CONTEXT-DEPENDENT RECOGNITION MEMORY

A Senior Scholars Thesis

by

SHAAN SYED SHAHABUDDIN

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2010

Major: Psychology

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Associate Dean for Undergraduate Research: Robert C. Webb

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ABSTRACT

Context-dependent Recognition Memory. (April 2010)

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It is a widespread belief that the ability to recognize information is enhanced when environmental context is reinstated, such as when a witness returns to the scene where a crime was committed in order to enhance their memory of the event. The present study used a new method to examine context-dependent recognition effects by showing a movie clip that involved manipulating the background context. Participants were shown a video clip with various words and background environments and were given a test in order to study whether more words were recognized by the participants when the background scenes changed or remained the same. The movie scenes were either reinstated with the original context, which were referred to as “old words”, or with a different context, or “new words”. The results support previous studies in favor of context-dependent recognition and show that a higher chance of recognition occurs when individuals are exposed to the information in the same context as they were when it was first encoded into their memory. In practical terms, this study shows that when

participants return to the same context, such as the place where an event occurred, they will improve the chance of recognizing information.

DEDICATION

I dedicate this thesis to my parents. It is because of them and their constant encouragement, motivation, and dedication that I have the ability to continue past my undergraduate career. They are the heroes that I have looked up to as a child and regardless of how much effort I put into my life, I will never be able to accomplish the impossible tasks that they have achieved.

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I would also like to give special thanks to the graduate students who have helped me conduct this research. Justin Handy and Genna Angello were in their first-year as graduate students and took time out of their frantic schedule to help me run the

participants for the study, a task that could not have been completed without their assistance.

I would especially like to thank Isabel Manzano for all of the help that she has given me for the past two years. Isabel spent long hours teaching me about the procedure for running the studies. She took the time to speak to me about my future goals of graduate school, and also helped edit my curriculum vitae; tasks that were above and beyond anything that she had to do. She patiently went over material that I did not understand in order for me to fully comprehend the method of the experiment. Thank you, Isabel, for sacrificing your busy time as a doctorate student to helping me in succeeding.

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My undergraduate experience was enriched the most by all of my loving roommates that I have had for the past two years: Saad Azeem, Haroon Siddique, Waleed Faiz, Abdul

Rahman, Usman Rasheed, and Amir Masood. They have cooked for me when I was sick, talked to me about my worries when I was feeling overwhelmed, and have always made me laugh when I was studying too much. I have never met a group of people that I can be proud to call my friends until I lived in the community of Bryan/College Station.

Sincere honor is given to the Undergraduate Research Scholars program for allowing me to conduct an independent experiment under a prestigious advisor. The students have been encouraged to publicly present their studies during “Student Research Week” in order to gain prizes, some of which I am thankful to have won. It has been a terrific experience to be a research scholar during my last year at Texas A&M, and this opportunity will be the stepping stone in gaining admission into graduate school. I know this program will provide even more resources for its upcoming students in the future and I hope that all of them will be able to enjoy their research as much as I have.

It is a pleasure to pay tribute to the undergraduate advisors at the psychology department of Texas A&M University for always providing a wonderful atmosphere of smiles whenever I entered the building. Thank you for being patient with my questions and requests and making my undergraduate years as a psychology major something worth smiling about.

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I will never be able to pay you all back, but I will try my best to support a fellow student in the future who has the determination to follow their dreams by giving them a special gift that was given to me by numerous people who will remain dear to my heart, opportunity. Without this gift, I would have never been able to witness the amount of goals that I was able to accomplish and the abilities that helped push me towards a higher dream. Thank you all.

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CHAPTER I

INTRODUCTION

It is a common held belief that memory is remembered more accurately when an individual is tested in the same environment in which an event first occurred or certain material is memorized (Smith, 1979, Smith et al., 1978, Smith & Manzano, 2010). For example, a student that studies for an exam while listening to classical music has a higher chance of remembering more of the learned material when the same genre of music is again reinstated during an exam (Smith, 1985a). Similarly, if a list of non-related words is tested in the same room where it was initially studied, more words from the list will be recognized (Smith, 1986). Studies conducted on manipulating environments (Godden & Baddeley, 1975) and sounds (Balch, Bowman, & Mohler, 1992) are only a few techniques used to research the retrieval of memory in a given context.

Balch et al. (1992) did a study where sound was manipulated, by having a song play in the background, and reinstatement effects were measured as participants rated words for pleasantness. The study found that if participants are exposed to the same background music on the test, then they are able to recall more of the words that they memorized.

This thesis follows the style of *Memory and Cognition.*

Herz (1997) did an experiment where participants learned a list of words while a distinct odor was present in the room. A free-recall test was given and participants were instructed to list all of the words that they were able to remember. Herz (1997) found that if the same odor is present when participants recall the list as it is when the list was memorized, then more words are often recalled.

Memory exists in different forms and ranges from procedural, working, and episodic (Tulving, 1984). Episodic memory consists of specific personal events and the connection to their contexts, such as a student trying to remember their first day of college by mentally reinstating themselves to the same environment of their campus building. Episodic memory can be related to information being encoded into a "memory store", and when an individual tries to retrieve a certain event that has occurred in the past, they are browsing through the selection of that store to find the memory that they want (Tulving, 1984; Tulving & Thomson, 1973). Various methods of reinstatement have been used to study episodic memory, including state-dependent (e.g., Eich, 1982; Miles & Hardman, 1998), mood-dependent (e.g., Bartlett & Santrock, 1979), scent-dependent, (e.g., Herz, 1997; Pointer & Bond, 1998) and context-dependent (Smith & Manzano, 2010). Through all of the previously described methods, context-dependent techniques most often benefit the study of episodic memory, even though it has been shown to have only a reliable effect (Smith & Vela, 2001).

Context-dependent memory occurs when an individual's memory is enhanced by reinstating the environment or background context in which the person first studied the

material (Smith, 1979). When a witness returns to the scene of a crime, he or she is likely to remember the events of the incident more accurately when they are in the same context as when the crime occurred, compared to a different context (Smith & Vela, 1992). Due to the amount of methods of reinstatement that exist to test context-dependent memory, it should be noted that the manipulation of the verbal context differs from environmental context. By manipulating verbal context, the attention of the participants is aimed at the context itself, whereas in environmental manipulation it is not (Smith, 1986).

Studies (Smith & Vela, 2001; Smith, 2007; Smith, 1986; Godden & Baddeley, 1975) show that a general method of studying context-dependent recall is through the manipulation of natural environments. In order to conduct these studies, participants encode information in a specific context and are then tested in two conditions, either in the same context where they encoded the information, or in a different context. Thompson et al. (2001) did a study that tested context and state-dependent memory of high levels of emotional arousal by comparing the participants' responses to remembering words on the ground or in the air. For the study, 16 professional skydivers were given a list of words to remember and were instructed to recall the list items in two conditions, either on land or in the air. The results of the study found that participants were less likely to recall words correctly when in a state of extreme arousal and their ability to remember new material was weakened. A similar study was conducted (Godden and Baddeley, 1975) where scuba divers learned a list of words either on land or underwater. Their study found that participants recall the words most accurately when reinstated in the same context. This study differed from Thompson et al. (2001) because it did not incorporate the combined factor of state-

dependent memory and only tested the context variable. Aside from field experiments of context-dependent recall, numerous laboratory experiments have also been conducted where recall is tested in different rooms (Smith et al., 1978; Smith, 1979), while chewing gum (Miles & Johnson, 2007), and hearing sounds (Balch, Bowman & Mohler, 1992). Pointer and Bond (1998) did a study comparing olfactory and visual stimuli to test whether autobiographical memory had an effect through context-dependent memory. Participants were exposed to either an odor or a color while reading a passage and were later asked to recall as many words from the passage as possible.

Another method of studying context-dependent memory is through recognition, where participants remember new material by distinguishing between different stimuli. An example is of a witness who is taken into a police station to recognize a criminal from a line-up. Instead of trying to recall the appearance of the criminal, they will be given choices to distinguish their decision, which will allow them to compare the face they see to the face that they remember.

