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Negation-induced forgetting: Is there a consequence to saying "no"?

by

Rachel Elizabeth Dianiska

A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Psychology

Program of Study Committee:
Christian A. Meissner, Major Professor
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Gary L. Wells

The student author and the program of study committee are solely responsible for the content of this thesis. The Graduate College will ensure this thesis is globally accessible and will not permit alterations after a degree is conferred.

Iowa State University

Ames, Iowa

2017

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ABSTRACT

The negation effect refers to the cognitive detriment associated with correctly saying “no” (a negation), compared to correctly saying “yes” (an affirmation). A recent study has shown this detriment for item memory following the negation of a feature of an item (Mayo, Schul, & Rosenthal, 2014). This research examines the replicability of the negation effect using the original paradigm, as well as an adapted list-learning paradigm. Participants studied a set of objects and were then asked questions about features of objects that elicited “yes” or “no” responses. After a filler task, participants completed a final memory test during which they indicated whether a given object label was present or not present during the study phase.

Experiment 1 failed to conceptually replicate the negation-induced forgetting effect present in Mayo et al. (2014) using a list-learning paradigm. Experiment 2 was a pre-registered replication, and the negation effect was successfully replicated using the original stimulus and test materials from Mayo et al. (2014). Experiment 3 successfully replicated the negation effect using a list-learning paradigm, and found that the magnitude of the negation effect is influenced by the number of alternatives suggested by a feature statement.

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CHAPTER I: INTRODUCTION

Imagine the following scene: one afternoon, you hear through your window what you think may be gunshots. Turning around to look, you see one man lying on the ground behind a car, and another man holding a gun a few feet away. You make a note of the gunman's description in your head: tall, average build, white t-shirt and jeans, black baseball cap. While you are phoning the incident in to the police, the man with the gun grabs a backpack from the trunk of the car and runs away. The police arrive a few minutes later, and once the area is secured you are asked to make a statement. A detective asks you a simple question: "Was the baseball cap blue?" Your answer to this question – a "yes" or "no" – may later influence what you remember about the event.

Cognitive psychologists have long been aware of the limitations and malleability of human memory (e.g., Loftus, 2005). An understanding of these limitations has informed decades of research on how memory can be altered or falsely recollected, as well as how memory retrieval can be improved in applied contexts (e.g., interviewing of witnesses and suspects). However, advances in interviewing techniques have only been accompanied by a partial understanding of how the type of question a person is asked can influence his or her memory. Studies have assessed the influence of mnemonic techniques (the Cognitive Interview; Geiselman, Fisher, MacKinnon, & Holland, 1986), generating verbal descriptions (the verbal overshadowing effect; Schooler & Engstler-Schooler, 1990), suggestive questioning and social influence (e.g., Garven, Wood, Malpass, & Shaw, 1998; Hope, Ost, Gabbert, Healey, & Lenton, 2008), and interference due to selective retrieval of event information (e.g., Camp, Wesstein, & Bruin, 2012; Chan, Thomas, & Bulevich, 2009) on subsequent memory for an event or suspect. One

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aspect of questioning that has been overlooked involves the potential influence of *negation* on subsequent memory – that is, the cognitive detriment associated with correctly saying **no** to a question (negation), compared with correctly saying **yes** to a question (affirmation).

Prior studies have primarily situated negation in a context of lexical comprehension, focusing on how negations themselves are communicated and understood; however, memory researchers utilizing manipulations requiring a “yes” or “no” response have also observed differences in performance based upon the response given. The finding that a person’s memory or comprehension can be differentially influenced based upon whether one responds affirmatively or negatively appears to have been demonstrated consistently, yet has garnered little attention. The following studies attempted to replicate this negation effect in memory, and to further identify factors that may moderate the effect. Specifically, these studies examined the influence of affirmative or negative responses to forced-choice, yes-no statements related to a feature of an object (e.g., “The glass was empty”) on subsequent memory for the object of the question. In this context, the negation effect encompasses a comparative memory impairment based upon an accurate response of “no” to questions about features of studied objects, rather than an accurate response of “yes.”

The Negation Effect

The negation effect has been studied since the 1960s, particularly in the area of psycholinguistics. In this context, negations are represented as sentences describing how a situation is *not* (e.g., Susan does not bake cookies), whereas affirmations are represented as sentences describing the actual situation (e.g., Stephen tidied up his

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drawers). The nature of how negations are represented and accessed, as well as how accessibility influences understanding and inference-making has been explored. Using lexical comprehension and sentence verification tasks, a "negation effect" has been shown when participants more quickly and more accurately verify affirmative statements (Gough, 1965; Wason, 1961). Negated words and phrases have also been associated with decreased accessibility and slower response times (Engelkemp & Hormann, 1974; Kaup & Zwann, 2003; MacDonald & Just, 1989; Meyer, 1975).

Despite years of research, the manner in which negations are represented in memory is still debated. Two models of negation representation that have been explored include the schema-plus-tag model and the fusion model. The schema-plus-tag model proposes that a negated message is first processed using an affirmative meaning and is then negated (e.g., Mayo, Schul, & Burnstein, 2004). For example, this model suggests that a negated statement such as "not red" would first be processed as "red" with the negation operator subsequently added to the representation. The fusion model, in contrast, proposes that the meaning of the negated phrase is the result of merging of the negation operator with the affirmed meaning. The phrase "the door is not open" would thus be represented as the fusion of "not" and "open", or "closed." These competing models of representation yield different implications for associations that are activated when the negated statement is processed, as well as for long-term retention of the meaning of the negated statement.

To compare the two models, Mayo and colleagues (2004) examined the inferences participants made as different negations and affirmations were processed. Participants encoded affirmed target sentences (e.g., "Tom is a tidy person") or negated

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target sentences (e.g., "Tom is not a tidy person") and then determined whether a probe sentence describing a behavior (e.g., "Tom forgets where he left his car keys") fit the meaning of the target sentence. Negations in this study were presented three ways: *semantically negated*, as sentences with negation operators; *visibly negated*, with a red background that signaled that a sentence should be negated; or *dually negated*, as sentences with negation operators that were also displayed on a red background. The behavioral probes could be consistent with, inconsistent with, or irrelevant to the meaning of the target sentence. A baseline condition was included for comparison, wherein people first saw the behavioral probe and then assessed the congruency of the affirmed or negated sentences. Compared to this baseline, people were quicker to respond when the probe meaning was consistent with an affirmed target phrase, as well as when the probe meaning was inconsistent with a negated target phrase. Processing a negated message first as an affirmation in the schema-plus-tag model would activate associations that are inconsistent with the negated meaning. Thus, Mayo and colleagues (2004) suggested that the facilitation of incongruent associations with negated sentences in this study supports the schema-plus-tag model (e.g., Hasson & Glucksberg, 2006). In addition to representations, research into negation has extended to other areas of cognition, including attention and memory.

Negation in Attention

Negations are a crucial element of communication, for instance in directing attention away from or administering instructions not to do something. The use of negation as a communication device can sometimes itself lead to communication errors. Consider the classic studies of thought suppression: when people were instructed, "don't

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think about white bears," sometimes that instruction led people to paradoxically think about white bears (Wegner, Schneider, Carter, & White, 1987). Recently, Maciuszek (2013) examined the nature of negations in commands (e.g., "don't pay attention to [target],") in memory and comprehension. Attention focus, as measured by the amount of details recalled about the target, was found to be greater for people who received the negation order, compared to people in control groups who either were not told anything about the target, or who were not ordered to pay attention to the target. In other words, when participants were instructed not to pay attention to something, attention was drawn to the object to a greater extent.

Orenes, Beltrán, and Santamaría (2014) used a visual world paradigm to investigate how negations are understood and represented based on the situational context and number of available alternatives. The visual world paradigm allowed for both images and verbal information to be presented simultaneously, and eye movement data was collected to determine the focal point of attention. Four images of colored figures (red, green, blue, yellow) were displayed while a statement was presented. Initial statements that were presented to participants manipulated the situation in which figures would appear: either with two alternatives ("The figure could be red or green") or with multiple alternatives ("The figure could be red, or green, or blue, or yellow"). Subsequent statements were ether phrased as affirmations ("The figure was red") or negations ("The figure was not red"). When the initial statement set up a context in which multiple alternatives were present, people tended to direct their attention to the object of a negated sentence. That is, participants who were presented with the negated statement "the figure was not red" would focus on the red figure, rather than any of the other alternate colored

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figures. On the other hand, when a situation implied only two alternatives, participants' attention was directed to the intended color conveyed by the statement. That is, when presented with the negated statement, "the figure was not red," participants focused on the figure of the other color present in the scenario. The attentional component of negation thus appears to be sensitive to the number of alternatives suggested by the statement, and this may differentially influence what is remembered following that negation.

