduced for road signs. Because road signs look more similar, discrimination between two road signs would be harder than for normal objects, potentially leading to a reduced ultimate effect for the road signs.

Although there were some results that need to be explained more, the general outcomes tell that pictures do not always provide better memory than words. Especially when pictures are presented earlier, later memory can suffer. Pictures provide strong memories that are detrimental to the memory updating performance. On the other hand, earlier presented words do not produce strong proactive interference because of relatively less strong memory. Strong memory of pictures also limits the impact of proactive interference when pictures are recently presented in a sequence.

CHAPTER V

GENERAL DISCUSSION

Two experiments were introduced in this paper examining picture superiority effect. The first experiment examined whether people remember picture road signs better than word road signs because two types of road signs should be processed equally. Both normal objects and road signs showed a picture superiority effect with people remembering items better when they are represented in picture form. According to dual-coding theory, pictures are more likely to evoke both image code and verbal code and that redundancy enhanced its memory. Sensory-semantic model explained picture code itself is qualitatively better memory cue than verbal code. Perceptual distinctiveness theory explains that pictures are remembered better because they provide more perceptual information. We predicted that picture superiority would be equivalent for normal objects and road signs according to dual-coding theory. On the other hand, according to sensory semantic model and the perceptual distinctiveness theory, the amount of picture superiority should be stronger for normal objects because normal pictures are perceptually much distinctive than normal words compared to less distinctive picture and word road signs. However, the results did not follow both predictions that picture superiority effect was larger for road signs.

Although one theory cannot explain the result from first experiment entirely, we think all of the theories are not mutually exclusive. Rather, all of the theories might explain different aspects of the encoding and memory test phases. People could easily evoke both image code and verbal code for picture items while they encode presented items according to dual-coding theory and that led to better memory of pictures. However, on the memory test, people may have made use of distinctiveness of presented alternatives for the process of elimination. When we analyzed the conceptual error data, people made more errors to words for normal objects and to pictures for road signs. Because normal pictures are more distinctive, people could eliminate nonpresented pictures more easily on the memory test. Distinctiveness of normal pictures helped not only on choosing correct picture answers but also on excluding incorrect pictures. This resulted in better memory for both pictures and words that decreased the memory difference between pictures and words. However, they might have difficulty in eliminating not encountered picture road signs on memory test because picture road signs share more perceptual information with word road signs. Perceptually and semantically related picture and word road signs are not easy to discriminate by its distinctiveness and thus people are more likely to choose picture road signs due to its familiarity from real world. This could have led to a greater tendency to choose not encountered picture road signs when participants did not remember correct answer. Bias for picture road signs on memory test might have resulted in the superior memory of picture road signs leading to a bigger picture superiority effect for road signs. Thus, dual-coding theory and sensory-semantic/distinctiveness theories might play different roles in this experiment.

The second experiment examined whether this superior memory of pictures could be detrimental in remembering recent information. In real driving situations, drivers are required to remember recently encountered road signs rather than all of the road signs they have encountered. In this circumstance, the form of previously encountered road signs can affect the memory of most recently encountered road signs. Thus, we presented picture and word road signs along with normal pictures and words and asked people to choose the most recently encountered item. In general, when previously encountered items were pictures, it was harder to remember the most recently encountered items due to superior memory from previous pictures. On the other hand, when words were encountered previously, there was a reduced amount of proactive interference. However, road signs data did not show this pattern clearly compared to normal objects. Although previously encountered picture road signs still impaired the current memory like normal items, the form of the most recently encountered road signs did not show significant effect. This might be due to different memory systems being employed in Experiments 1 and 2. Experiment 1 examined long-term visual memory system that participants needed to remember all the visual information they have encountered. However, Experiment 2 examined long-tern working memory that required people to remember the more recent visual information of a category between two items that had been seen. Picture superiority effect might work better in longer memory representation system where one is judging if something has been seen rather than the temporal order of presentation. Longer retention time (in some cases several minutes) might provide better chance and enough time to form clearer and stronger memory. Picture memory might get more advantage from this longer retention time because of the use of dual codes and distinctiveness. Thus, we could find the picture superiority effect from Experiment 1 and its detrimental effect from previously encountered pictures. However, because the most recently encountered item of a category only appeared five items before the memory test in Experiment 2, differences in memory strength between pictures and word may not be that significant. This lack of a difference in strength may be more prevalent for the picture and word road signs because they are perceptually and semantically related and may explain the failure to find a significant effect of ultimate item for road signs.

