Activation of Imaginal Information on True and False Memories

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Abstract

The present study examined the activation of imaginal information on true and false memories. Participants studied a series of concrete objects in pictures or words. The imagery group (*n* = 96) was instructed to form images and the control group (*n* = 96) was not instructed to do so. Both groups were then given a standard recognition memory test and two criterial recollection tests. Results showed that hit rates in the imagery group were significantly higher than those in the control group, but false alarm rates did not differ in both groups.

Keywords: imaginal information, true memory, false memory

Activation of Imaginal Information on True and False Memories

According to Paivio's (1971) dual coding theory, the verbal system processes and stores linguistic information (e.g., visual, auditory, articulatory, and other verbal representations for words) whereas the nonverbal system processes and stores imaginal information (e.g., images for shapes, environmental sounds, actions, skeletal or visceral sensations related to emotion, and other nonlinguistic objects and events). He further stated that memory for linguistic information was enhanced if relevant imaginal information was activated, and such activation of both verbal and nonverbal systems resulted in dual coding of information.

One way to activate the imaginal information is to give instructions to form an image of the linguistic information. Such instructions to form an image have been found to be effective in learning pair-associated lists (Gupton & Frincke, 1970; Hertzog, Price, & Dunlosky, 2008; Robbins, Bray, Irvin, & Wise, 1974; Rowe & Smith, 1973; Smith, Stahl, & Neel, 1987; Yarmey & Barker, 1971). These studies asked participants to form images of the word pairs. The dual coding of information provided additional memory trace in retention of the pair-associated lists, and increased the number of word pairs recalled or recognized.

However, instructions to form an image do not facilitate memory performance of other materials. Using the Deese-Roediger-McDermott (DRM) word lists (e.g., butter, food, sandwich, rye, jam, etc.) in which all the words were associates of a nonstudied critical lure (i.e., bread), Newstead and Newstead (1998) asked participants to create images of the studied words. They found that such instructions to imagine yielded no significant memory improvement. In a similar way, Hynman and Pentland (1996) and Wade, Garry, Read, and Lindsay (2002) guided participants to imagine their childhood events and describe the image in detail. Results showed that there was no difference in the percentage of events recalled no matter whether participants were given the guided imagery instructions.

In addition to investigate the quantity of information people remember or true memory, studies on instructions to form an image in semantically associated lists (Newstead & Newstead, 1998) and autobiographical events (Hynman & Pentland, 1996; Wade, Garry, Read, & Lindsay, 2002) have also included the accuracy of information people remember or false memory. In fact, Roediger and Gallo (2002) noted that memory research has increasingly emphasized the errors that people make in retrieving the information. Roediger and McDermott (1995) called the incident of either remembering items or events that never happened, or remembering them quite differently from the way they happened "false memory."

From the studies of word lists, instructions to form an image have no effect on false memories (Franco-Watkins & Dougherty, 2006; Newstead & Newstead, 1998). Such studies usually involve asking participants to create images of the words at the study phase, and recalling or recognizing the studied words at the test phase. Participants receiving imagery instructions exhibited the same amount of false alarm rates as those receiving no imagery instructions.

From the studies of autobiographic memory, instructions to form an image increase the likelihood of generating false memories (Hyman & Pentland, 1996; Wade, Garry, Read, & Lindsay, 2002). Such studies usually involve asking participants to imagine an erroneous event suggested by the experimenter, and describing the imagined event in detail. Participants receiving such guided imagery instructions were more likely than those who did not receive such instructions to create false childhood memories.