Negation in Memory

Manipulations using yes-no questions to assess memory are prevalent throughout the cognitive literature. While the impact of negation on subsequent memory for word lists has been documented in classic studies of the levels of processing effect (Craik & Tulving, 1975), the implications for object or event memory have only recently been explored (Mayo, Schul, & Rosenthal, 2014). In their original demonstration of the levels of processing effect, Craik and Tulving (1975) required participants to respond "yes" or "no" to prompts that systematically manipulated the level of semantic processing for a list of words – varying, for example, the physical structure of the word (e.g., "Is the word in capital letters?"); whether or not the target word rhymed with another (e.g., "Does the word rhyme with ___?"); or whether or not the target word fit a given category (e.g., "Is the word a type of ____?") or syntactical structure (e.g., "Would the word fit the sentence: '_____'?"). Across several experiments, Craik and Tulving noted a consistent effect of response type (*yes* or *no*), with the pattern of means suggesting that words associated with a "yes" response were better remembered compared to words associated with a "no" response. Positive responses allowed for the encoding prompts to be better

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integrated with the target items, resulting in a more elaborate memory trace.

More recently, Mayo, Schul, and Rosenthal (2014) demonstrated that correctly negating a feature of an object can subsequently impair memory for that object, compared to affirming a feature of the object. Mayo and colleagues examined a "negation-induced forgetting" effect based on the nature of a rehearsal (affirmative or negative). Participants were shown a video tour of an apartment and were later asked questions about features of items that were shown in the video. The initial memory test in Experiment 1 was composed of 16 questions, eight eliciting "no" responses and eight eliciting "yes" responses. After a 20-minute unrelated filler task, subjects completed a final recognition test for the objects they saw in the video. Overall, when feature questions elicited correct "no" responses, participants were less likely to remember the object (e.g., "ashtray") on the final memory test, compared to when feature questions elicited "yes" responses (d = 0.53 [0.19, 0.87][1]). Mayo and colleagues termed this comparative memory impairment "negation-induced forgetting." That is, when subjects thought about an object and negated it, the representation of that object was subsequently less accessible. Given the potential applicability of this negation impairment to domains like education and forensic interviewing, I sought to examine the replicability and robustness of the effect.

Overview of the Current Studies

In three experiments, I examine the replicability of the negation effect in memory. In Experiment 1, I attempt a conceptual replication of Mayo et al. (2014) using a list-learning paradigm. In Experiment 2, I conduct a pre-registered direct replication of Mayo

[1] The effect size was provided by the primary author, and confidence intervals for effect sizes were constructed using ESCI software (Cumming, 2012).

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et al. (2014) using the original stimulus and test materials. In Experiment 3, I return to the list-learning paradigm to examine two potential moderators of the negation effect: memory load at encoding, and the number of alternatives suggested by a test statement.

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CHAPTER 2: EXPERIMENT 1

The "negation-induced forgetting" effect seen in Mayo et al. (2014) prompted a replication attempt using a list-learning paradigm. Subjects in the first of Mayo and colleagues' (2014) experiments studied all of the stimuli (i.e., everyday household objects) by watching a video of a computer-simulated tour of an apartment. After watching the video, subjects provided "yes" and "no" responses to statements describing features of the objects that they had seen in the apartment. Following a 20-minute unrelated filler task, subjects then completed a final object recognition test.

The following experiment examined the replicability of the negation effect when using a single-item presentation list-learning paradigm. Subjects in the current study were shown images of simple objects and presented with statements about features of those objects that elicited "yes" or "no" responses. To conceptually replicate the encoding experience of subjects in the Mayo paradigm, subjects in Experiment 1 studied a series of objects in sequence and were then immediately tested on the feature statements (see Figure 1). Following a 20-minute filler period, subjects were administered a final test involving either object recognition (Exp. 1A) or free recall (Exp. 1B).

Method

Participants. A total of 84 subjects (42.9% male) completed Experiment 1 for partial course credit. Mean age was 18.86 (*SD* = 2.28). In Experiment 1A, 49 subjects completed a final *recognition* test. In Experiment 1B, 35 subjects completed a final *free recall* test. Three subjects were excluded from the analysis in 1B due to a failure to follow instructions.

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Materials and Design. Stimuli included 32 images of simple objects retrieved from the Massive Visual Memory Stimuli dataset (Brady, Konkle, Alvarez, & Oliva, 2013). Object images were selected to vary based upon the features of both an attribute (e.g., color) and state (e.g., open/closed). The feature statements for each studied object were administered via pre-recorded audio files that involved a female speaker reading the statements aloud. Each statement recording was between 2500ms and 3000ms. Statements that were presented to participants can be found in Appendix A.

This study employed a within-subjects design manipulating response to feature questions on an initial memory test (yes or no)[2]. Object memory was assessed via performance on a final memory test. In Experiment 1A, subjects indicated that an object was "Present" or "Not Present" in the study phase on a final recognition test. In Experiment 1B, subjects freely recalled all of the items that they could remember seeing in the study phase.

Procedure. This study was divided into three phases: a study phase, an initial test phase, and a final test phase. A schematic representation of the procedure can be found in Figure 1. Prior to the first phase, subjects provided informed consent and received instructions about the experiment. Specifically, they were instructed that they would study a set of simple objects and be asked questions about features of those objects at a later time. They were not informed that they would take a final test with regard to the

[2] This condition was independent of another study manipulation in which the yes/no questions were presented immediately prior to encoding an image, similar to the paradigm used by Craik & Tulving (1975). For subjects in that pre-encoding condition, there was no significant negation effect in either recognition (d = .02 [-.28, .23]) or recall (d = .45 [-.14, 1.03]). For the purpose of this paper, I focus the discussion on this post-encoding manipulation of negation, consistent with the Mayo et al. (2014) paradigm.

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images that they studied. The remaining instructions and tasks were presented to subjects via E-Prime 2.0™.

Subjects were randomly assigned to a condition prior to arriving for the experiment. In the study phase, subjects studied the full set of 32 objects for 250ms each with a 1000ms ISI. Following the presentation of all object images, subjects completed the initial test phase, which was comprised of feature statements that described correct or incorrect attributes of the studied objects. These feature statements were randomly divided into "yes" or "no" responses, and counterbalanced so that each object was equally associated with both responses across all conditions.

Immediately following the study phase, all subjects completed an unrelated 20-min filler task that required them to locate sequences of numbers vertically, horizontally, or diagonally, similar to a word search. Next, subjects completed a final object memory test. In Experiment 1A, this final test was a *recognition* test: subjects were shown simple object labels (e.g., "highlighter") and were asked to indicate whether that object was present or not present in the first part of the study. The final recognition test was comprised of 64 object labels – half of these object labels corresponded to the 32 studied objects from the first phase of the experiment (and thus elicited correct "Present" responses), while the other half corresponded to new, unstudied objects (and thus elicited correct "Not Present" responses). The order of presentation for test items was determined randomly for each subject. For each item, subjects were also asked to provide a confidence estimate and phenomenological memory (i.e., remember-know-guess) judgment. Confidence was assessed using a 1 to 5 scale, with 1 corresponding to "not sure at all" and 5 corresponding to "definitely sure" that the object was or was not

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studied. Subjects were provided instructions with respect to remember/know/guess responses and were asked to choose between "I (would have) recollected seeing the object", "The object is (not) familiar to me", and "I am guessing" for each decision on whether an object was studied.[3] Specific instructions can be found in Appendix B. The order of presenting confidence and memory basis judgments was counterbalanced such that half of the subjects first rated confidence and then provided the memory basis judgment, while the other half first provided a memory basis judgment and then the confidence rating.

The final test in Experiment 1B involved a *free recall* test. Subjects were given as much time as they needed to list objects recalled from the first part of the experiment. Subjects were prompted twice to recall all of the objects they could remember studying. Free recall responses were coded by a research assistant blind to the images used in the study. A response was counted as correct/present if the research assistant could discern what object was being named, even if the label was not a perfect fit. For instance, the terms "marker" and "highlighter" would both be considered as correct for "highlighter". After completing the final memory test, subjects were debriefed and dismissed from the study.

Given my interest in replicating the negation-induced forgetting effect in Mayo et al. (2014), I will report Bayes Factors (BF_{10}) in addition to the traditional null hypothesis significance tests (NHST). Bayes factors enable the comparison of evidence strength for two models: one in which there is no significant negation effect (the null hypothesis,

[3] Subjects provided these responses for both "old" and "new" responses. In the results, I focus on the phenomenological memory judgments for only correct "old" responses.

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Model 0), and one in which there is a significant effect (the alternative hypothesis, Model 1). The BF_{10} factor will be used to express the probability of the data given the alternative hypothesis (Model 1) relative to the probability of the data given the null hypothesis (Model 0). However, when this value is less than 1, I will invert it for interpretation. For the subject-level effects, I will use the effect size for Mayo et al. (2014) Experiment 1 as provided by the primary author, d = 0.53 [0.19, 0.87], as the prior distribution. For the item-level analyses, I will use the standard Cauchy prior of 0.707 to calculate BF_{10}. The magnitude of BF_{10} can be used to interpret the strength of the evidence: a factor of 0 to 3 is considered *anecdotal* evidence; 3 to 10 is considered *substantial* evidence; 10 to 100 is considered *strong* evidence; while a factor greater than 100 is considered *decisive* evidence (Jeffreys, 1961).