Although road signs data showed less convincing results compared to normal pictures and words, picture items were remembered better than word items in general. However, this superior memory of pictures is not always beneficial. When people are required to remember only the recent information, superior picture memory from previous can interfere with the current memory and produces less accurate memory.

Limitations and Future Directions

In Experiment 1, the finding of a larger picture superiority effect for road signs did not follow our predictions by both dual-coding theory and sensory-semantic/distinctiveness theory. One possible reason is that we used recognition test for the memory test. Although not intended, on the four alternative recognition test, participants could compare alternatives and eliminate possible incorrect answers. For this process, distinctiveness may have played a significant role on the memory test. People could easily exclude unseen normal pictures on memory test by comparing alternatives based on distinctiveness. Another form of memory test such as recall test could be used in the future to limit the role of distinctiveness on the memory test. A recall test will not provide the chance to compare alternatives by its distinctiveness. Thus, if we use recall test, we can limit the role of distinctiveness theory that may examine the role of dual-coding theory more carefully.

Finally, the lag manipulation in the Experiment 2 did not follow the prediction that proactive interference from the previous items was superior when two items were closer each other. Due to the experimental design issue, memory test for the shorter distance always occurred before the memory test for the longer distance, potentially harming the memory for the longer lag. In the future, lag could be manipulated between participants or using another experimental design in order to address this potential problem.

Conclusions

This paper examined picture superiority effect with road signs because both picture and word road signs should be processed equally effectively. Experiment 1 showed that people remember picture road signs better than word road signs along with superior memory for normal pictures over normal words. However, we could not simply insist that we need to use picture road signs more than word road signs because people remember picture road signs better.

In real driving situation, drivers are more required to remember the information from recently encountered road signs not the entire road signs they have encountered. This idea was tested with memory updating task that required people to choose the most recently encountered item of a category against to previously encountered item. Because picture memory was superior to word memory, when previously encountered item was a picture there was more proactive interference. Thus, superior memory of pictures is not always beneficial. However, when most recently encountered item was a picture, it limited proactive interference from previous information that yielded better memory performance than when recent information was a word. Road signs also showed previously encountered picture road signs could be detrimental to remember the most recently encountered road sign. However, the form of most recently encountered road sign did not have significant effect. Less perceptually and semantically different road signs might produce its not significant effect. Thus, although we found that people could remember picture road signs better than word road signs, picture road signs do not always have advantages in real driving situation. Previously encountered road signs could be harmful in remembering recently encountered road signs due to its superior memory. However, the role of most recently encountered picture or word road signs are still not clear that we cannot simply argue one type of road signs would be better in its effectiveness in real world.

Although more studies could be conducted to confirm the clear role of theories for picture superiority effect, the presented studies confirmed the presence of a picture superiority effect with road signs, and the potential of a detrimental effect of superior picture memory in a memory updating task.

REFERENCES

Amrhein, P. C., McDaniel, M., & Waddill, P. (2002). Revisiting the picture-superiority effect in symbolic comparisons: Do pictures provide privileged access?. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *28*(5), 843-857. doi:10.1037/0278-7393.28.5.843

Anderson, S. W., Rizzo, M. ., Skaar, N. N., Stierman, L. L., Cavaco, S. S., Dawson, J. J., & Damasio, H. H. (2007). Amnesia and driving. *Journal Of Clinical And Experimental Neuropsychology*, *29*(1), 1-12. doi:10.1080/13803390590954182

Baddeley, A. (1986). *Working memory*. New York, NY, US: Clarendon Press/Oxford University Press.