Smith and Vela (1992) tested the validity of eyewitness memory by staging an unexpected incident in a university lecture hall. Two experiments were conducted, one in which a confederate asked the class a false name of a student, and one in which a confederate dressed up as a delivery man and asked if someone in the class had ordered a pizza. The participants, who were oblivious to the fact that their memory would later be tested, were given a recognition test and were asked to recognize the confederate from a group of pictures presented on a list of slides. One-third of the participants were tested in the same

context as the incident occurred, the original room, while the remaining two-thirds were tested in a different context, a new room. The results show that that eyewitness identification of an individual is improved if the environmental context is reinstated.

Kintsch's (1974) model is used in past studies (Smith, 1986) to describe the role that recognition plays on memory. During recognition tests, information of previously encoded events is retrieved from semantic memory; if the context of where the information was learned is reinstated, recognition should be enhanced (Smith, 1986).

Studies have shown that recognition is affected when participants are tested in a new environment compared to an old environment (Murnane and Phelps, 1993). Even though some context-dependent recognition tests in the past have failed to show a significant effect (Goddley & Baddeley, 1980; Smith et al., 1978), Smith (1985b; 1986) found that participants tested in different rooms most often remember words three times higher when they are given a recognition test compared to a free-recall test.

What happens when participants associate a relationships between information that they are presented and do not pay much attention to the environment? Smith (1988, 1994) terms this phenomenon as the "outshining hypothesis" in order to describe the overpowering of the information stored in memory to the environmental recognition. If an individual makes an inter-item association to a word on a list, then the information stored in memory overpowers, or "outshines", possible environmental context cues. For example, the outshining hypothesis would support the idea that if a student intensely studies for an exam

in a variety of different environments and supports themselves with examples to the material that they are studying, such as memorizing the order of operation rule as P.E.M.D.A.S (**P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally), then they will retain the same amount of information regardless of what environment they take the test. This example has been used (Smith, 1988, 1994; Russo et al., 1999) to describe a set of other forms of brighter light, such as the sun. The stars make a significant contribution at night by providing sufficient lighting, however, the light is not able to be seen during the day. The environment context cues acts like a star on a night sky because they provide cues to assist the participants in recognizing the words. Associations that the participants generate to assist them on the task act like the sun because it "outshines" the environmental context cue due to the fact that more participants are relying on their own association that they have created.

In the past, most context-dependent recognition tests have had participants view a list of words in one room, and then change the context of the room to test for effects (Smith, 1979; Smith, 1986; Smith et al., 1978; Russo et al., 1999). Our study uses a new method of displaying different words on top of random video scenes; the scenes represent the manipulation of the environmental context.

In the present experiment, participants were shown a video clip of several words displayed on top of random movie scenes (Figure 1a). They were then shown another video clip that had either the same word as the previous video clip and the same background context, same word and different background context, different word and same background context,

or different word and different background context (Figure 1b). After all of the scenes had been shown, participants were given a recognition test and had to decide, by circling either "yes" or "no", whether they had been shown the scene and word before in the original video clip. The list of words was displayed over a five second video clip of a random movie scene, where the ratio of words per scene was 1:1. We predicted that words would be recognized better when paired with the same background movie scene as the original study list than compared to words that had been accompanied with new video scenes. Our prediction supports previous studies (Smith & Vela, 1992) that show that participants will more likely recognize an incident or word when they see it reinstated in the same environmental context.

Past studies have found a significant recall effect when testing for context-dependent memory but a strong recognition effect has only been found in a few studies (Canas & Nelson, 1986; Geiselman & Bjork, 1980; Smith, 1985b; Smith & Vela, 1992). Most studies conducted on recognition either do not find a significant effect (Smith et al., 1978; Godden & Baddeley, 1980) or find a very low effect (Smith, 1986; Smith & Vela, 2001; Canas & Nelson, 1986).

CHAPTER II

METHODS

Participants

A total of 60 undergraduate students from Texas A&M University participated in this experiment in exchange for partial course credit for an introductory psychology class. Sign-up sheets were posted on the university's online psychology website and included various days of the week and different timings. Participants self-enrolled and were randomly assigned to one of two counterbalance groups. Each group was given a test for recognition that was used to study the following conditions: Old Words and Old Scenes, Old Words and New Scenes, New Words and Old Scenes, and New Words and New Scenes. The number of participants in each experiment varied from 1-10, with 10 being the maximum number of participants per session.

Materials and design

125 unrelated words were used in the experiment and each word was superimposed on top of a background movie scene. The words were selected from the MRC Psycholinguistic Database and had written frequencies ranging from 50-300/million (Kucera and Francis frequency norms). The words were all concrete nouns and ranged from 5-9 letters and 1-3 syllables (Figure 2a).

All of the movie scenes contained everyday clips (e.g., inside of a library, customers sitting on a table at café, people exercising at the gym) and were displayed for five seconds. The

word appeared two seconds from the start of a new scene and had a duration of three seconds. A red colored “Arial” font was used for every word on the experiment. Any obvious relationship between a word and a movie scene was avoided. The production of the video clips was made possible by “Windows Movie Maker” software that was pre-installed on an HP Pavillion dv6000 laptop which used an Intel Pentium Dual-Core Processor and functioned through “Windows Vista”. A projector from the psychology department was used to display the movie scenes and words. The projector was placed on a table and was four feet away from the overhead screen.

This experiment used a 2 (counterbalance 1 vs. counterbalance 2) x 2 (new words vs. old words) x 2 (new scenes vs. old scenes) design that consisted of one between-subjects variable and two within-subjects variables. Two separate measures were conducted: recognition of old words and recognition of old scenes. The hit rate was calculated by participants correctly choosing either “Yes” or “No” for the answer choice on the recognition test and the false alarm rate was calculated by the participants selecting the wrong answer choice (e.g., if they circled “Yes” to state that the word on the recognition test was the same as the word on the original study list, when the answer was “No”).

The original study list contained 75 words and was composed of three sets, arbitrarily named “Set A”, “Set B”, and “Set C”; each set contained 25 words. The scenes were arbitrarily named “Set X”, “Set Y”, and “Set Z” and were divided evenly among each word set (Figure 3). Counterbalance 1 was produced in a manner where for every four scenes, the first scene contained 25 words from the original “Set A” that was paired with 25

original scenes from “Set X”, the second scene contained 25 original words from “Set B” paired with 25 New Scenes (which will be called “Set R”), the third scene contained 25 new words that were not shown on the original study list (which will be called “Set P) that were paired with 25 original scenes from “Set Z”, and the fourth scene contained 25 new words that were not shown in the original study list (which will be called “Set Q”) that were paired with 25 new scenes that were also not shown in the original study list (which will be called “Set S); counterbalance 2 was produced a similar way (Figure 4). The overall design of the 2 x 2 x 2 experiment was then made into a simplified square model (Figure 5).

Procedure

The experiment was conducted on the fourth floor of the psychology building, in a mid-sized room. Participants were seated on a rectangular table and were told to face the video screen for instructions. Regardless of the counterbalance that each participant was randomly assigned, all of the participants watched the original study list movie that lasted approximately 7 minutes and contained 75 scenes and words. The participants were told by the experimenter to pay attention to the video clip because their knowledge would be tested later. The beginning of each video was provided with a set of instructions for the participants to follow (Figure 6).

After the original study list was shown, a test form was given to each participant and a new video was displayed. The new video was approximately 13 minutes in length and the time it took to hand out the test forms was less than ten seconds. The test form contained two

columns, “Words” and “Scenes”, with the words “Yes” and “No” written under each column (Figure 7). Participants were instructed to circle “Yes” on the test form under the column “Words” if a word that had previously been shown in the original study list was shown again in the new study list, and if it was not, then they were instructed to circle “No”. For the “Scenes” column, the same instructions were given. The total amount of time used to test the participants was less than 30 minutes per each session.

Both of the counterbalances were produced by two new scenes, two new words, two old scenes, and two old words for every eight movie clips. The first counterbalance was shown a video clip of 100 movie scenes that contained 25 old scenes with 25 old words, 25 old scenes with 25 new words, 25 new scenes with 25 old words, and 25 new scenes with 25 new words. The second counterbalance was shown a similar video but contained different words for the “old words” set.