Results – Experiment 1A

Initial Memory Test. The initial memory test was used to elicit "yes" and "no" responses from participants. It consisted of 32 statements pertaining to features of objects that were studied. Half of the statements described correct features of the objects and required "yes" responses; the other half described incorrect features of the objects and were correctly answered with "no" responses. A paired-samples t-test was used to assess the influence of initial memory test response (yes, no) on the proportion of accurate responses to the feature statements. Subjects were similarly accurate for statements requiring a "yes" response (M = .72, SE = .02) and for statements requiring a "no" response (M = .70, SE = .02), $t(48) = 1.52$, $p = .14$, d = 0.17 [-0.05, 0.40].

Final Memory Test. Two outcome measures were of primary interest: (1) conditionalized errors on the final memory test, and (2) phenomenological memory bases

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for accurately recognized objects on the final memory test. For each person, the proportion of conditionalized errors made on the final memory test was calculated. Conditionalized errors refer to items that were associated with a correct response on the initial memory test, but were responded to as "Not Present" on the final memory test. Proportions of Remember and Know responses were also calculated for objects correctly recognized as having been present in the first part of the experiment. Know responses were corrected for independence of the two processes by dividing the number of Know responses (K) by the opportunities to respond Know (1 – R; see Yonelinas & Jacoby, 1995).

A paired-samples t-test was used to assess the influence of initial memory test response (yes, no) on the proportion of errors on the final memory test (i.e., studied items that were correctly answered on the initial test but were not recognized as having been studied in the first part of the experiment). Although numerically more errors were made following "no" responses ($M = .10$, $SE = .02$) than following "yes" responses ($M = .07$, $SE = .01$), a statistically significant negation effect was not observed, $t(48) = 1.49$, $p = .14$, $d = .27$ [-.09, .62].

To further examine the null effect, a Bayesian paired-samples t-test was conducted using JASP software (JASP Team, 2016). An estimated BF_{10} of 0.54 suggests that the data were 1.85 times more likely under the null hypothesis, which is considered weak evidence. In addition to these subject-level analyses, an item-level analysis was conducted to determine if a negation effect was present across the 32 target items. When examined at an item-level, there was a marginally significant negation effect, $t(31) = 2.03$, $p = .05$, $d = 0.38$ [.01, .74]. An estimated BF_{10} of 1.15 suggests that the data were

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1.15 times more likely under the alternative hypothesis on an item-level. Again, this Bayes Factor is considered weak or anecdotal evidence.

The second measure of interest involved the basis upon which subjects correctly recognized objects. A paired-samples t-test was used to assess the influence of initial memory test response (yes, no) on the proportion of accurately recognized objects based on *remembering* and *knowing*. No differences in recollection responses were observed following "yes" (M = .85, SE = .02) vs. "no" responses (M = .84, SE = .03), $t(48)$ = .48, p = .63, d = 0.07 [-0.22, 0.35]; nor were differences observed in familiarity responses following "yes" responses (M = .55, SE = .07) vs. "no" responses (M = .58, SE = .07), $t(48)$ = .39, p = .70, d = 0.06 [-0.37, 0.25].

Results – Experiment 1B

Initial Memory Test. A paired-samples t-test was used to assess the influence of initial memory test response (yes, no) on the proportion of accurate responses to the feature statements. Subjects were similarly accurate for statements requiring a "yes" response (M = .71, SE = .02) and for statements requiring a "no" response (M = .69, SE = .02), $t(31)$ = .93, p = .36, d = 0.18 [-0.20, 0.55].

Final Memory Test. A paired-samples t-test was used to assess the influence of initial memory test response (yes, no) on the proportion of studied objects correctly recalled. This measure was conditionalized for accuracy on the initial test, such that only objects correctly answered with "yes" or "no" on the initial test were included in the final proportion recalled. Subjects recalled fewer objects associated with a "no" response (M = .29, SE = .02) than those associated with a "yes" response (M = .32, SE = .03); however, this difference was not significant, $t(31)$ = 1.04, p = .31, d = .21 [-.14, .56]. An estimated

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BF_{10} of 0.39 suggests that the data were 2.58 more likely under the null hypothesis. An item-level analysis was used to determine if a negation effect was present across the 32 target items. The item analysis revealed a significant negation effect, $t(31) = 2.28$, $p = .03$, $d = -0.81$ [-1.52, -.08]. More objects were correctly recalled after a "yes" response ($M = .59$, $SE = .04$) than after a "no" response ($M = .41$, $SE = .04$). An estimated BF_{10} of 1.79 indicates that the data provided weak evidence for the alternative hypothesis on an item-level.

Discussion

The present studies failed to find a significant negation effect for either conditionalized errors on a final recognition test (1A) or for conditionalized accuracy on a final free recall test (1B). A similar effect size for the negation effect was observed for both recognition, $d = .27$ [-.09, .62] and recall, $d = .21$ [-.14, .56]. While these effects fall within the confidence intervals of the original effect produced by Mayo et al. (2014) [0.19, 0.87], they are at the lower end of the distribution and were about half the size original effect ($d = 0.53$). Bayes factors ($BF_{10} = 0.54$ and 0.39, respectively) suggested only weak evidence in favor of the null hypothesis. Despite the presence of a negation effect in an item-level analyses, the lack of subject-level effects takes precedence in the interpretation of the negation effect's non-significance (e.g., Raaijmakers, Schrijnemakers, & Gremmen, 1999).

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Table 1

Means for final test measures in Experiment 1A (false rejection, accurate recognition) and Experiment 1B (proportion recalled)

	After "yes"		After "no"	
Measure	Mean	*SD*	Mean	*SD*
False Rejection				
Proportion Errors	.07	.10	.10	.11
Confidence	2.76	1.00	2.61	1.02
Accurate Recognition				
Response Latency	1525	314	1612	431
Confidence	4.68	.28	4.59	.28
Remember	.85	.15	.84	.18
Know (Corrected)	.55	.48	.58	.47
Proportion Recalled				
Accurate	.32	.15	.29	.13

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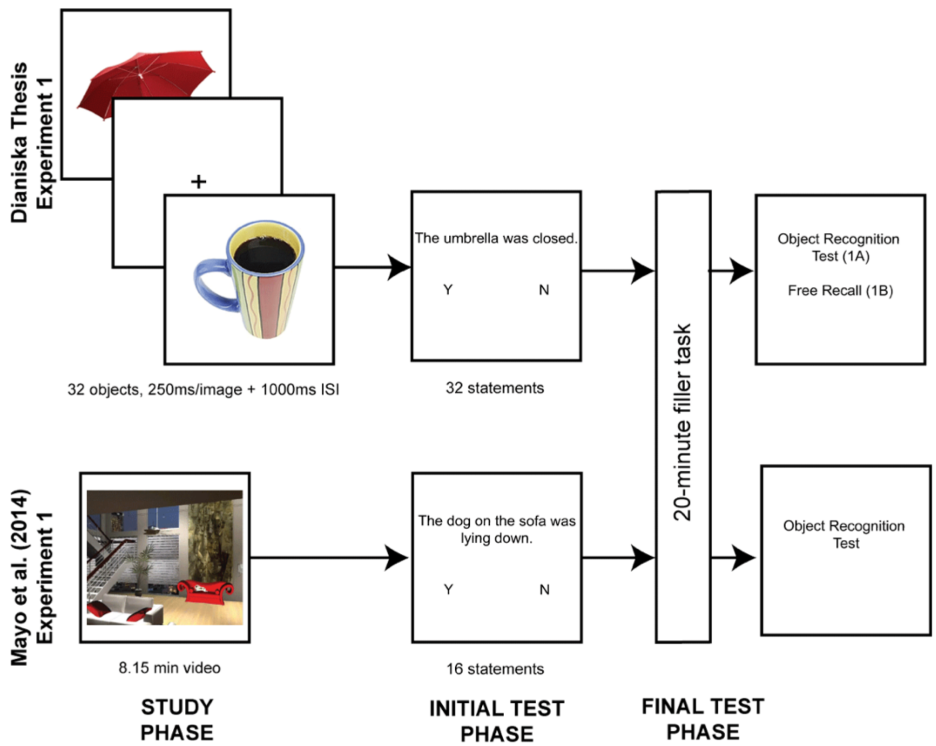

Figure 1. Graphic representation of the procedure used in the present Experiment 1 to conceptually replicate the procedure used in Experiment 1 of Mayo, Schul, & Rosenthal (2014).