Badre, D., & Wagner, A. D. (2005). Frontal lobe mechanisms that resolve proactive interference. *Cerebral Cortex*, *15*(12), 2003-2012. doi:10.1093/cercor/bhi075

Bousfield, W. A., Esterson, J. J., & Whitmarsh, G. A. (1957). The effects of concomitant colored and uncolored pictorial representations on the learning of stimulus words. *Journal Of Applied Psychology*, *41*(3), 165-168. doi:10.1037/h0047473

Castelhano, M. S., & Henderson, J. M. (2005). Incidental visual memory for objects in scenes. *Visual Cognition, 12,* 1017-1040.

Dewar, R., & Olson, P. (2007). *Human factors in traffic safety* (2nd ed.). Tucson, AZ: Lawyers and Judges.

Ells, J. G., & Dewar, R. E. (1979). Rapid comprehension of verbal and symbolic traffic sign messages. *Human Factors*, *21*(2), 161-168.

Ericsson, K., & Kintsch, W. (1995). Long-term working memory. *Psychological Review*, *102*(2), 211-245. doi:10.1037/0033-295X.102.2.211

Fisher, J. (1992). Testing the effect of road traffic signs' informational value on driver behavior. *Human Factors*, *34*(2), 231-237.

Fozard, J. L. (1970). Apparent recency of unrelated pictures and nouns presented in the same sequence. *Journal Of Experimental Psychology*, *86*(2), 137-143. doi:10.1037/h0029983

Frey, W. G., & Fozard, J. L. (1970). Effect of presentation time on the judged recency of pictures. *Journal Of Experimental Psychology*, *85*(1), 105-110. doi:10.1037/h0029505

Jaeggi, S. M., Buschkuehl, M., Perrig, W. J., & Meier, B. (2010). The concurrent validity of the N-back task as a working memory measure. *Memory*, *18*(4), 394-412. doi:10.1080/09658211003702171

Jongen, E. M., Brijs, K., Mollu, K., Brijs, T., & Wets, G. (2011). 70 km/h speed limits on former 90 km/h roads: Effects of sign repetition and distraction on speed. *Human Factors*, *53*(6), 771-785. doi:10.1177/0018720811419848

Jonides, J., & Nee, D. E. (2006). Brain mechanisms of proactive interference in working memory. *Neuroscience*, *139*, 181 – 193.

Koenke, K., & Otto, W. (1969). Contribution of pictures to children's comprehension of the main idea in reading. *Psychology In The Schools*, *6*(3), 298-302. doi:10.1002/1520-6807(196907)6:3<298::AID-PITS2310060315>3.0.CO;2-L

Nickerson, R. S. (1965). Short-term memory for complex meaningful visual configurations: A demonstration of capacity. *Canadian Journal Of Psychology/Revue Canadienne De Psychologie*, *19*(2), 155-160. doi:10.1037/h0082899

Nickerson, R. S. (1968). A note on long-term recognition memory for pictorial material. *Psychonomic Science*, *11*(2), 58.

Makovski, T., & Jiang, Y. V. (2008). Proactive interference from items previously stored in visual working memory. *Memory & Cognition*, *36*(1), 43-52. doi:10.3758/MC.36.1.43

Mecklinger, A. A., Weber, K. K., Gunter, T. C., & Engle, R. W. (2003). Dissociable brain mechanisms for inhibitory control: Effects of interference content and working memory capacity. *Cognitive Brain Research*, *18*(1), 26-38. doi:10.1016/j.cogbrainres.2003.08.008

Nelson, D. L., Reed, V. S., & Walling, J. R. (1976). Pictorial superiority effect. *Journal Of Experimental Psychology: Human Learning And Memory*, *2*(5), 523-528. doi:10.1037/0278-7393.2.5.523

Paivio, A. (1969). Mental imagery in associative learning and memory. *Psychological Review*, *76*(3), 241-263. doi:10.1037/h0027272

Paivio, A. (1971). *Imagery and verbal processes*. Oxford, England: Holt, Rinehart & Winston.