The other way to activate the imaginal information is to provide an image of the linguistic information. Schacter and colleagues (e.g., Dodson & Schacter, 2002; Israel & Schacter, 1997; Schacter, Israel, & Racine, 1999) found that when Deese-Roediger-McDermott (DRM) word lists were studied with black and white line drawings, hit rates to words and pictures were similar, but participants were less likely to falsely recognize nonstudied critical lures on a later test. The researchers argued that pictorial encoding was more distinctive than word encoding. Consequently, at test, participants might expect to recollect the pictorial details of studied items and make their recognition decisions on the presence of these distinctive features. Since nonstudied items would not be accompanied with distinctive picture features, the failure to recollect the expected features would suggest that they were not studied. Schacter and colleagues have termed this the “distinctiveness heuristic,” in which the absence of distinctive features of an item provides memorial evidence that a nonstudied item has not been previously studied.

Previous studies showed inconsistent results of the activation of imaginal information on true and false memories. For example, the superiority of instructions to form an image on true memory was shown with pair-associated lists (Gupton & Frincke, 1970; Hertzog, Price, & Dunlosky, 2008; Robbins, Bray, Irvin, & Wise, 1974; Rowe & Smith, 1973; Smith, Stahl, & Neel, 1987; Yarmey & Barker, 1971), but not with semantically associated word lists (Newstead & Newstead, 1998). Instructions to form images of the studied words had no effect on false memories (Franco-Watkins & Dougherty, 2006; Newstead & Newstead, 1998), but instructions to form an image of childhood events increased the likelihood of generating false memories (Hyman & Pentland, 1996; Wade, Garry, Read, & Lindsay, 2002). In addition, presentation of pictures with the studied words lowered the false alarm rates of nonstudied words(e.g., Dodson & Schacter, 2002; Israel & Schacter, 1997; Schacter, Israel, & Racine, 1999).

In contrary to previous studies which either gave instructions to form an image or provided an image, the present study used both ways to activate the imaginal information. Participants were randomly selected to be in the control and imagery groups. The control group was not instructed to form imaginal information of studied items. The imagery group was instructed to imagine a picture of an item when they saw the same item studied as a red word, and to visualize a red word of an item when they saw the same item studied as a picture.

In contrary to previous studies which used pair-associated or semantically associated word lists, the present study used unrelated concrete words and pictures from Gallo, Weiss, and Schacter's (2004). Since words that are high in concreteness also tend to be high in imageabiltiy, concrete words are used in the present study to activate the imaginal information.

The present study further examined the activation of imaginal information on true and false memories. Two research questions were asked: (a) Was true memory different between the imagery and control groups? (b) Was false memory different between the imagery and control groups? It was hypothesized that true and false memories are different between the imagery and control groups because of the dual coding of linguistic and imaginal information.

Method

Participants

One hundred and ninety-two college students (mean age = 21.07 years) participated in the present study in return for extra course credit. Half of the participants was randomly selected to the control group (n = 96) and the other half to the imagery group (n = 96). The procedures met all American Psychological Association (APA) ethical principles for use of human subjects (APA, 2002), and participants were provided informed consent in accordance with guidelines set by the Institutional Review Board of a southwestern university.

Materials

Stimuli materials were taken from Gallo, Weiss, and Schacter's (2004). These materials consisted of 288 unrelated concrete words and their corresponding pictures taken from the Internet (see Appendix A for the words list). Average word length was 6.1 letters (*SD* = 1.7), average printed word frequency (Kucera & Francis, 1967) was 21.49 per million (*SD* = 46.52), and average imageability rating (Wilson, 1988) was 583.64 (*SD* = 34.06). Frequency information was not available for 14% of the words, and imageability rating was not available for 30% of the words. Each picture represented a single isolated object on a white background.

Stimuli materials were divided into 12 sets of 24 items each. The sets were counterbalanced so that each set occurred once in each of the 12 study/test combinations, which were obtained by crossing the four item types (pictures, red words, both, or nonstudied) with the three test types (standard test, red word test, or picture test). The standard test always came first to provide a measure of overall recognition memory for the different classes of stimuli. The order of the two criterial recollection tests was counterbalanced across participants, resulting in a total of 24 counterbalancing conditions.