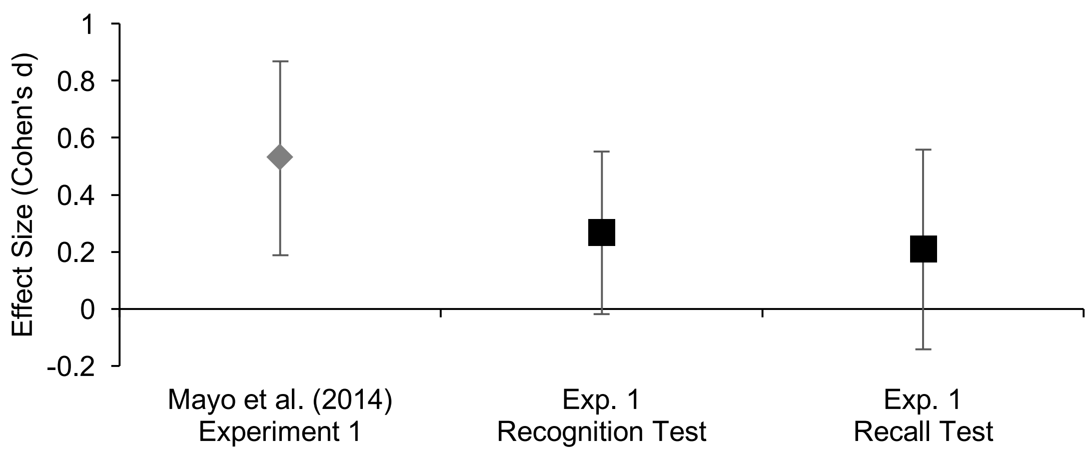

Figure 2. Effect sizes with 95% confidence intervals for Mayo et al. (2014), Experiment 1A (recognition test), and Experiment 1B (recall test).

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CHAPTER 3: EXPERIMENT 2

Experiment 2 attempted a direct replication of Mayo et al.'s (2014) Experiment 1, using the original stimuli and test materials. Following the failed conceptual replication, I contacted the primary author and requested her materials. I also clarified the type of filler task and items used as lures on the final recognition test to elaborate on the concise description provided in the original article. The primary author reviewed the procedure to verify the similarity between my proposed method and the complete method used in the original experiment. Experiment 2 was thus a direct replication using the translated materials (from Hebrew to English) published in the original paper, as well as those obtained from the primary author. This study was pre-registered via the Open Science Framework prior to beginning data collection as part of the Pre-Registration Challenge (osf.io/p2qfv; Spies et al., 2012). As I pre-registered only a laboratory sample, I will first present the results for the pre-registered sample (Experiment 2a) and then discuss the additional unregistered online sample (Experiment 2b).

Method

Sampling Plan and Participants. The sampling plan was based on a power analysis to detect a small to medium effect size. Using G*Power 3.1 (Faul et al., 2009), a planned sample size of $n = 68$ was calculated to achieve power of 0.90 using a two-tailed dependent t-test, given a small to medium effect size.

In total, the pre-registered laboratory sample (Experiment 2a) was comprised of 75 students (45.3% male) from Iowa State University, who participated in this experiment for partial course credit. Mean age was 19.54 ($SD = 1.05$). Due to a program error, demographic information is missing for one subject. Data from ten subjects was

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excluded from analysis due to subjects being non-native English speakers (*N* = 9) or being identified as multivariate outliers via Mahalanobis distance (*N* = 1; Tabachnick & Fidell, 1996)[4].

Additionally, 80 subjects (41.40% male) completed an unregistered online sample (Experiment 2b) via Amazon's Mechanical Turk. Mean age was 35.49 (SD = 10.49). Workers were paid $1.00 to complete the task. Data from ten subjects were excluded from the online sample for failing to respond correctly to attention checks.

Materials. This experiment was presented to subjects in the laboratory using E-Prime 2.0™, and to subjects on Mechanical Turk via Qualtrics. The video presented in this study involves an 8 min, 15 s video provided by the primary author of the original experiment (Mayo et al., 2014). The video depicted a tour of the upstairs and downstairs portions of a digitally simulated apartment. Present in the video were a number of everyday household objects. The original experiment instructions and test items used in Experiment 2 can be found in Appendix C and Appendix D, respectively. Four different randomizations of the initial test were programmed and counterbalanced across participants.

Design and Procedure. This study was a fully within-subjects design, manipulating yes-no responses to statements on an initial memory test. Only slight variations in the procedure were present in the online study (when compared with the

[4] The original study eliminated the few subjects who erred in more than 50% of initial memory test statements. The registration overlooked the exclusion of these subjects. I performed the analyses with these subjects (*N* = 6) and without, and the conclusions did not change. To be consistent with the pre-registration, the results presented here include the 6 subjects who were less than 50% accurate on the initial memory test.

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laboratory version). Subjects provided informed consent and were told that they would view a brief film and answer questions about it. Prior to beginning the experiment, subjects in the online sample also answered a set of attention check questions (e.g., “Who is the current president of the United States?”) to ensure that subjects attended throughout the duration of the study. With the exception of an additional set of attention check questions present after the filler task was completed, the remainder of the procedure did not differ between the laboratory and online samples.

After receiving instructions for how to proceed, subjects were instructed to view the stimulus video. They were then told that they would complete a short memory task involving a series of sentences. The task was comprised of 16 feature statements that described either congruent features of objects in the apartment, and were thus correctly answered with “yes” responses, or incongruent features of objects in the apartment, and were thus correctly answered with “no” responses. The questions were randomly split twice, and in each random split the correct “yes” and “no” responses were counterbalanced, resulting in four randomization conditions. After responding to all 16 statements, participants completed a 20-minute unrelated filler task comprised of a word-construction task in which participants were presented with 15-character words in English (e.g., “overadjustments”) and were instructed via the computer program to generate as many new words as possible using only the letters in the given base word (e.g., “random”, “mentors”, etc.). Subjects were given 4 min to generate as many words as possible for each of five base words.

Once all five base words had been completed, subjects were administered a final object recognition test in which they were presented with a series of object labels (e.g.,

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"chair") and asked to indicate whether the object was seen in the video. Items on the final test included the 16 tested objects on the initial memory test, as well as 16 novel objects that were not featured in the video. The 32 objects on the final test were identical to those used by Mayo and colleagues (2014). After completing the final test, subjects were debriefed and dismissed from the study.

Results – Experiment 2A

Initial Memory Test. The initial memory test consisted of 16 statements pertaining to features of objects seen in the apartment video. Half of the statements described correct features of the objects and required "yes" responses; the other half described incorrect features of the objects and were correctly answered with "no" responses. Accuracy on the initial memory test refers to the proportion of correct "yes" and "no" responses to the feature statements. Subjects were more accurate for statements requiring a "no" response ($M = .75$, $SE = .02$) than for statements requiring a "yes" response ($M = .65$, $SE = .03$), $t(64) = 3.07$, $p = .003$, $d = 0.53$ [.18, .88]. This effect is inconsistent with Mayo et al. (2014) – there was no difference between "yes" and "no" response accuracy on the initial test in the original experiment.

Final Memory Test. The final memory test consisted of 32 object labels pertaining to 16 tested objects that were present in the video, as well as 16 novel objects that were not present in the video. Subjects indicated whether the object was present or not present in the apartment that they viewed. Accuracy on this final test was calculated as the proportion of the 32 test items correctly indicated as being present (critical items) or not present (lure items) in the video. Subjects were mostly accurate on this test ($M = .85$, $SD = .19$).

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The measure of primary interest is that of *errors* on the final memory test: objects that were present in the video that were incorrectly categorized as "not present" on the final memory test. This measure was conditionalized for accuracy on the first test, such that only items that subjects correctly answered with "yes" or "no" on the initial memory test were included in the analysis. For both "yes" and "no" responses, the proportion of target objects that were correctly responded to on the initial memory test but were not recognized as having been present on the final test was calculated. Consistent with Mayo et al. (2014), subjects demonstrated a significant negation effect such that target objects associated with "no" responses ($M = .14$, $SE = .02$) produced more errors in memory, compared to target objects associated with "yes" responses ($M = .07$, $SE = .02$), $t(64) = 3.08$, $p = .003$, $d = 0.50$ [.17, .82]. An estimated BF_{10} of 11.16 suggests strong evidence for the alternative hypothesis (the presence of a negation effect) for a subject-level analysis. An item-level analysis was conducted separately to determine if the negation effect was present across the 16 target items. A paired-samples t-test found only a marginally significant negation effect, $t(15) = 2.01$, $p = .06$, $d = .60$ [-.04, 1.23] [5]. An estimated BF_{10} of 1.26 suggests anecdotal evidence for an item-level negation effect in the laboratory sample.

Results – Experiment 2B

Initial Memory Test. With regard to the initial memory test involve yes-no responses, accuracy was again greater for statements requiring a "no" response ($M = .66$, $SE = .02$) than for statements requiring a "yes" response ($M = .56$, $SE = .03$), $t(69) = 2.51$,

[5] The registration also overlooked the item-level analysis. I present it here to be consistent with the results presented in Mayo et al. (2014).

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p = .014, d = 0.46 [.09, .82]. Although this effect is inconsistent with Mayo et al. (2014), it replicates what was observed in the laboratory sample in Experiment 2A.