Paivio, A., & Csapo, K. (1969). Concrete image and verbal memory codes. *Journal Of Experimental Psychology*, *80*(2, Pt.1), 279-285. doi:10.1037/h0027273

Paivio, A., & Csapo, K. (1973). Picture superiority in free recall: Imagery or dual coding?. *Cognitive Psychology*, *5*(2), 176-206. doi:10.1016/0010-0285(73)90032-7

Paivio, A. (1986). Mental representation: A dual coding approach. Hillsdale, NJ: Erlbaum.

Readence, J. E., & Moore, D. W. (1981). A meta-analytic review of the effect of adjunct pictures on reading comprehension. *Psychology In The Schools*, 18(2), 218-224. doi:10.1002/1520-6807(198104)18:2<218::AID-PITS2310180219>3.0.CO;2-1

Shepard, R. N. (1967). Recognition memory for words, sentences and pictures. *Journal of Verbal Learning and Verbal Behavior, 6,* 156-163.

Standing, L. (1973). Learning 10,000 pictures. *The Quarterly Journal Of Experimental Psychology*, *25*(2), 207-222. doi:10.1080/14640747308400340

Still, A. W. (1969). Proactive interference and spontaneous alternation in rats. *The Quarterly Journal Of Experimental Psychology*, *21*(4), 339-345. doi:10.1080/14640746908400229

Strawderman, L., Huang, Y., & Garrison, T. (2013). The effect of design and placement of work-zone warning signs on driver speed compliance: a simulator-based study. *IEE Transactions on Occupational Ergonomics and Human Factors, 1,* 66-75. DOI: 10.1080/21577323.2012.714839

Szmalec, A., Verbruggen, F., Vandierendonck, A., & Kemps, E. (2011). Control of interference during working memory updating. *Journal Of Experimental Psychology: Human Perception And Performance*, *37*(1), 137-151. doi:10.1037/a0020365

Traffic signal timing manual [electronic resource]. (2008). [Washington, D.C.] : U.S. Department of Transportation, Federal Highway Administration, [2008].

Walker, R. E., Nicolay, R. C., & Stearns, C. R. (1965). Comparative accuracy of recognizing American and international road signs. *Journal Of Applied Psychology*, *49*(5), 322-325. doi:10.1037/h0022525

Weldon, M., & Coyote, K. C. (1996). Failure to find the picture superiority effect in implicit conceptual memory tests. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *22*(3), 670-686. doi:10.1037/0278-7393.22.3.670

Williams, C.C. (2010). Not all visual memories are created equal. *Visual Cognition, 18,* 201-228.