CHAPTER III

RESULTS

An analysis of variance (ANOVA) was used to test the effect of recognition between words and movie scenes. Separate 2 x 2 x 2 ANOVAs were computed for context and environment test conditions, using participants' context score (i.e., number of words correctly recognized – number of scenes correctly recognized) as a dependent measure. Counterbalance (1 vs. 2) was a between-subjects variable while test item (words vs. scenes) and reinstatement (old word vs. new word and old scene vs. new scene) were within-subjects variables. Figure 8a and 8b show a graph illustrating the different hit rates and false alarms rates between these different conditions.

Recognition words – hits

A hit occurs when participants choose a correct answer on the recognition test, such as selecting "yes" when the word actually was shown on the original study list. The analysis shows a significant effect of old words reinstated with old scenes, F (1, 58) = 45.62, p < .05, η^2 = .44. The proportion of participants correctly identified "old words" when they were reinstated with the old movie scenes (M = .83) more often than different words that had not been previously shown on the original study list (M = .73) (See Figure 8a). A difference between counterbalancing conditions did not show on the analysis, F (1, 58) = 12, p < .05, η^2 = .17; it can therefore be concluded that the difference between counterbalance 1 and 2 did not significantly affect the scores.

Recognition words – false alarms

When a participant selects the wrong answer, such as thinking that a word was previously displayed on the original study list when in fact it was not, it is referred to as a false alarm. A similar reinstatement effect was shown for the false alarm rates of the words, F (1, 58) = 44.19, $p < .05$, $\eta^2 = .43$; however, no effect was shown for the counterbalance condition, F (1, 58) = .16, $p < .05$, $\eta^2 = .00$. The proportion of participants that mistakenly identified a word as "old" when it was "new" ($M = .20$) and also as "new" when it was "old" ($M = .30$) was smaller than the effect shown for the hit rate (See Figure 8a).

Recognition scenes – hits

For the hit rate of the movie scenes, a significant effect of recognition occurred for the reinstated variable, F (1, 58) = 39.17, $p < .05$, $\eta^2 = .40$, as well as the counterbalancing condition, F (1, 58) = 8.09, $p < .05$, $\eta^2 = .12$. The proportion of students who correctly identified the old scenes ($M = .89$) was larger than the proportion who correctly identified the new scenes ($M = .83$) (See Figure 8b).

Recognition scenes – false alarms

For the false alarm rates of the movie scenes, a small effect was shown, F (1, 58) = 23.23, $p < .05$, $\eta^2 = .29$; no effect was seen for the counterbalance condition, F (1, 58) = .01, $p < .05$, $\eta^2 = .00$. The proportion of participants who mistakenly identified a scene as "new" when it was "old" ($M = .15$) was smaller than the proportion who mistakenly identified a scene as "old" when it was "new" ($M = .09$) (See Figure 8b).

The results of the experiment show that a significant effect between reinstated movie scenes and words did occur for recognition. More participants recognized the words more often when they were reinstated with the old movie scenes and also recognized the movie scenes more often when they were reinstated with the old words. The participants were also able to reject new words more often when they were paired with old scenes. A similar effect also occurred when an old word was superimposed over a new movie scene because this condition yielded the smallest hit rate, with a proportion of .75 for counterbalance 1 and .7 for counterbalance 2. One reason for this effect, once again, is due to a reinstatement of the movie scenes. When an old word was superimposed over a new movie scene, the participants believed that the word was also new. It can be concluded that the words had a significant effect due to the context of the movie scenes.

CHAPTER IV

CONCLUSIONS

This study examined how performance on recognition tasks is affected by either reinstating a similar context (old scenes) or presenting a new context (new scenes). Recognition was greatest when the previously shown movie scene from the original study list was displayed with the same word. The false alarm rate was the highest in word recognition when new words were displayed over new movie scenes. The explanation behind these results shows that when old scenes were presented, participants were more able to recognize old words and they were also more able to reject new words. Our study supports previous studies (Smith, 1985b; 1986; Smith & Vela, 1992) and shows that when context is reinstated, there is a significant effect on recognition.

One reason to why the current study produced a significant effect when past recognition studies (Godden & Baddeley, 1980; Smith et al., 1978) did not find an effect may be because of the method that was used. The video context method, which involves concrete nouns superimposed on top of random movie scenes, has shown a significant effect in a recent study (Smith & Manzano, 2010). Smith and Manzano (2010) explain that the use of this method in their study provided rich context (Murnane et al., 1999) that was less overloaded (Watkins & Watkins, 1975). The video scenes were rich because they provided a plethora of details that the participants were able to focus on (e.g. color, movement, speech, sound), and the items were displayed on a 1:1 word to scene ratio. Further research

can be conducted to study whether an increased number of items per scene have the same effect for recognition memory as they do for recall (Smith & Manzano, 2010).

A theoretical claim that can be argued on the basis of this study is the participant's ability to make associations between the video context and the word. We randomly assigned the words to the movie scenes and removed any obvious associations that the participants may notice. One example includes the video scene of a man who is standing by a horse carriage and the word "wheel" is superimposed. Before finalizing the video, we removed the word "wheel" and replaced it with another word; however, we have no control over words and movie scenes that the participant may make personal association with (e.g. if the participant has a cat named "officer" and the movie displays a video of a cat with the word "officer" superimposed). An advantage of using this method that contains multiple contexts compared to a natural context of a single room is that if participants do make an association, there is a low chance of it affecting the results due to the quantity of movie scenes.

The study of context-dependent recognition can have many empirical benefits, such as eyewitness testimony. Smith and Vela (1992) show that if a witness returns to the same context where a certain event occurred, there is a higher chance of them recognizing a confederate from a line-up. An implication for future research, under ethical considerations from the Institutional Review Board, can have participants witness a crime that they perceive to be real in a variety of different contexts, and then test their performance on recognition. Another possible application of this research can be used towards education. If teachers and professors have their students sit in an assigned seat, then there is more of a

chance that the students will recognize previously presented information from a lecture when it is asked again on an exam.

In conclusion, a significant effect on context-dependent recognition memory was found by manipulating video scenes. Old scenes proved to be the major contribution to the high hit rate and the low false alarm rates on the word recognition task. There is a very low chance that participants formed associations between the words and the background movie scenes, and if possible associations were made, it did not affect the results of our experiment. When participants are reinstated to the original context where information was previously presented, there is a higher chance that they will be able to recognize the items.

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APPENDIX

FIGURES

a.

Figure 1. Sample of video scenes used for study list. (a) Shows a sample of the original study list that was shown to both groups. The recognition test was given to the two counterbalance groups and the information regarding the words and the scenes was manipulated. (b) Shows a sample of the recognition list. In contrast to the original study list, (b1) contained old words and old scenes, (b2) – old words and new scenes, (b3) – new words and old scenes, and (b4) – new words and new scenes.

b.

b1

b2.

b3

b4

Figure 1 continued.

a.