Final Memory Test. Performance on the final memory test was assessed with the same measure of conditionalized errors. For each item type (yes, no), a proportion was calculated of objects that were correctly answered on the first test, but were incorrectly categorized as "not present" on the final memory test. Similar to the laboratory sample, subjects demonstrated a significant negation effect: objects associated with "no" responses (M = .16, SE = .02) produced more errors in memory, compared to objects associated with "yes" responses (M = .08, SE = .02), $t(69) = 2.54$, p = .014, d = 0.41 [.17, .65]. An estimated BF_{10} of 3.04 suggests substantial evidence for the alternative hypothesis (the presence of a negation effect) for this subject-level analysis. An item-level analysis was conducted separately to determine if the negation effect was present across the 16 target items. A paired-samples t-test found a significant negation effect, $t(15) = 2.88$, p = .01, d = .88 [.19, 1.55]. Objects associated with a "no" response were more likely to be incorrectly responded to as "Not Present" (M = .16, SE = .03) than were objects associated with a "yes" response (M = .07, SE = .02). On an item-level, an estimated BF_{10} of 4.90 suggests substantial evidence for the presence of the negation effect.

Results – Combined Samples Analysis (Experiments 2a and 2b)

The same pattern of results on the final test was observed for both the laboratory (Experiment 2a) and online (Experiment 2b) samples, as confirmed by a 2 x 2 mixed model ANOVA assessing the influence of sample (laboratory, online) and response to feature statements (yes, no) on conditionalized final memory test errors. No main effect

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of sample was observed, $F(1, 133) = .23$, $p = .63$, nor an interaction between yes-no response and sample, $F(1, 133) = .01$, $p = .94$. However, consistent with the original Mayo et al. (2014) study, a significant negation effect was found such that target objects associated with "no" responses ($M = .15$, $SE = .02$) produced more errors in memory compared to target objects associated with "yes" responses ($M = .08$, $SE = .01$), $F(1, 133) = 14.93$, $p < .001$, $d = 0.45$ [0.21, 0.68]. An estimated BF_{10} of 124.10 suggests that the data were 124.10 times more likely under the alternative hypothesis, which exceeds the threshold for decisive evidence (greater than $BF_{10} = 100$) of the negation effect.

An item-level analysis was conducted separately to determine if the negation effect was present across the 16 target items. A paired-samples t-test found a significant negation effect, $t(15) = 2.70$, $p = .02$, $d = .81$ [.27, 1.34]. On an item-level, more items associated with "no" responses ($M = .16$, $SE = .03$) were erroneously indicated as Not Present on the final test than were items associated with "yes" ($M = .08$, $SE = .02$) responses.

Discussion

Experiment 2 was a direct replication of the negation-induced forgetting effect using Mayo et al.'s (2014) original materials and instructions from Experiment 1. In addition to the pre-registered laboratory sample (Experiment 2a), an online sample using Amazon's Mechanical Turk was included (Experiment 2b). The primary interest was in replicating the negation effect; however, I was also interested in examining the difference in effect size between the Mechanical Turk sample and a traditional laboratory sample. Numerous studies have demonstrated Mechanical Turk's validity as a data collection tool (e.g., Mason & Suri, 2012). The observed negation effect did not significantly differ

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across the samples: the laboratory sample demonstrated a slightly larger effect size, d = .50 [.17, .82], when compared with the online sample, d = .41 [.17, .65], however, the confidence intervals suggest the magnitude of the effect does not differ between the samples (see Figure 3). These findings add further support to the validation of Amazon's Mechanical Turk as an effective pool of subjects.

In recent years, replication has become a priority in psychological research, including establishing guidelines for conducting replications (e.g., the "replication recipe," Brandt et al., 2014). I was able to replicate the negation effect using the original stimulus and test materials from Mayo and colleagues. Although the observed effect size was marginally smaller in magnitude, the upper limit of the confidence interval encompasses the observed effect size from the Mayo et al. (2014) Experiment 1 (see Figure 3). Thus, this replication is best described as a *successful* replication: the effect size of the replication was significantly different from the null, and similar to the original effect size.

While the Mayo et al. (2014) paradigm is effective in producing the negation effect, there may be external factors that influenced the size of the effect produced in the present replication. Most notably is the potential influence of language. The original study was conducted in Hebrew, while the materials in publication and those provided by the author involved translations into English. However, I cannot identify a theoretical reason that language differences would have resulted in a smaller effect size. Another general limitation is that Mayo and colleagues did not collect confidence or memory basis judgments. Following the successful replication of the effect, I returned to a list-learning paradigm to examine potential moderators of the negation effect.

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Table 2

Means for final memory test errors in Experiment 2

Experiment	After "yes" Mean	*SD*	After "no" Mean	*SD*
Experiment 2A	.07	.15	.14	.15
Experiment 2B	.08	.18	.16	.19
Combined Samples	.08	.16	.15	.17

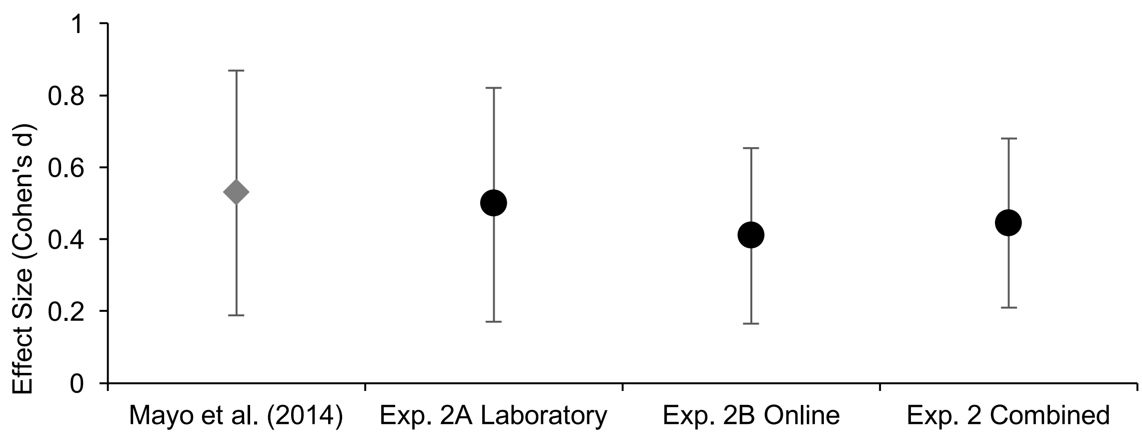

Figure 3. Comparison of effect sizes (Cohen's *d*) for the direct replication in a laboratory (Experiment 2A) and online (Experiment 2B) samples.

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CHAPTER 4: EXPERIMENT 3

Following the failure to demonstrate a negation effect in Experiments 1A and 1B, I corresponded with the primary author and more closely examined the procedures and materials used in Mayo et al. (2014). Upon reviewing the stimulus video shown to participants in the original study, I hypothesized that the discrepant findings between the original experiment and the conceptual replication may have been related to differences in how the stimuli were presented to subjects. Specifically, Mayo et al. (2014) demonstrated a significant negation effect using a video tour of an apartment. This video included a large number of household objects and furniture, 16 of which were chosen to be tested after the presentation of the video. I estimated that for every object that was tested, there were 3 to 4 items present within the apartment that were not tested.

The replication efforts in Experiment 1 utilized the same basic principles of the paradigm in Mayo et al. (2014) – a number of objects presented to subjects, followed by an initial memory test, then a 20-minute filler task, and lastly a final memory test. However, the paradigm in Experiment 1 did not include additional non-tested items during the study task. The presence of the non-tested objects in the Mayo et al. (2014) paradigm may have resulted in an increased memory load for those subjects that was not present in the Experiment 1 single-item presentation paradigm. That is, subjects' task in Mayo et al. (2014) may have been more difficult due to encoding necessarily being distributed over more items (both the target items and the non-tested items). In the misinformation literature, people have been shown to be more susceptible to misinformation when memory quality is degraded, due to factors such as the passage of time (e.g., Loftus, Miller & Burns, 1978) or centrality at encoding (e.g., Wilford, Chan, &

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Tuhn, 2014; or Wright & Stroud, 1998). Following this logic, the distribution of encoding over more items in Mayo et al. (2014) may have resulted in decreased memory strength for those participants. Experiment 3 thus varied the number of items present at encoding in order to determine if the magnitude of the negation effect would be greater for subjects with an increased memory load, presumably weakening the strength of subjects' memory.

A second factor that I examined as a possible moderator of the negation effect relates to the potential number of alternatives associated with a response to a yes-no question. The effect of negation on attention has been shown to be differentially influenced when the negation context implies two alternatives or multiple alternatives (Orenes et al., 2014). When multiple alternatives were suggested by a context, subjects were more likely to direct their attention in a manner that facilitated negation effects. Further, negated behavioral descriptions associated with less accessible opposing constructs (i.e., with multiple alternatives) have been shown to be more susceptible to memory errors than descriptions associated with easily available opposing constructs (Mayo et al., 2004). To examine this factor in Experiment 3, I varied the number of alternatives that a yes-no question prompted. On the initial memory test, I manipulated whether the feature statement had a pre-defined opposite construct that easily comes to mind (e.g., "not open" → "closed"), or if the feature statement was instead associated with multiple alternatives (e.g., "not red" → "blue" "green" "purple", etc.). Two-option features statements *did* have an opposite construct accessible (e.g., full/empty, open/closed) and multi-option feature statements *did not* have an accessible opposite representation (e.g., colors, shapes, type). Given the previous findings that negations associated with multi-option constructs can paradoxically increase attention to a negated

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object (Orenes et al., 2014) and can lead to more meaning-based memory errors (Mayo et al, 2004), I hypothesized that negations associated with multiple alternatives would result in more errors on the final memory test. To my knowledge, this factor has not been tested within an object recognition paradigm, thus precluding a more sophisticated theoretical prediction.