APPENDIX A

STIMULI LIST FOR EXPERIMENT I

1. elephant – rhinoceros 5. frog – turtle 9. cat – dog 13. cow – hippo 17. buffalo – leopard 21. swan – flamingo 25. starfish – coral 29. clothespin – nailclipper 33. tape dispenser – stapler 37. paper clip – stamp 41. calculator – pencil sharpner 45. cell phone – telephone 49. telescope – binocular 53. broom – luggage 57. poker chips – dart 61. chess board – bowling pin 65. brush – lipstick 69. tie – bowtie 73. button – hanger 77. garlic – peanut 81. pizza – soup 85. cherry – plum 89. banana – cheese 93. cookie – pretzel 97. broccoli – artichoke 101. eggplant – zucchini 105. soap – perfume 109. scale – toilet plunger 113. whisk – peeler	2. giraffe – deer 6. horse – kangaroo 10. pig – red fox 14. chicken – sheep 18. koala – panda 22. ostrich – peacock 26. seashell – crab 30. snail – grasshopper 34. book – calendar 38. compass – scissors 42. chair – magnifying glass 46. microphone – headphone 50. hair dryer – cloth iron 54. seesaw – swing 58. roulette – slot machine 62. dice – bat 66. gloves – watch 70. crown – necklace 74. belt – scarf 78. hamburger – sandwich 82. apple – kiwi 86. pear – strawberry 90. cupcake – muffin 94. chocolate – icecream 98. cabbage – lettuce 102. mushroom – pepper 106. comb – curler 110. washing machine – refrigerator 114. can opener –	3. penguin – beaver 7. monkey – bear 11. lizard – snake 15. lion – tiger 19. woodpecker – parrot 23. hawk – turkey 27. squid – lobster 31. dragonfly – butterfly 35. envelope – binder 39. typewriter – file cabinet 43. video tape – video camera 47. computer – printer 51. sewing machine – fan 55. balloon – globe 59. mask – tube 63. backpack – life jacket 67. hat – wig 71. glasses – sunglasses 75. graduation cap – umbrella 79. waffle – pancakes 83. lemon – lime 87. watermelon – cantaloupe 91. donut – bagel 95. carrot – corn 99. onion – potato 103. pumpkin – squash 107. towel – bathing suit 111. spoon – knife 115. ice cream scoop – cheese grater	4. squirrel – rabbit 8. zebra – camel 12. seal – polar bear 16. moose – alligator 20. owl – eagle 24. shrimp – seahorse 28. shark – dolphin 32. paint brush – easel 36. ruler – pencil 40. notebook – clip board 44. television – radio 48. CD – computer mouse 52. faucet – joystick 56. pacifier – baby bottle 60. teddy bear – crib 64. ring – earing 68. jeans – skirt 72. boots – socks 76. shoes – sandal 80. corn dog – sushi 84. mango – avocado 88. grapes – pineapple 92. cake – pie 96. asparagus – celery 100. tomato – radish 104. tooth brush – tooth paste 108. bathtub – toilet 112. chopsticks – fork 116. microwave – oven mitt

117. cutting board – rolling pin 121. cup – milk bottle 125. sparybottle – can 129. rug – cushion 133. boat – airplane 137. tool box – brick 141. plug – lock 145. clamp – wrench 149. car battery – gas can 153. extension cord – handcuff 157. wallet – purse 161. first-aid-kit – oxygen mask 165. flute – trumpet 169. iceskate – rollerskate 173. jump rope – glof club 177. tent – pyramid 181. bump ahead – yield ahead 185. no parking – no left turn 189. falling rocks – gravel road 193. divided highway – two way traffic 197. merge left – narrow bridge 201. playground – survey crew ahead 205. center lane closed-draw bridge	pizza cutter 118. tongs – straw 122. mirror – window 126. bell – key 130. pillow – bed 134. crane – bulldozer 138. screwdriver – hammer 142. handdrill – torch 146. candle – lamp 150. roller – dolly 154. rifle – pistol 158. crutch – walker 162. pill – syringe 166. drum – tambourine 170. baseball gloves – boxing gloves 174. windmill – lighthouse 178. dumbbell – helmet 182. flagger ahead – workers ahead 186. bus stop – no right turn 190. hill – steep grade 194. curve ahead – no turns 198. merge right – road narrows 202. tow away – do not tracks 206. handicapped crossing – fasten seatbelt	119. toaster – waffle maker 123. watercan – trash bin 127. frame – light switch 131. vaccum – cane 135. tractor – lawn mower 139. shovel – axe 143. ladder – garden hose 147. flashlight – lantern 151. airpump – fire extinguisher 155. bullet – grenade 159. stethoscope – thermometer 163. guitar – violin 167. harp – piano 171. skateboard – sleigh 175. fire hydrant – road pylon 179. sword – cannon 183. no bicycles – no trucks 187. bicycle crossing – share road 191. sheep crossing – golf cart crossing 195. pedestrian crossing – school crossing 199. traffic circle – junction 203. left lane closed – keep left 207. signal ahead – rest area	120. blender – kettle 124. clock – basket 128. bookshelf – ironing board 132. baby carriage – shopping cart 136. wheel – tire 140. ladle – frypan 144. screw – bolt 148. cigarette – lighter 152. ashtray – bucket 156. coin – pig bank 160. wheelchair – golf cart 164. saxophone – xylophone 168. cactus – pinecone 172. cowbell – whistle 176. music stand – mail box 180. saw – lightbulb 184. no hitchhiking – no pedestrian crossing 188. cattle crossing – deer crossing 192. low shoulder – slippery road 196. stop ahead – school bus stop 200. fire station – low flying 204. right land closed – keep right 208. photo enforced – tunnel