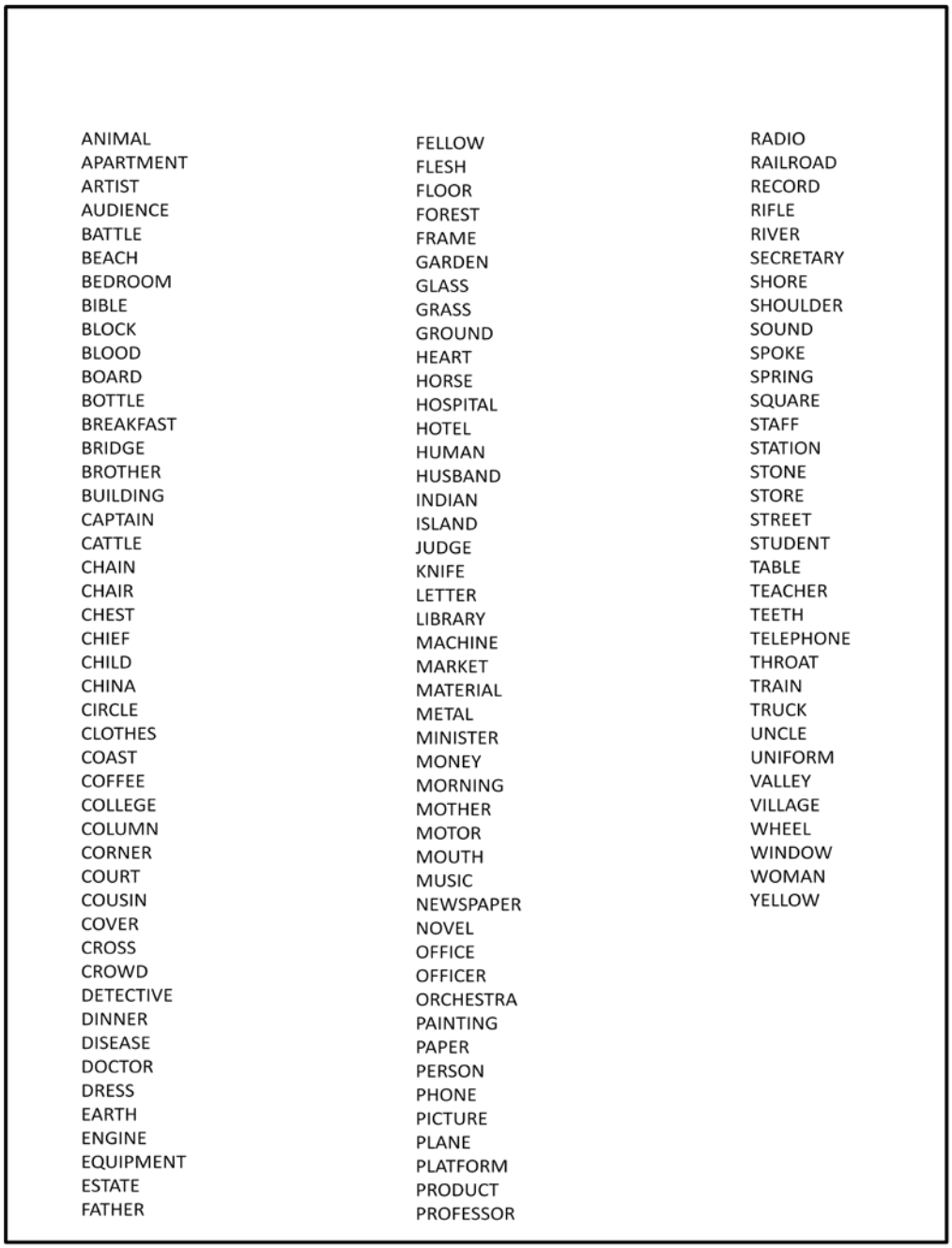


Figure 2. Sample of the unrelated words that were superimposed on top of the movie scenes. (a) shows all of the words used in the entire experiment, (b) shows the words used in the original study list that every participant first viewed, (c) shows the words in counterbalance 1, and (d) shows the words in counterbalance 2. The numbering is used to represent the order in which the words were shown, with “1” being the first word that was superimposed on the first movie scene, and “100” being the one-hundredth word that was superimposed on the one-hundredth movie scene.

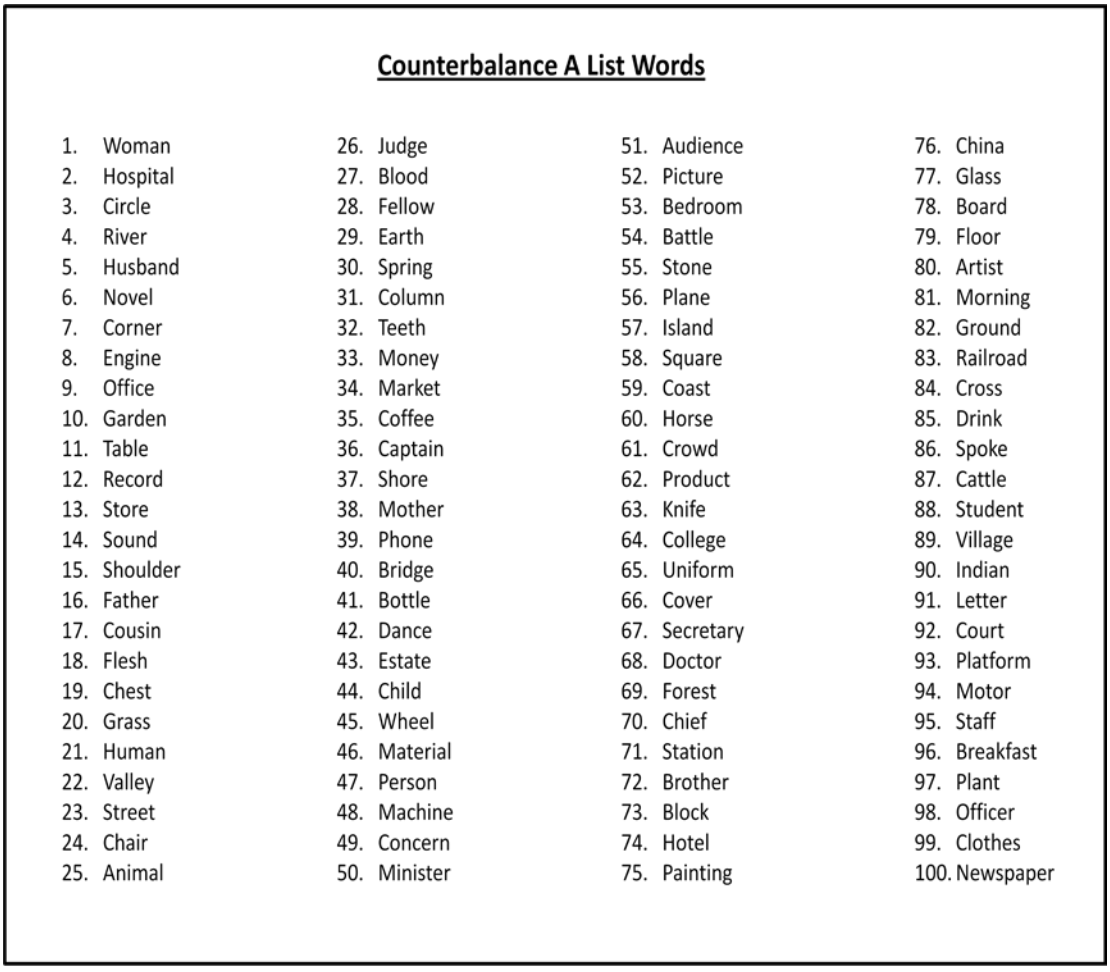
b.

Original Study List Words

1. Crowd	26. Indian	51. Window
2. Mother	27. Paper	52. Human
3. Building	28. Drink	53. Flesh
4. Glass	29. Square	54. Mouth
5. Chief	30. Dinner	55. Uniform
6. Disease	31. Bedroom	56. Board
7. Radio	32. Sound	57. Heart
8. Motor	33. Uncle	58. Bottle
9. Yellow	34. Village	59. Minister
10. Earth	35. Ground	60. Professor
11. Officer	36. Library	61. Block
12. Rifle	37. Platform	62. Market
13. Store	38. Product	63. Truck
14. Garden	39. Bible	64. Cousin
15. Chain	40. Office	65. Spring
16. Forest	41. Valley	66. Detective
17. Novel	42. Music	67. Concern
18. Dress	43. Woman	68. Hotel
19. Husband	44. Judge	69. Throat
20. Spoke	45. Beach	70. Morning
21. Train	46. Animal	71. Battle
22. Wheel	47. Hospital	72. Teacher
23. Dance	48. Frame	73. Money
24. Metal	49. Shore	74. Cover
25. Island	50. Material	75. Plant

Figure 2 continued

c.