Method

Participants. Using G*Power 3.1 (Faul et al., 2009), I calculated a planned sample size of n = 136 for achieving power of 0.90 in a within-between interaction using a repeated measures ANOVA, given a small to medium effect size. In total, 190 students (46.3% male) from Iowa State University participated in this experiment for partial course credit. Mean age was 19.35 (SD = 1.05). Due to a program error, demographic information is missing for two subjects. Eleven subjects were excluded from the final analysis for being non-native English speakers (N = 8) or being color-blind (N = 3). After exclusion, the between-subject conditions were not equal, with the load-present condition having slightly fewer (N = 88) than the load-absent condition (N = 91)[6].

Materials and Design. The number of stimuli used in this experiment was increased to 48 images of objects from the Massive Visual Memory Stimuli dataset (Brady et al., 2013). Object images were chosen such that they varied based upon the features of emptiness and openness (two-option features), as well as type, color, and shape (multi-option features). The feature statements created for the studied objects were

[6] I performed the analyses with and without subjects who were less than 50% accurate on the initial memory test (N = 6), and the results did not change.

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administered via pre-recorded audio files of a female speaker reading the statements aloud. Each statement recording was between 2500ms and 3500ms.

A 2 x 2 x 2 mixed design was used to assess the influence of memory load (present or absent), number of possible alternatives (two-option or multi-option), and response to feature statements (yes or no) on object memory. Memory load was manipulated between-subjects, allowing for an experimental assessment of the 4:1 ratio of distractor objects to target objects I estimated from the Mayo et al. (2014) stimulus video. Half of the subjects in Experiment 3 encoded only the 48 tested objects (load-absent condition), and the other half studied the 48 tested objects and 144 additional distractor objects (load-present condition). The variables number of possible alternatives and responses to the feature statements were both manipulated within-subjects. Object memory was assessed via performance on a final recognition test wherein subjects indicated that an object was "Present" or "Not Present" from the study phase.

For each memory load group, subjects encountered one of four types of questions per trial: *yes, multi-option* (questions that elicit a "yes" response and did not call to mind a specific opposing representation of a construct; e.g., "The canister was pink"); *yes, two-option* (questions that elicit a "yes" response and are associated with an easily accessible opposing construct; e.g., "The mp3 player was turned on"); *no, multi-option* (questions that elicit a "no" response and do not call to mind a particular opposing representation of a construct; e.g., "The street sign was rectangular"); and *no, two-option* (questions that elicit a "no" response and are associated with an easily accessible opposing construct; e.g., "The pencil cup was empty"). See Appendix E for the full set of questions that were used in Experiment 3.

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Procedure. The experiment was divided into three phases: a study phase, an initial test phase, and a final test phase. The initial test and final test phases were separated by a 20-min filler task. Subjects were randomly assigned to either the load-present or load-absent conditions.

Prior to the beginning the experiment, subjects provided informed consent and were instructed that they would be asked to study a set of pictures of objects. Subjects then began the study phase, during which they studied either 48 objects (load-absent) or 196 objects (load-present) for 1000ms[7] each, with a 1000ms ISI between object presentations. After studying all of the objects, subjects began the initial memory test. This test was comprised of 48 feature statements that required a yes/no response. Half of the statements were correctly responded to with "yes" and half were correctly responded to with "no." Further, half of the feature statements referred to a multi-option construct while the remaining half referred to a two-option construct. Questions were counterbalanced so that across the experiment, each object was associated with each response type (yes or no). After responding to all 48 features statements, subjects completed the same word-construction filler task used in Experiment 2 (cf. Mayo et al., 2014).

The final test phase followed the 20-min filler task period. Subjects completed an object recognition test comprised of 96 object labels that they were to categorize as "Present" or "Not Present" in the study phase. Forty-eight of the object labels

[7] Various encoding times were pilot tested in Experiment 1, ranging from 5000ms to 250 ms. Encoding time variations did not drastically alter initial test accuracy (83% to 92%) but did often lead to ceiling effects for final test accuracy (87% to 93%) that may have prevented the detection of a negation effect.

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corresponded to the 48 target objects from the study phase for both the load-absent and load-present conditions, and would thus be correctly categorized as “Present”. The remaining 48 object labels on the final test corresponded to novel filler objects that were neither target objects nor distractor objects (in the load-present condition), and would thus be correctly categorized as “Not Present”. For each judgment, subjects were asked to indicate their confidence in that decision on a half-range scale of 50% to 100% in 10%-increments. Further, for objects categorized as “Present” subjects were asked to indicate the basis (i.e., remember, know or guess) on which they made that recognition decision. Prior to beginning the test, subjects were given instructions as to what constituted a “Remember” vs. a “Know” judgment. These instructions were adapted from the instructions used in Meissner, Brigham, and Butz (2005) and can be found in Appendix F. When subjects completed the final recognition test, they were debriefed and dismissed from the study.

Results

Initial Memory Test. The initial memory test consisted of 48 statements pertaining to features of objects that were presented in the study phase. Half of the statements described correct features of the objects and required “yes” responses; the other half described incorrect features of the objects and were correctly answered with “no” responses. Additionally, half of the statements referred to a feature with multiple alternatives, and half referred to a feature with two alternatives. A 2 x 2 x 2 mixed-model ANOVA was used to assess the influence of memory load (present, absent), number of possible alternatives (two-option, multi-option), and response to feature statements (yes, no) on the proportion of correct “yes” and “no” responses to the feature statements. As

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expected, subjects in the load-absent condition (*M* = .75, *SE* = .01) performed significantly better on the test than subjects in the load-present condition (*M* = .67, *SE* = .01), $F(1, 177) = 23.68$, $p < .01$, $\eta_p^2 = .12$. Subjects were also significantly more accurate when feature statements referred to multi-option features (*M* = .72, *SE* = .01) rather than two-option features (*M* = .70, *SE* = .01), $F(1, 177) = 5.94$, $p = .02$, $\eta_p^2 = .03$. Finally, as found previously, subjects were more accurate for statements requiring a "no" response (*M* = .72, *SE* = .01) than for statements requiring a "yes" response (*M* = .70, *SE* = .01), $F(1, 177) = 4.11$, $p = .04$, $\eta_p^2 = .02$. Neither the three-way interaction ($F(1, 177) = 2.59$, $p = .11$, $\eta_p^2 = .01$), the response x load interaction ($F(1, 177) = .36$, $p = .55$, $\eta_p^2 < .01$), the number of alternatives x load interaction ($F(1, 177) = 1.38$, $p = .24$, $\eta_p^2 < .01$), nor the response x number of alternatives interaction ($F(1, 177) = .03$, $p = .86$, $\eta_p^2 < .01$) were significant.

Final Memory Test. The primary measure of interest on the 96-item final object recognition test involved *conditionalized errors* in performance – that is, studied objects that were correctly answered on the initial test, but incorrectly categorized as "Not Present" on the final test. A 2 x 2 x 2 mixed-model ANOVA assessed the influence of memory load (present, absent), number of possible alternatives (two-option, multi-option), and response to feature statements (yes, no) on the proportion of studied objects incorrectly categorized as "Not Present' on the final memory test. This proportion was conditionalized by accuracy on the first test, such that only objects that subjects had correctly responded to on the initial memory test were included in the final proportion. The number of alternatives associated with a feature did not significantly contribute to final memory test errors, $F(1, 177) = .69$, $p = .41$, $\eta_p^2 < .01$; however, main effects of

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memory load and negation were observed. Specifically, subjects in the load-present condition made significantly more errors on the final memory test (*M* = .18, *SE* = .02) than did subjects in the load-absent condition (*M* = .11, *SE* = .02), $F(1, 177) = 8.80$, $p = .003$, $\eta_p^2 = .05$. Subjects demonstrated a significant negation effect, such that objects that were associated with a "no" response were less likely to be correctly remembered (*M* = .18, *SE* = .01) than objects that were associated with a "yes" response (*M* = .12, *SE* = .01), $F(1, 177) = 33.53$, $p < .001$, $d = 0.36$ [.23, .48].