Participants studied 216 unique items, with 1/3 presented as red words, 1/3 presented as pictures, and 1/3 presented as both red words and pictures. During the study phase, each item was presented first for 700 ms, using a black Courier New font in lowercase letters. The word was then replaced with either a picture of the word or with the same word in red for 2000 milliseconds. Pictures ranged in size from 1 inch × 1 inch to 3 inches × 3 inches. Red words were presented in a Kristen ITC font that was visibly larger and notably distinct from the Courier New font. A blank screen for 700 ms separated each picture or red word from the next item. Items were randomly presented during study, with the exception that 1/3 of the items from each study/test combination were presented in the beginning, middle, and end of the study phase. This was done to ensure an even sampling of the different types of items across the three sections of the study phase, which were separated by two rest prompts. For items that were studied as both a picture and a red word, the two occurrences were randomly spaced in the corresponding third of the study list.

During the test phase, items were presented using the same black font that was used for each item during study, so that the perceptual overlap between the study and test phases could not serve as a cue for whether the item had been studied with a red word or with a picture (or both). Each test contained four types of items: items studied as red words, items studied as pictures, items studied as both red words and pictures, and nonstudied items. On the standard recognition test, 3/4 of the items were true targets and 1/4 were lures, whereas on the criterial recollection tests, half of the items were targets and the other half were lures. For each of the three tests, items were freshly randomized for each participant.

Design

The research design was a 2 (instruction: control vs. imagery) × 4 (study item type: both, red word, picture, new) mixed analysis of variance (ANOVA) on one standard recognition test and two separate criterial recollection tests. Instruction was the between-subjects factor and study item type was the within-subjects factor. In the control group, participants were asked to pay close attention to both the words and pictures because their memory would later be tested. In the imagery group, participants were instructed to imagine a picture of an item when they saw the same item studied as red words, and to visualize a red word for an item when they saw that item studied as a picture. They were also asked to press the key labeled "yes" if the picture or red word they generated was vivid and press "no" if it was not. In the both condition, each item was studied twice on separate occasions, once as a picture, and another time as a red word. In the red word condition, each item was studied only as a red word. In the picture condition, each item was studied only as a picture. In the nonstudied condition, the items were not studied.

On the standard recognition test, participants were instructed to say "yes" to any item that they studied, regardless of whether it had been studied as a red word or a picture. The two criterial recollection tests included a red word test and a picture test. On the red word test, participants were instructed to say "yes" only to items that had been studied as red words, regardless of whether the item had also been studied as a picture. On the picture test, participants were instructed to say "yes" only to words that they had studied as pictures, regardless of whether the picture had also been studied as a red word.

Procedure

Participants were tested in small groups of up to three people each in a laboratory. After completing the informed consent form, all participants were given the memory task during a 30-minute session. The memory task was programmed by E-prime experimental software (Version 1.1; Schneider, Eschman, & Zuccolotto, 2002), and presented in a Dell Desktop PC with 17-inch screen.

Procedure for the memory task was adapted from Gallo, Weiss, and Schacter (2004, Experiment 1). During the study phase, participants were told that they would study a list of items presented on the computer screen. Some items were studied as red words, some studied as pictures, and some as both red words and pictures. The control group was told to pay close attention to both the words and pictures because their memory would later be tested. The imagery group was instructed to imagine a picture of an item when they saw the same item studied as red words, and to visualize a red word for an item when they saw that item studied as a picture. They were also asked to press the key labeled "yes" if the picture or red word they generated was vivid and press “no” if it was not. The total study phase took approximately 20 min, with two break prompts (“Rest briefly. Press space to resume study phase.”) separating the beginning, middle, and end of the study list.