APPENDIX B

INFORMED CONSENT

INFORMED CONSENT

Title of Study: WP Signs

Study Site: Psychology Department – Magruder Hall

Name of Researchers & University affiliation: **Eunji Kang, Cognitive Science Student, MSU**
Dr. Carrick Williams, Associate Professor, MSU

What is the purpose of this research project?
We are interested in how people process and memorize picture and word road signs differently.

How will the research be conducted?
In this experiment, you will be shown sequences of picture and word stimuli on a computer screen. Before we begin, you will fill out a demographic questionnaire and then you will be seated in front of the computer monitor with a button box in front of you. Your task is to follow the instructions on the computer monitor. Between each visual stimulus, you will rate the pleasantness of the stimuli. You may have a break between each block of experiment. Your participation will last for approximately 1 hour.

Are there any risks or discomforts to me because of my participation?
There are no foreseeable risks to your participation.

Does participation in this research provide any benefits to others or myself?
Incidental memory for road signs will expand our understanding about the effect of road signs. The current experiment will see how people remember the picture and word road signs differently. Additionally, participants observe how psychological research is performed.

What incentive is there for my participation?
You will receive 1 PRP credit for your participation. The experiment should last approximately 1 hour.

Will this information be kept confidential?
All information will be kept confidential. You will be assigned a subject number and that is the only information that will be kept with your data; however, it cannot be connected to your name or identity. This informed consent form will not be associated with your data and will be kept in a locked cabinet in the laboratory where only investigators will have access. Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law. The results will only be reported in the aggregate and individuals will not be identified. All data that is collected will be retained for a minimum of 5 years after any publication of the data.

Who do I contact with research questions?
If you should have any questions about this research project, please feel free to contact April Kang at 662-694-1501. For questions regarding your rights as a research participant, or to express concerns or complaints, please feel free to contact the MSU Regulatory Compliance Office by phone at 662-325-3994, by e-mail at irb@research.msstate.edu, or on the web at http://orc.msstate.edu/participant/.

What if I do not want to participate?
Please understand that your **participation is voluntary**, your **refusal to participate will involve no penalty or loss** of benefits to which you are otherwise entitled, and you **may discontinue your participation** at any time without penalty or loss of benefits.

You will be given a copy of this form for your records.

________________________ ________
Participant Signature Date

________________________ ________
Investigator Signature Date

MSU IRB
Approved: 3/2/12
Expires: -/-/-

APPENDIX C

DEMOGRAPHIC QUESTIONNAIRE

Participant#___________

WP DEMOGRAPHIC QUESTIONNAIRE

Please do not put you name on this form.

How old are you (in years)? ________________

What class year are you (circle 1)? Freshman Sophomore Junior

Senior Other

What is your sex? ________________

Please indicate your ethnic/racial identification(s) (mark as many as is appropriate):

Hispanic or Latino	________	White/Caucasian	________
Native American/Alaska Native	________	Asian	________
Native Hawaiian/Pacific Islander	________		
Black/African American	________		

What City and State are you from? ______________________________

Do you:	Wear glasses?	Yes	or	No
	Wear contacts?	Yes	or	No
	Have normal color vision?	Yes	or	No

Have you ever had brain injury or trauma (including loss of consciousness)?