Counterbalance A List Words

1. Woman	26. Judge	51. Audience	76. China
2. Hospital	27. Blood	52. Picture	77. Glass
3. Circle	28. Fellow	53. Bedroom	78. Board
4. River	29. Earth	54. Battle	79. Floor
5. Husband	30. Spring	55. Stone	80. Artist
6. Novel	31. Column	56. Plane	81. Morning
7. Corner	32. Teeth	57. Island	82. Ground
8. Engine	33. Money	58. Square	83. Railroad
9. Office	34. Market	59. Coast	84. Cross
10. Garden	35. Coffee	60. Horse	85. Drink
11. Table	36. Captain	61. Crowd	86. Spoke
12. Record	37. Shore	62. Product	87. Cattle
13. Store	38. Mother	63. Knife	88. Student
14. Sound	39. Phone	64. College	89. Village
15. Shoulder	40. Bridge	65. Uniform	90. Indian
16. Father	41. Bottle	66. Cover	91. Letter
17. Cousin	42. Dance	67. Secretary	92. Court
18. Flesh	43. Estate	68. Doctor	93. Platform
19. Chest	44. Child	69. Forest	94. Motor
20. Grass	45. Wheel	70. Chief	95. Staff
21. Human	46. Material	71. Station	96. Breakfast
22. Valley	47. Person	72. Brother	97. Plant
23. Street	48. Machine	73. Block	98. Officer
24. Chair	49. Concern	74. Hotel	99. Clothes
25. Animal	50. Minister	75. Painting	100. Newspaper

Figure 2 continued

d.

Counterbalance B List Words

1. Spoke	26. Shore	51. Audience	76. China
2. Block	27. Blood	52. Picture	77. Indian
3. Circle	28. Fellow	53. Minister	78. Uniform
4. River	29. Chief	54. Husband	79. Floor
5. Product	30. Store	55. Stone	80. Artist
6. Drink	31. Column	56. Plane	81. Board
7. Corner	32. Teeth	57. Officer	82. Cousin
8. Engine	33. Judge	58. Platform	83. Railroad
9. Novel	34. Radio	59. Coast	84. Cross
10. Office	35. Coffee	60. Horse	85. Motor
11. Table	36. Captain	61. Material	86. Bedroom
12. Record	37. Square	62. Animal	87. Cattle
13. Valley	38. Island	63. Knife	88. Student
14. Forest	39. Phone	64. College	89. Ground
15. Shoulder	40. Bridge	65. Hospital	90. Money
16. Father	41. Spring	66. Village	91. Letter
17. Garden	42. Morning	67. Secretary	92. Court
18. Metal	43. Estate	68. Doctor	93. Flesh
19. Chest	44. Child	69. Cover	94. Crowd
20. Grass	45. Mother	70. Woman	95. Staff
21. Dance	46. Earth	71. Station	96. Breakfast
22. Concern	47. Person	72. Brother	97. Sound
23. Street	48. Machine	73. Battle	98. Human
24. Chair	49. Hotel	74. Glass	99. Clothes
25. Market	50. Bottle	75. Painting	100. Newspaper

Figure 2 continued

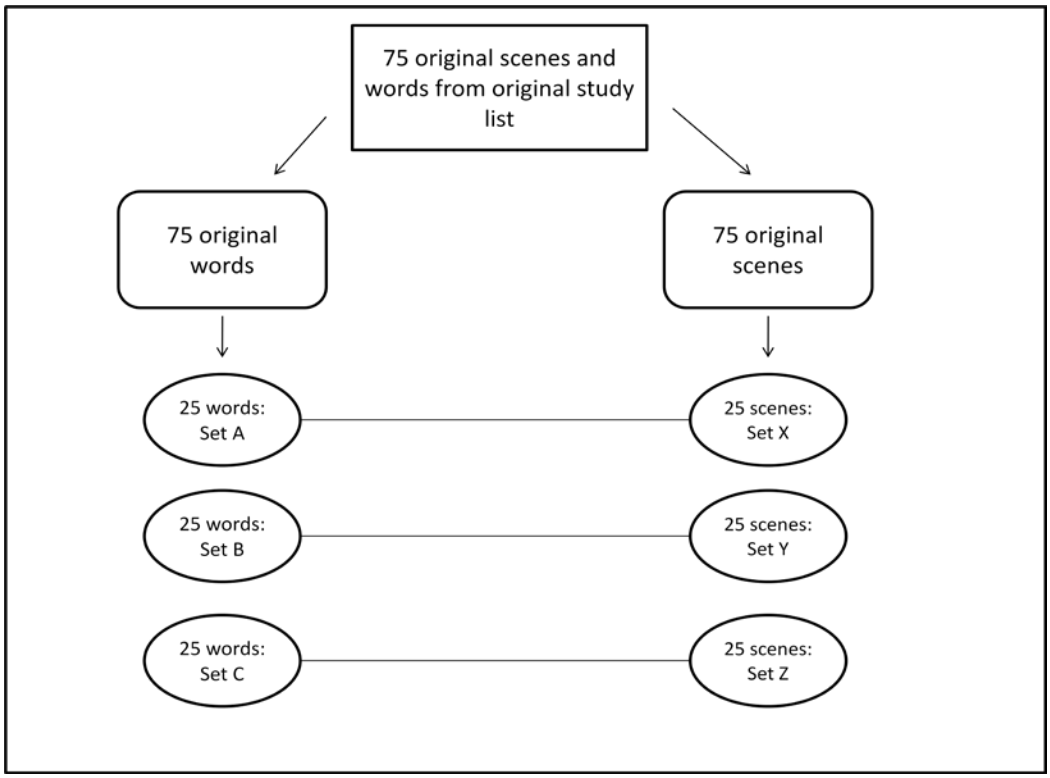


Figure 3. Design of the original study list. The 75 total words and scenes were divided into three sets of 25.

a.

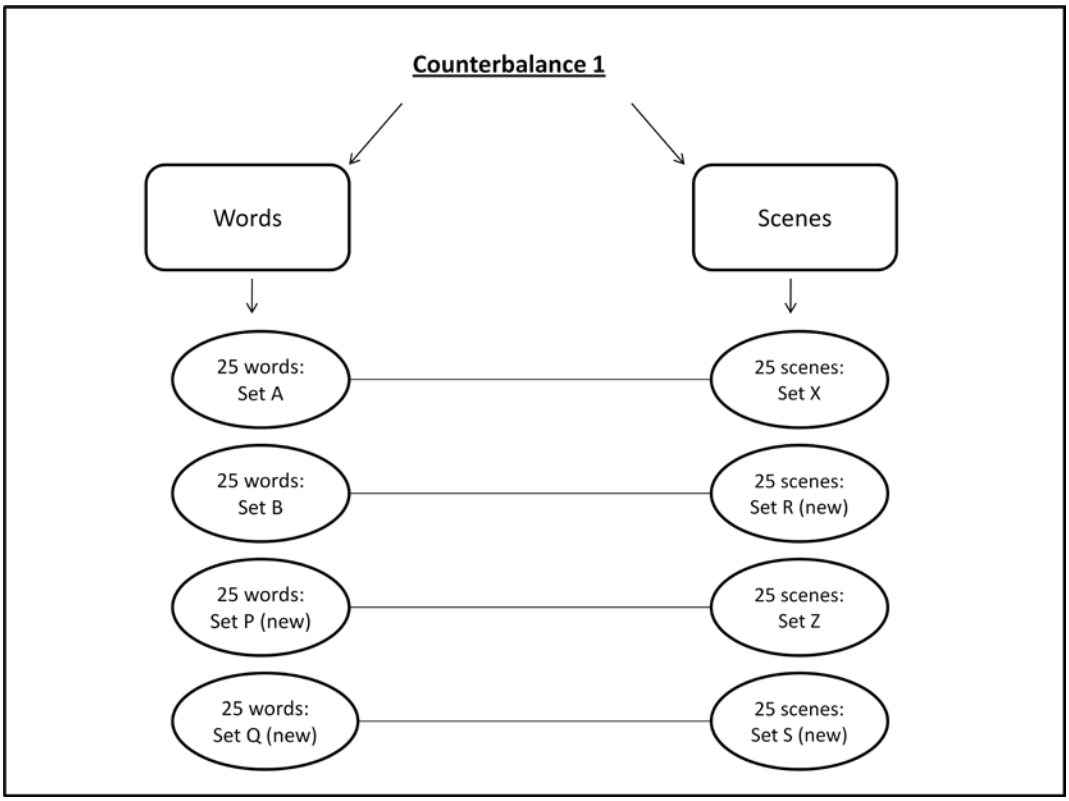


Figure 4. Design of the two groups used during the recognition task. (a) – Counterbalance 1 and (b) – counterbalance 2. Words and scenes that are "new" refer to those that were not shown on the original movie scene but were added to the recognition test.

b.