During the standard recognition test, participants were told that they would see test words, one at a time, and that some of these words were studied (with red words or pictures or both) and some were not studied (new items). Participants were told that if they remembered an item either as a red word or as a picture, they should respond by pressing the key labeled “yes.” If they did not remember studying the item as a red word or as a picture, they should respond by pressing the key labeled “no.” For the red word test, participants were told that their memory for the red words would be tested. They were instructed to respond “yes” only if they remembered studying the test word in red letters. They were reminded that some of the red words were also studied as pictures, and some of the red words were never studied as pictures. Thus, whether or not they remembered studying a picture would be irrelevant on the red word test. Instructions for the picture test was identical, except that participants were instructed to say “yes” only to words that they had studied as pictures, and that their memory for red words would now be irrelevant. All three of the tests were self-paced, and the experimenter made sure that participants fully understood each of the sets of instructions. Following the final test phase, participants were debriefed.

Results

Unless noted otherwise, a significance level of $p < .05$ was used on all statistical tests in this study.

True Recognition

Data on true recognition rates for all participants are presented in Table 1. On the standard recognition test, a 2 (instruction: control vs. imagery) × 3 (study item type: both, red word, picture) mixed analysis of variance (ANOVA) revealed a main effect of study item type, $F(2, 380) = 216.095$, $p < .001$, partial $\eta^2 = .532$. Further pairwise comparisons using a Bonferroni correction showed that all study item types were significantly different from each other. Hit rates to items studied once as a picture and another time as a red word (.92) were greater than hit rates to items studied only as a red word (.72), and to items studied only as a picture (.79). Hit rates to items studied as pictures (.79) were also higher than those to items studied as red words (.72). There was also a main effect of instruction, $F(1, 190) = 17.656$, $p < .001$, partial $\eta^2 = .085$. Further pairwise comparisons using a Bonferroni correction showed that hit rates to all study item types in the control group (.77) were significantly lower than those in the imagery group (.85).

There was an interaction between study item type and instruction, $F(2, 380) = 61.035$, $p < .001$, partial $\eta^2 = .243$. Further pairwise comparisons using a Bonferroni correction showed that hit rates to items studied once as a picture and another time as a red word in the control group (.90) were lower than those in the imagery group (.95, $p < .05$), hit rates to items studied as red words in the control group (.62) were also lower than those in the imagery group (81, $p < .05$), but hit rates to items studied as pictures in the control group (.80) did not differ from those in the imagery group (.78, $p > .05$).

On the red word test, a 2 (instruction: control vs. imagery) × 2 (study item type: both, red word) mixed analysis of variance (ANOVA) revealed a main effect of study item type, $F(1, 190) = 158.431$, $p < .001$, partial $\eta^2 = .455$. Further pairwise comparisons using a Bonferroni correction showed that hit rates to items studied once as a picture and another time as a red word (.72) were greater than hit rates to items studied only as a red word (.58). There was also a main effect of instruction, $F(1, 190) = 16.588$, $p < .001$, partial $\eta^2 = .080$. Further pairwise comparisons using a Bonferroni correction showed that hit rates to all study item types in the imagery group (.70) were significantly higher than those in the control group (.60). However, there was no interaction between study item type and instruction, $F(1, 190) = .091$, $p = .764$, partial $\eta^2 = .000$.

On the picture test, a 2 (instruction: control vs. imagery) × 2 (study item type: both, picture) mixed analysis of variance (ANOVA) revealed a main effect of study item type, $F(1, 190) = 78{,}337$, $p < .001$, partial $\eta^2 = .292$. Further pairwise comparisons using a Bonferroni correction showed that hit rates to items studied once as a picture and another time as a red word (.76) were greater than hit rates to items studied only as a picture (.66). There was also a main effect of instruction, $F(1, 190) = 13.013$, $p < .001$, partial $\eta^2 = .064$. Further pairwise comparisons using a Bonferroni correction showed that hit rates to all study item types in the imagery group (.76) were significantly higher than those in the control group (.66). However, there was no interaction between study item type and instruction, $F(1, 190) = .053$, $p = .818$, partial $\eta^2 = .000$.

False Recognition

Data on false recognition rates for all participants are also presented in Table 1. On the standard recognition test, a one-way analysis of variance (ANOVA) revealed no difference between the control group (.12) and the imagery group (.11) on false alarms to nonstudied items, $F (1, 190) = .007$, $p = .931$.