Memory load did not moderate the negation effect, as evidenced by the non-significant memory load x response type interaction, $F(1, 177) = 2.72$, $p = .10$, $\eta_p^2 = .02$. However, there was a significant number of alternatives x response type interaction, $F(1, 177) = 4.86$, $p = .03$, $\eta_p^2 = .03$. There was no difference in conditionalized errors after a correct "yes" response on the initial test for objects tested with two-option feature statements (*M* = .12, *SE* = .01) or with multi-option feature statements (*M* = .11, *SE* = .01), $t(178) = .91$, $p = .37$. However, there was a significant increase in errors after a correct "no" response for objects tested with multi-option feature statements (*M* = .19, *SE* = .01), compared to objects tested with two-option feature statements (*M* = .16, *SE* = .02), $t(178) = 2.14$, $p = .03$ (see Figure 4). The effect size for feature statements regarding a multi-option construct, $d = 0.43$ [.29, .58], was twice that of the effect for statements regarding a two-option construct, $d = 0.20$ [.06, .34], though both proved significant effects. Neither the number of alternatives x load interaction ($F(1, 177) = .07$, $p = .79$, $\eta_p^2 < .01$) nor the three-way interaction ($F(1, 177) = 1.12$, $p = .29$, $\eta_p^2 < .01$) were significant.

Bayesian paired-samples t-tests were conducted separately for the multi-option and two-option constructs. Again, the Cauchy prior used in calculating the factors was

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0.53, the effect size present in the Mayo et al. (2014) study. An estimated BF_{10} of 5.45 in the two-option condition suggested that the data were 5.45 times more likely under the alternative hypothesis (negation effect), which is substantial evidence. For feature statements associated with a multi-option construct, a BF_{10} of well over 100 (1,694,000) suggested that the data were decisive evidence for the presence of the negation effect.

An item-level analysis was also conducted to determine if the negation effect was present across the 48 target items. A 2 x 2 x 2 mixed-model ANOVA was used to compare the influence of memory load (present, absent), number of possible alternatives (two-option, multi-option), and response to feature statements (yes, no) on the measure of conditionalized errors on an item-level. There was no main effect of number of alternatives, $F(1, 92) = .09$, $p = .77$. However, there was a main effect of memory load, $F(1, 92) = 13.50$, $p < .001$, $d = 0.75$ [.33, 1.16]. Similar to the subject-level analysis, there were significantly more conditionalized errors for subjects in the load-present condition ($M = .17$, $SE = .01$) than in the load-absent condition ($M = .11$, $SE = .01$). A significant negation effect was observed, $F(1, 92) = 30.43$, $p < .001$, $d = 0.69$ [.39, .99]. Objects associated with a "no" response on the initial memory test produced more memory errors ($M = .17$, $SE = .01$) than did objects associated with a "yes" response on the initial memory test ($M = .11$, $SE = .01$). On an item-level, an estimated BF_{10} of 2419 suggested there is decisive evidence for the presence of a negation effect.

The other measure of interest assessed subject's phenomenological memory basis (i.e., RKG judgments) for correctly recognized objects on the final memory test. Several data points were missing for subjects who did not correctly recognize any objects associated with multiple alternatives ($N = 1$) or with two alternatives ($N = 2$) following a

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correct "no" response on the initial test. Subjective memory basis judgments (remember, know, or guess responses) were provided by subjects for all "Present" responses; here, I consider only the basis judgments associated with accurate recognition of studied objects as having been studied. Know judgments were again corrected using the independence remember-know procedure (Yonelinas & Jacoby, 1995). A 2 x 2 x 2 mixed-model ANOVA was used to assess the influence of memory load (present, absent), number of possible alternatives (two-option, multi-option), and response to feature statements (yes, no) on the proportion of correct recognition judgments based on "*remembering*". There was a significant effect of memory load, $F(1, 177) = 11.16$, $p = .001$, $d = 0.49$ [.19, .79]. Subjects in the load-absent condition based more correct recognition decisions on recollection ($M = .74$, $SE = .03$) than did subjects in the load-present condition ($M = .62$, $SE = .03$). There was also significant effect of response type, $F(1, 177) = 19.61$, $p < .001$, $d = .18$ [.08, .28]. Correct recognition of objects that received a "yes" response on the initial test were based more on recollection ($M = .71$, $SE = .02$) than were objects that received a "no" response on the initial test ($M = .65$, $SE = .02$). There was no effect of number of alternatives on recollection-based accurate recognition, $F(1, 177) = 1.52$, $p = .22$, $\eta_p^2 < .01$. Neither the three-way interaction ($F(1, 177) = .19$, $p = .66$, $\eta_p^2 < .01$), the response x load interaction ($F(1, 177) = 3.24$, $p = .07$, $\eta_p^2 = .02$), the number of alternatives x load interaction ($F(1, 177) = .19$, $p = .66$, $\eta_p^2 < .01$), nor the response x number of alternatives interaction ($F(1, 177) = .62$, $p = .43$, $\eta_p^2 < .01$) were significant.

A 2 x 2 x 2 mixed-model ANOVA was also used to assess the influence of memory load (present, absent), number of possible alternatives (two-option, multi-option), and response to feature statements (yes, no) on the proportion of correct

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recognition judgments based on "*knowing*". The present manipulations had no effect on these familiarity-based judgments. There was no main effect of memory load, $F(1, 177) = 1.66$, $p = .20$, $\eta_p^2 < .01$; nor of number of alternatives, $F(1, 177) = 3.21$, $p = .08$, $\eta_p^2 = .02$; nor of response type, $F(1, 177) = 3.36$, $p = .07$, $\eta_p^2 = .02$. Neither the three-way interaction ($F(1, 177) = .04$, $p = .84$, $\eta_p^2 < .01$), the response x load interaction ($F(1, 177) = 1.95$, $p = .16$, $\eta_p^2 = .01$), the number of alternatives x load interaction ($F(1, 177) = 1.21$, $p = .27$, $\eta_p^2 < .01$), nor the response x number of alternatives interaction ($F(1, 177) = .03$, $p = .87$, $\eta_p^2 < .01$) were significant.

Discussion

In Experiment 3, I returned to a list-learning paradigm to examine the potential role of memory load at encoding and number of alternative features as moderators of the negation effect. Using this paradigm, I successfully replicated the negation effect as seen in previous studies, though not of the same magnitude. The measures of subjective memory basis suggest that the negation effect in Experiment 3 may be related to diminished recollection for objects associated with "no" responses. Additionally, the data show that the number of alternatives associated with a feature can influence the magnitude of the negation effect. When a feature statement elicited a correct "no" response, objects tested with a multi-option feature were less likely to be recognized as having been seen before than objects associated with a two-option feature. This suggests that an object representation without a pre-defined alternate (i.e., a multi-option feature) is particularly susceptible to the negation effect. In contrast, the presence of memory load at encoding only increased errors overall, and did not significantly moderate the magnitude of the negation effect itself.

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Table 3

Means for final test measures in Experiment 3 in the Load-Absent condition

	After "yes"				After "no"			
	Two-option		Multi-option		Two-option		Multi-option	
Measure	Mean	*SD*	Mean	SD	Mean	SD	Mean	SD
False Rejection								
Errors	.09	.12	.09	.09	.13	.10	.14	.12
Confidence	3.11	1.44	3.13	1.58	3.14	1.53	3.10	1.53
Accurate Recognition								
Response Latency	1624	416	1623	372	1634	388	1694	377
Confidence	5.46	.77	5.48	.82	5.38	.86	5.33	.91
Remember	.74	.28	.78	.28	.72	.25	.73	.26
Know (Corrected)	.56	.46	.49	.47	.66	.43	.58	.45

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Table 4

Means for final test measures in Experiment 3 in the Load-Present condition

	After "yes"				After "no"			
	Two-option		Multi-option		Two-option		Multi-option	
Measure	Mean	*SD*	Mean	SD	Mean	SD	Mean	SD
False Rejection								
Errors	.15	.20	.13	.18	.20	.24	.24	.23
Confidence	2.72	1.43	2.80	1.71	2.53	1.60	2.62	1.41
Accurate Recognition								
Response Latency	1591	430	1668	552	1683	461	1767	666
Confidence	5.21	.98	5.35	.84	4.96	1.09	5.03	.97
Remember	.65	.31	.67	.30	.58	.32	.58	.30
Know (Corrected)	.63	.43	.62	.44	.65	.41	.62	.41

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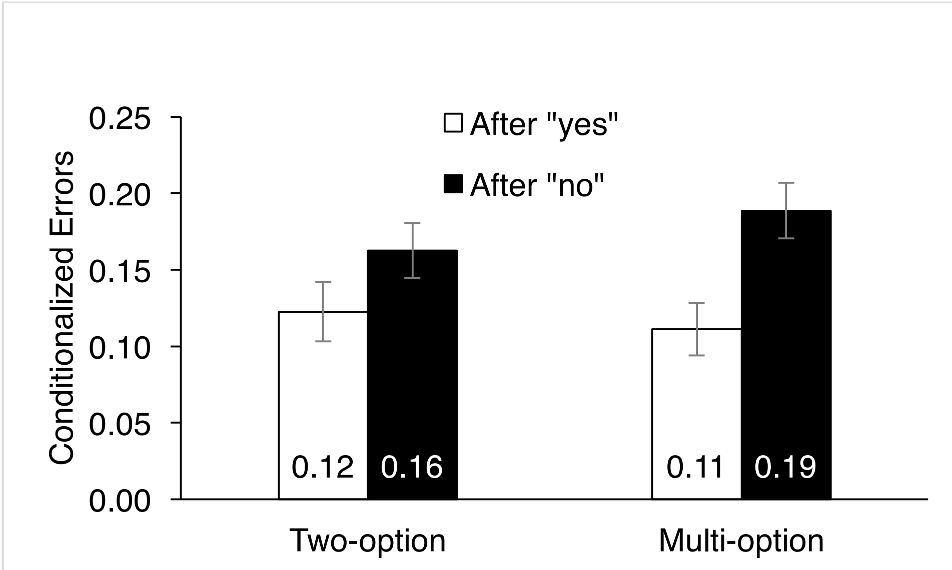

Figure 4. Size of negation effect (yes-no difference) for the different number of alternatives suggested by a feature statement (two-option, multi-option). Error bars represent 95% within-subjects confidence intervals.