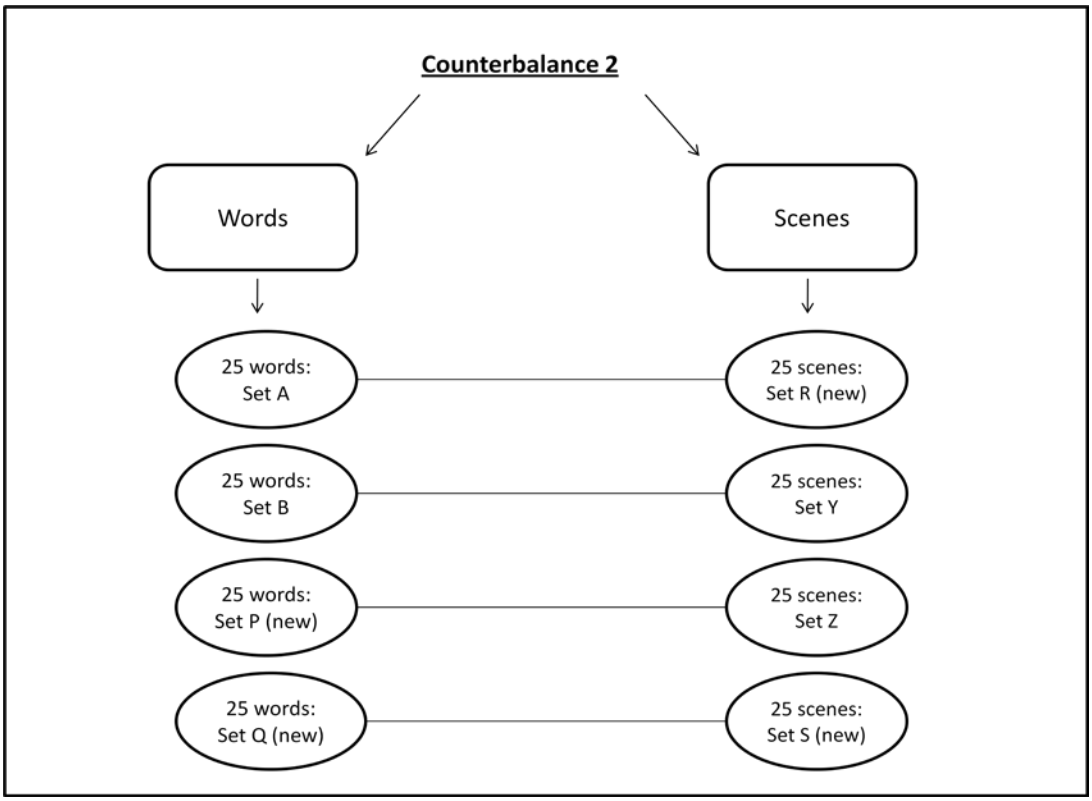


Figure 4 continued.

a.

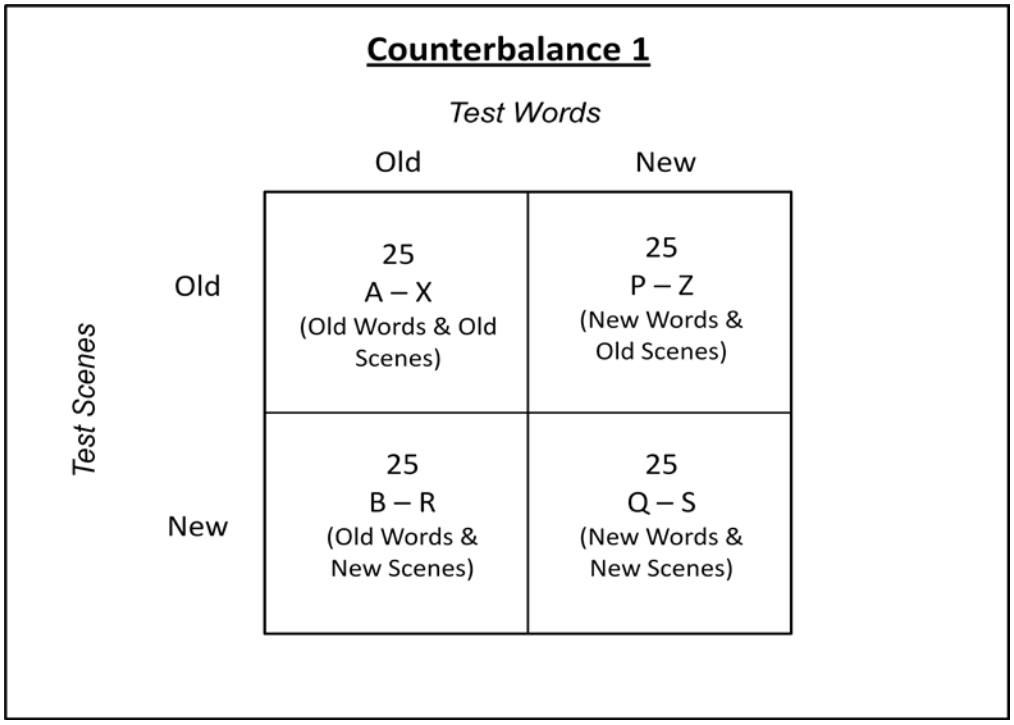


Figure 5. Design used to determine the distribution of scenes and words. (a) – counterbalance 1 and (b) – counterbalance 2. Words and scenes that are "new" refer to those that were not shown on the original study list.

b.

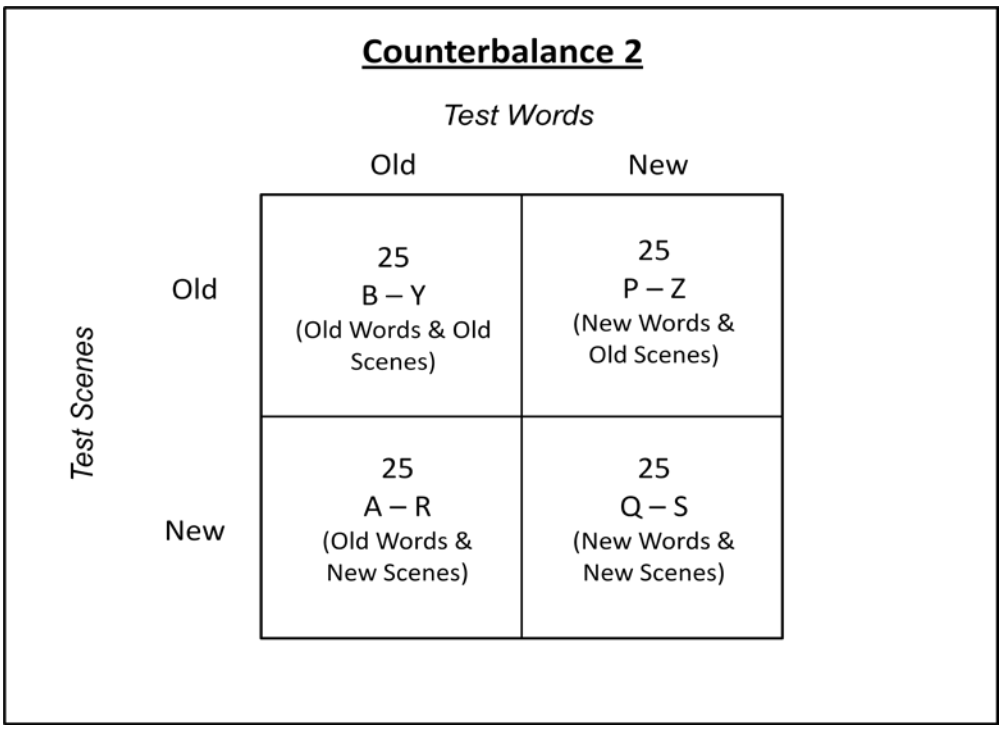


Figure 5 continued.

a.