On the red word test, a 2 (instruction: control vs. imagery) × 2 (study item type: picture false alarms vs. new false alarms) mixed analysis of variance (ANOVA) revealed a main effect of study item type, $F(1, 190) = 441.764$, $p < .001$, partial $\eta^2 = .699$. Further pairwise comparisons using a Bonferroni correction showed that false alarms to items studied as pictures (.42) were significantly higher than those to nonstudied items (.12). No main effect of instruction was found, $F(1, 190) = .043$, $p = .836$, partial $\eta^2 = .000$. However, There was an interaction between study item type and instruction, $F(1, 190) = 20.008$, $p < .001$, partial $\eta^2 = .095$. Further pairwise comparisons using a Bonferroni correction showed that false alarms to items studied as pictures in the control group (.39) did not differ from those in the imagery group (.45), but false alarms to nonstudied items in the control group (.16) were higher than those in the imagery group (.09).

On the picture test, a 2 (instruction: control vs. imagery) × 2 (study item type: red word false alarms vs. new false alarms) mixed analysis of variance (ANOVA) revealed a main effect of study item type, $F(1, 190) = 94.128$, $p < .001$, partial $\eta^2 = .331$. Further pairwise comparisons using a Bonferroni correction showed that false alarms to items studied as red words (.19) were significantly higher than those to nonstudied items (.07). No main effect of instruction was found, $F(1, 190) = .577$, $p = .448$, partial $\eta^2 = .003$. However, there was an interaction between study item type and instruction, $F(1, 190) = 5.131$, $p < .05$, partial $\eta^2 = .026$. Further pairwise comparisons using a Bonferroni correction showed that false alarms to items studied as red words in the control group (.17) did not differ from those in the imagery group (.21), and false alarms to nonstudied items in the control group (.08) also did not differ from those in the imagery group (.07). Even though there were numerical differences in false alarms to items studied as red words and to nonstudied items between the two groups, the differences were not large enough to be significant.

Discussion

The present study examined the activation of imaginal information on true and false memories. Two research questions were asked: (a) Was true memory different between the imagery and control groups? (b) Was false memory different between the imagery and control groups?

Results showed that hit rates to all study item types in the imagery group were significantly higher than those in the control group on the standard recognition test, the red word test and the picture test. When participants were instructed to imagine a picture of an item presented as a red word, and to visualize a red word of an item presented as a picture, participants exhibited overall higher hit rates than those participants who were not given such instructions. The activation of imaginal information prompted the imagery group to study all items with dual coding of linguistic and imaginal information. The generation of dual codes in the imagery group may have increased hit rates in a similar fashion to that observed in Paivio's (1971) when participants exhibited higher hit rates to concrete words than to abstract words.

Results revealed no difference in false alarms rates between the imagery group and the control group on the standard recognition test, the red word test and the picture test. Even though the activation of imaginal information prompted the imagery group to study all items with both verbal and imaginal information, the generation of dual codes did not make the false alarm rates of the imagery group different from those in the control group.

The null effect of the activation of imaginal information on increasing false memory may be due to the insufficient time allotted to form the imaginal information and the insufficient frequency of generating the imaginal information. The imagery group was given only two seconds to imagine a picture of an item studied as a red word, and two seconds to visualize a red word of an item studied as a picture. This relatively brief time (i.e., 2 seconds) that participants were allotted to form images in the imagery group may have been insufficient to allow them to form stable images that they would later confuse with studied events. In addition, previous studies showed that instructions to form repeated images raise false alarm rates (Goff & Roediger, 1998; Johnson, Raye, Wang, & Taylor, 1979), but the present study asked the imagery group to form images only once. If the imagery group was presented with each item longer than two seconds and instructed to generate images of the items repeatedly, instructions to form an image may have increased false memories.

In sum, the present study found that the activation of imaginal information increases true memory but not false memory. Further studies should be conducted to understand more about the application of such imaginal information.