Yes or No

If yes, please describe____
____

Do you have driver's license?

Yes or no

If yes, How many years have you been driving? ______________________

APPENDIX D

STIMULI LIST FOR EXPERIMENT II

Category A (Animal)	Category B (Musical Instrument)	Category C (Fruit)	Category D (Kitchen Appliance)
Elephant	Guitar	Peach	Rolling pin
Giraffe	Xylophone	Apple	Spoon
Penguin	Piano	Lemon	Blender
Squirrel	Violin	Watermelon	Peeler
Frog	Saxophone	Banana	Tongs
Horse	Drum	Kiwi	Fry pan
Monkey	Keyboards	Grapefruit	Microwave
Zebra	Triangle	Grapes	Fork
Cat	Flute	Strawberry	Toaster
Sheep	Tambourine	Pineapple	Whisk
Kangaroo	Harp	Avocado	Chopsticks
Pig	Percussion	Lime	Oven mitt
Rabbit	Trumpet	Tomato	Pizza cutter
Lizard	Accordion	Pear	Knife
Dog	Cymbals	Cherry	Can opener
Turtle	Harmonica	Plum	Kettle

Category E (Clothes)	Category F (Stationery)	Category G (Sporting Goods)	Category H (Road Sign)
Vest	Notebook	Baseball	Bicycle crossing
Skirt	Scissors	Ping-Pong paddle	Bump ahead
Shirt	Pencil	Hockey stick	Curve ahead
Gloves	Tape dispenser	Baseball glove	Divided highway
Tie	Binder	Goggle	Do not stop on tracks
Sunglasses	Compass	Skateboard	Falling rocks
Sweater	Pencil case	Roller skate	Flagger ahead
Socks	Stamp	Sleigh	Hill
Jeans	Calculator	Boxing gloves	Keep left
Sandal	Envelope	Basketball	School crossing
Hat	Stapler	Dumbbell	Left lane closed
Belt	Paper clip	Baseball bat	Signal ahead
Scarf	Eraser	Swimsuit	Traffic circle
Jacket	Clip board	Badminton ball	Keep right
Shoes	Ruler	Golf club	Stop ahead
Earring	Pencil sharpener	Ice skate	Merge left

APPENDIX E

INSTITUTIONAL REVIEW BOARD APPROVAL FORM

March 2, 2012

Eumji Kang
940 N Jackson St.
Apt. 3F
Starkville, MS 39759

RE: IRB Study #12-053: Memory for Pictures and Words

Dear Ms. Kang:

This email serves as official documentation that the above referenced project was reviewed and approved via administrative review on 3/2/2012 in accordance with 45 CFR 46.101(b)(2). Continuing review is not necessary for this project. However, any modification to the project must be reviewed and approved by the IRB prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project. The IRB reserves the right, at anytime during the project period, to observe you and the additional researchers on this project.

Please note that the MSU IRB is in the process of seeking accreditation for our human subjects protection program. As a result of these efforts, you will likely notice many changes in the IRB's policies and procedures in the coming months. These changes will be posted online at http://www.orc.msstate.edu/human/aahrpp.php. The first of these changes is the implementation of an approval stamp for consent forms. The approval stamp will assist in ensuring the IRB approved version of the consent form is used in the actual conduct of research. Your stamped consent form will be attached in a separate email. You must use copies of the stamped consent form for obtaining consent from participants.

Please refer to your IRB number (#12-053) when contacting our office regarding this application.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact me at nmorse@research.msstate.edu or call 662-325-3994. In addition, we would greatly appreciate your feedback on the IRB approval process. Please take a few minutes to complete our survey at http://www.surveymonkey.com/s/YZC7QQD.

Sincerely,

Nicole Morse
Assistant Compliance Administrator

cc: Carrick Williams (Advisor)
Colleen Sinclair (SONA)