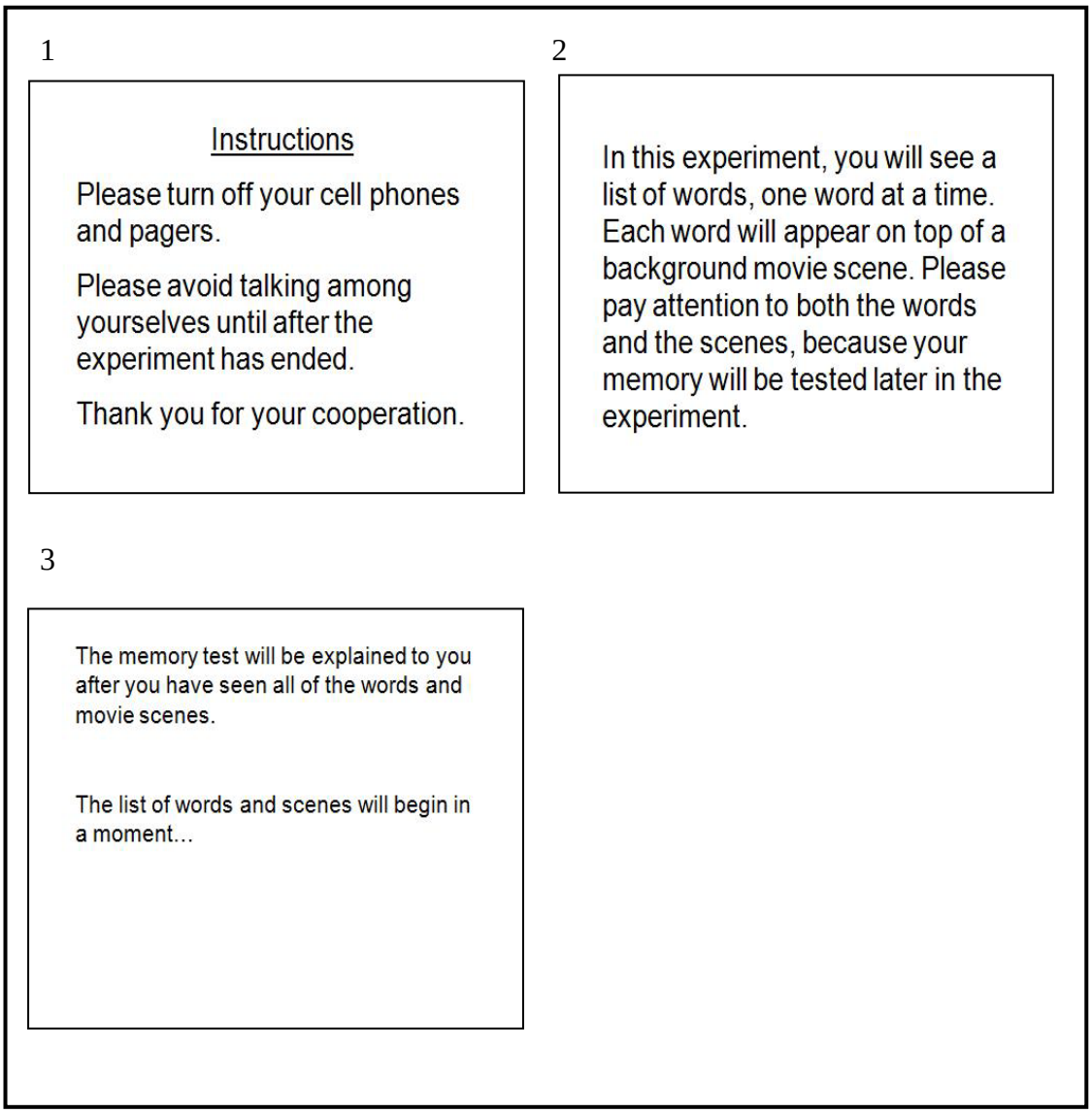


Figure 6. Instructions provided before the showing of (a) – the original study list and (b) – the recognition test for both groups. The numbers that are accompanied in the figures is the order in which the screens were presented.

b.

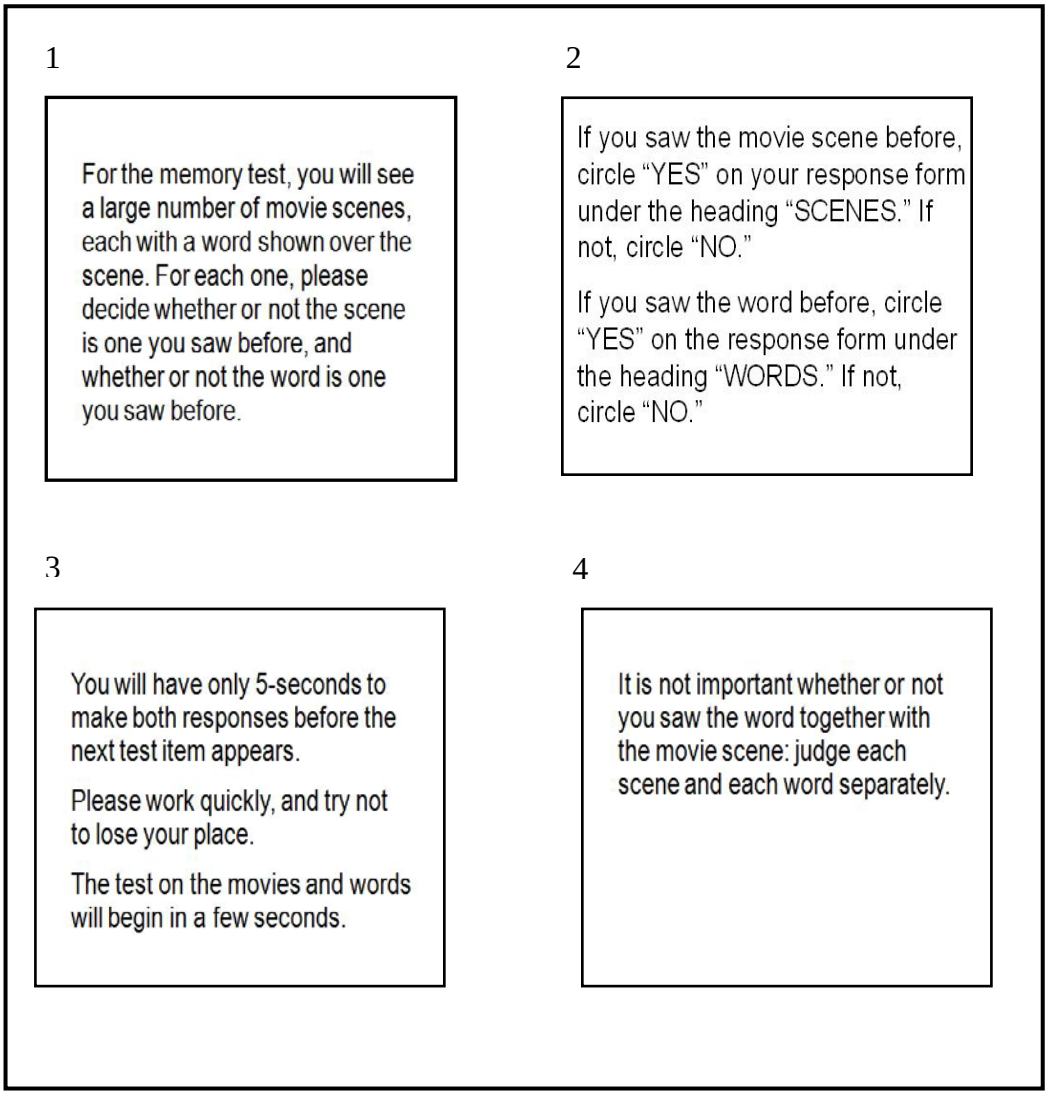
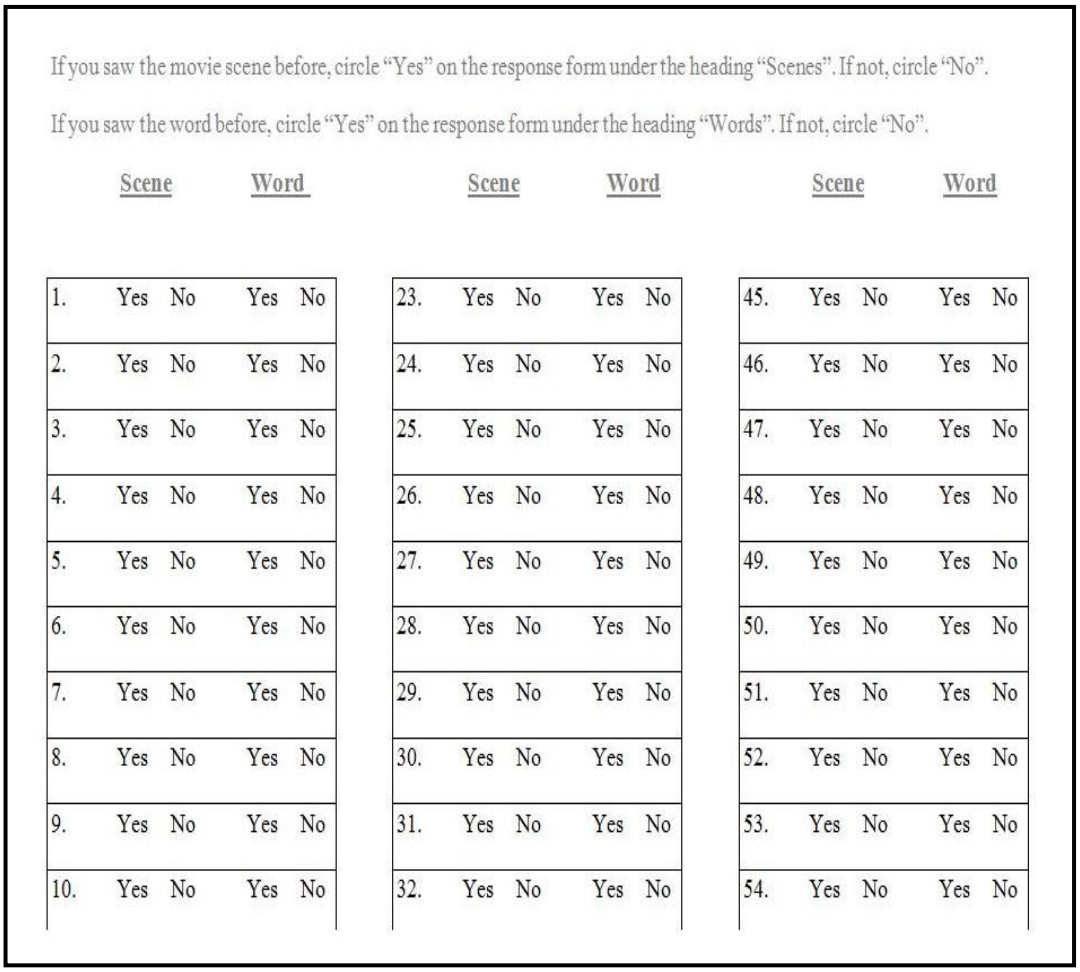