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Appendix

Word List

mailbox	snowman	violin	bed	nest	tape	suitcase
rope	waffle	airplane	necklace	mixer	horse	dragon
heart	trampoline	saddle	canoe	racecar	crown	bulldozer
matches	octopus	bench	lamp	stapler	car	wallet
peacock	anchor	ostrich	worm	rainbow	helicopter	cheese
razor	towel	pitcher	cherries	nail	fence	lizard
corkscrew	mug	cactus	eggs	desk	footprints	dartboard
caterpillar	hippopotamus	pig	pail	harp	lighthouse	toaster
rake	peas	bull	mushroom	turkey	fish	trombone
key	piano	sweater	walrus	jacket	windmill	carousel
ring	beaver	glasses	speakers	bandaid	bow	trophy
snail	skateboard	refrigerator	hanger	computer	dollars	elephant
camel	tree	bear	buffalo	book	socks	goat
lighter	camera	grasshopper	airpump	pie	magnet	plant
sandwich	ghost	table	fork	backpack	package	gloves
radio	seahorse	maracas	comb	starfish	rhinoceros	pliers
dinosaur	pear	watch	kangaroo	bat	mirror	watermelon
seal	cigar	microwave	monkey	knife	wheelchair	handcuffs
zebra	tie	cookie	hose	pan	fireplace	pretzel
boots	skunk	crutches	spider	slide	telephone	iron
sheep	cow	hammock	frog	thumbtack	blender	cat
joystick	sneakers	compass	alligator	owl	fan	drum
check	spatula	flower	house	banana	peanuts	racket
submarine	calendar	tuba	crayon	parrot	hamburger	orange
beetle	donut	swan	strawberry	notebook	bathtub	medal
apple	shirt	shelves	bucket	clover	corn	overalls
tractor	doll	astronaut	xylophone	microscope	pancakes	globe
skull	armadillo	canon	deer	yoyo	funnel	telescope
tent	football	sofa	dog	lemon	carrot	balloons
turtle	television	shovel	toothbrush	shoe	screen	lantern
palette	koala	penguin	potato	pineapple	drill	chain
bowl	dumbbell	bicycle	parachute	tiger	apron	pencil
barrel	accordion	cassette	pumpkin	spoon	vase	pepper
shorts	scissors	whistle	crab	truck	flashlight	dustpan
battery	gun	typewriter	butterfly	leaf	pillow	wagon
cake	giraffe	fox	broom	lobster	screwdriver	needle
duck	boat	hotdog	microphone	basket	pacifier	
brain	briefcase	snake	lightbulb	kite	hammer	
iceskate	hairdryer	clock	onion	train	umbrella	
dress	bread	hourglass	coconut	guitar	mouse	
tomato	calculator	panda	bus	castle	pipe	
dice	belt	sword	scooter	eagle	wrench	

Table 1

Mean Recognition of Each Study Item Type as a Function of Test Type for the control and imagery groups (N = 192)

	Control (n=96)		Imagery (n=96)		Total (N=192)	
	Mean	*SEM*	Mean	*SEM*	Mean	*SEM*
Standard test						
Both hits	.90	.01	.95	.01	.92	.01
Red word hits	.62	.02	.81	.02	.72	.01
Picture hits	.80	.02	.78	.02	.79	.01
New False Alarms	.12	.01	.11	.02	.12	.01
Red word test						
Both hits	.67	.02	.77	.02	.72	.01
Red word hits	.53	.02	.63	.02	.58	.01
Picture False Alarms	.39	.02	.45	.02	.42	.02
New False Alarms	.16	.02	.09	.01	.12	.01
Picture test						
Both hits	.71	.02	.80	.02	.76	.01
Red word False Alarms	.17	.02	.21	.02	.19	.02
Picture hits	.62	.02	.71	.02	.66	.02
New False Alarms	.08	.01	.07	.01	.07	.01