Figure 6 continued.

a.



If you saw the movie scene before, circle "Yes" on the response form under the heading "Scenes". If not, circle "No".

If you saw the word before, circle "Yes" on the response form under the heading "Words". If not, circle "No".

	Scene		Word			Scene		Word			Scene		Word	
1.	Yes	No	Yes	No	23.	Yes	No	Yes	No	45.	Yes	No	Yes	No
2.	Yes	No	Yes	No	24.	Yes	No	Yes	No	46.	Yes	No	Yes	No
3.	Yes	No	Yes	No	25.	Yes	No	Yes	No	47.	Yes	No	Yes	No
4.	Yes	No	Yes	No	26.	Yes	No	Yes	No	48.	Yes	No	Yes	No
5.	Yes	No	Yes	No	27.	Yes	No	Yes	No	49.	Yes	No	Yes	No
6.	Yes	No	Yes	No	28.	Yes	No	Yes	No	50.	Yes	No	Yes	No
7.	Yes	No	Yes	No	29.	Yes	No	Yes	No	51.	Yes	No	Yes	No
8.	Yes	No	Yes	No	30.	Yes	No	Yes	No	52.	Yes	No	Yes	No
9.	Yes	No	Yes	No	31.	Yes	No	Yes	No	53.	Yes	No	Yes	No
10.	Yes	No	Yes	No	32.	Yes	No	Yes	No	54.	Yes	No	Yes	No

Figure 7. Sample of test form given for recognition test.

a.

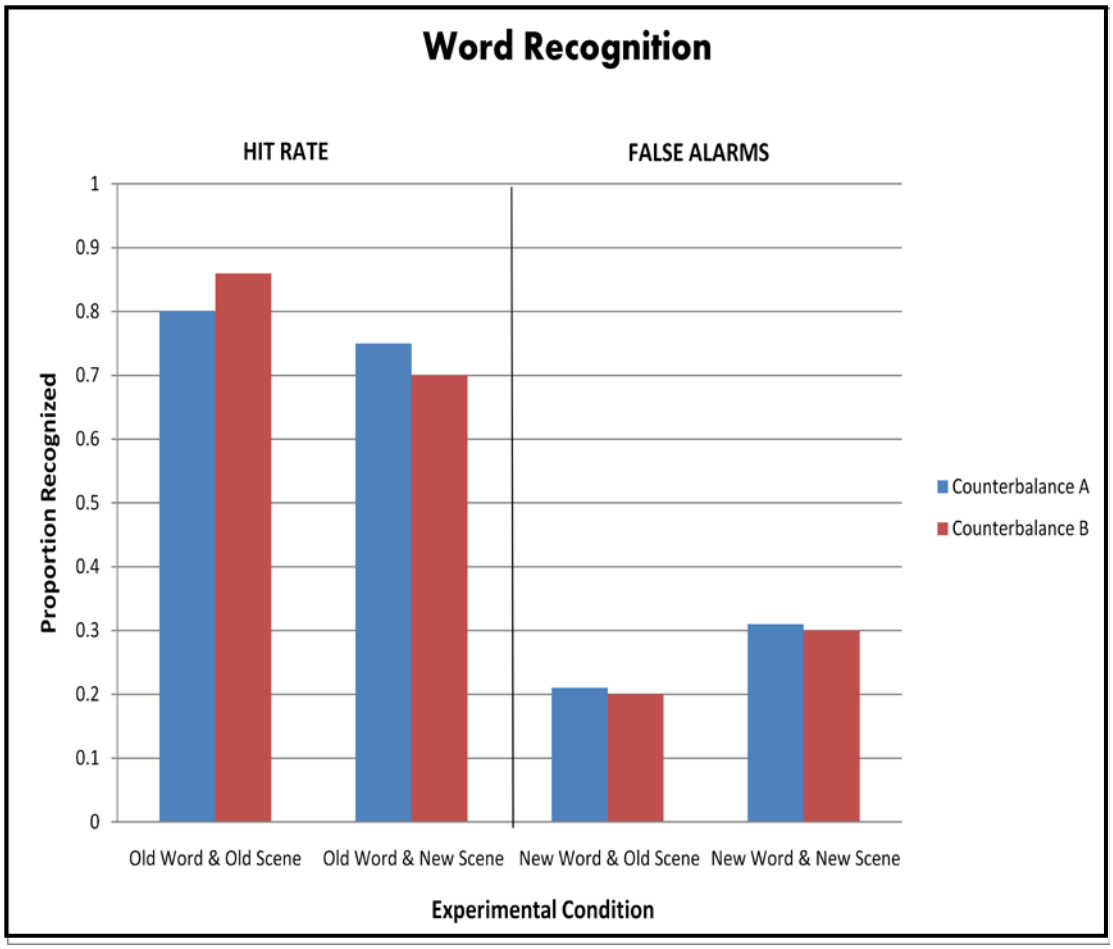


Figure 8. Results of the experiment. (a) Mean proportion of words recognized from both counterbalances. (b) Mean proportion of scenes recognized from both counterbalances.

b.

Figure 8 continued.

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