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CHAPTER 5: GENERAL DISCUSSION

The negation effect refers to the comparative detriment associated with saying "no" to a question or statement, versus saying "yes" to a question or statement. A large body of literature on language comprehension has examined how negations are differentially represented and understood. Several studies have also examined negation effects in terms of attention. However, only recently has negation been explored with respect to memory for objects. The current experiments thus sought to supplement this dearth in research by replicating and assessing potential moderators of the negation effect in object recognition.

Replicability of the Negation Effect

Overall, these studies show that a negation effect in memory *is* a replicable finding – items associated with a "no" response on an initial test were less likely to have been remembered on a final test, compared to items associated with a "yes" response on the initial test. Experiment 1 used a list-learning paradigm to conceptually replicate the "negation-induced forgetting" effect present in Mayo et al. (2014). The results revealed a non-significant memory impairment for objects associated with "no" responses; however, the effect size was within the lower bounds of the confidence interval associated with the original study. Experiment 2 was conducted in accordance with established best practices for conducting replications, outlined by the "replication recipe" (Brandt et al., 2014). I corresponded with the primary author to ensure that the proposed replication procedure matched that of the original study (Ingredient #1), as well as to obtain the materials used in that study (Ingredient #2). Further, I conducted a power analysis to ensure high statistical power to detect the effect (Ingredient #3). The replication study was pre-

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registered with the Open Science Framework, thus making complete details about the replication available to interested parties (Ingredient #4). Using these replication guidelines, significant negation effects were observed for both a laboratory sample (2a) and an online sample (2b). The effect size for the online sample was smaller than the effect size originally demonstrated by subjects in Experiment 1 of Mayo et al. (2014). Experiment 3 involved a return to the list-learning paradigm to investigate two potential moderators of the negation effect: the number of alternatives associated with a construct (two-option, multi-option), and memory load at encoding (absent, present). Although inducing memory load at encoding did not influence the magnitude of the observed negation effect, objects tested with multi-option constructs on the initial test demonstrated a larger negation effect than did objects tested with two-option constructs.

An average weighted effect size analysis, using a random effects model, was conducted based on the present studies and samples (Exp. 1A and 1B, Exp. 2A and 2B, Exp. 3). There was a small to medium effect size across the present studies ($k = 5$, $N = 395$, $d = 0.37$ [0.28, 0.47]). Additionally, a meta-analytic Bayes factor (BF_{10}) was computed by a weighted effect size analysis of the Bayes factors reported in the present studies. The observed meta-analytic Bayes factor was much greater than 100, suggesting that the data strongly supports the existence of a negation effect, as opposed to the null hypothesis of no effect. The original effect size of $d = 0.53$ reported by Mayo et al. (2014) was not encompassed in the average weighted effect size (see Figure 5); however, this is not unique to this replication endeavor – replications following the first reported effect size often produce weaker evidence (Open Science Collaboration, 2015).

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Theoretical Mechanisms Leading to Negation

Though the purpose of the present studies was to examine the *replicability* of the negation effect, it is also important to examine the underlying mechanism influencing the impairment following a "no" response. However, thus far, the reason that these negations may lead to memory impairment is unclear. Mayo et al. (2014) proposed that, in contrast to inhibition of competing concepts (e.g., *retrieval-induced forgetting*; Anderson, Bjork, & Bjork, 1994), the negation of a feature of an item results in the inhibition of the representation of the whole item. In retrieval-induced forgetting, this inhibition applies to the *nontested* competitive material. However, the spreading inhibition mechanism proposed by Mayo et al. (2014) refers to inhibition of the *tested* material (i.e., the object). Specifically, this mechanism suggests that when a statement describing an incorrect feature is negated, this prompts the formation of a temporary mental representation of that object with the incorrect feature. That transient representation is then wholly suppressed, resulting in the inhibition of that object's representation (with the correct feature) on the later test. Thus, Mayo and colleagues consider their effect in terms of a "spreading inhibition" mechanism, as facilitated by attribute-object relationships that are presented within the tested statements. Negation is proposed to cause the spread of inhibition from the attribute or feature associated with an object, to the object itself. This mechanism does not account for differences in the magnitude of the negation effect based on the number of alternatives associated with a tested feature.

An alternative potential mechanism is based on the consideration of number of alternatives. In Experiment 3, a greater negation effect was observed when a construct implied multiple alternatives rather than two alternatives. Subjects who encountered a

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feature statement that implied multiple possible alternatives likely considered a multitude of these potential attribute-object relationships, which may have led to diminished recollection (and increased uncertainty) for the true attribute-object relationship that was encoded. The two-option feature statements, however, presented subjects with a more absolute scenario that may have reinforced or enhanced their recollection of the encoded attribute-object relationship. Thus, the *two-option* feature statements may function by positioning a subject's memory for an object in a context of "if not *this* object, then *that* object", while the ambiguity associated with *multi-option* feature statements do not lend themselves to that context.

The distinction between two-option and multi-option feature statements on the initial memory test may also be conceptualized as analogous to true/false versus multiple-choice test items, respectively. Brown, Schilling, and Hockensmith (199) observed a *negative suggestion* effect – decreased performance on a test following exposure to incorrect alternatives on memory for correct information – that was greater when memory was assessed with a multiple-choice test than with a cued-recall test. Subjects in Brown et al. (1999) completed an initial cued-recall test over trivia facts, and were then administered an interpolated task that re-exposed them to the initially tested items with either no incorrect alternatives shown, three incorrect alternatives shown once, or three incorrect alternatives shown twice. When no incorrect alternatives were shown on the interpolated task, subjects performed better on a second memory test, regardless of delay and the number of alternatives. Further, Roediger and Marsh (2005) examined how the number of lures on an initial multiple-choice test influenced performance on a later memory test. When tested with multiple-choice statements that offered a greater number

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of alternatives (i.e., a 4-alternative multiple-choice item vs. 2-alternative multiple-choice item), subjects produced more of these incorrect alternatives on a final cued-recall test. Exposure to lures on an initial test in Brown et al. (1999) and Roediger and Marsh (2005) thus impaired performance on a final memory test. Consideration of multiple alternatives in the negative suggestion effect studies (as well as the present thesis studies) may have resulted in decreased confidence in the correct response and destabilization of the memory trace.

A possible moderator that was not explored in the present studies relates to the attentional centrality of an item. All of the items in the conceptual replications (Exp. 1 and Exp. 3) were *centrally* framed at encoding: in the list-learning paradigm, subjects studied one item at a time in the middle of the screen. Alternatively, the original Mayo et al. (2014) Experiment 1 paradigm (and the present Exp. 2) used a video in which centrality of, and attention to, the items in the scene could vary. Subjects in the Mayo et al. (2014) paradigm watched a video in which multiple items were present in each frame, and thus subjects could choose which objects in the video to attend to at any given moment. Subjects were encouraged to attend to and encode all of the items being presented in the list-learning paradigm, while subjects in the Mayo et al. paradigm had more control over the items to which they devote attention. Even using this central framing, subjects demonstrated a negation effect, though it was a small negation-related impairment by both conventional standards and when compared to the original finding. In the misinformation literature, people have been shown to be more susceptible to misinformation for peripheral details rather than central details (e.g., Wright & Stroud, 1998), and this central/peripheral distinction may be due to degraded or inadequate

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encoding, which could preclude monitoring when misinformation is presented. Based on this general finding, it stands to reason that correctly responding "no" may have more of an impairment on later memory when the object in question was presented in a peripheral, rather than a central, manner. Even though errors in Experiment 3 increased overall with the memory load manipulation, degraded encoding in the memory load condition did not influence the magnitude of the negation effect. Thus, if item centrality is defined as differential encoding strength, it is unclear if manipulating centrality will moderate the magnitude of the negation effect or increase errors overall.

Practical Implications of the Negation Effect in Memory

Closed-ended questions are prevalent throughout daily communication. Of particular interest in the current experiments was whether or not the answers to closed-ended questions – e.g., yes/no, true/false – can influence what people remember about an entity or an event. The data here suggest that the answer one gives in response to a statement that elicits either a correct "yes" or a correct "no" *can* lead to deleterious effects in memory.

After a crime occurs, witnesses may be questioned by police investigators in order to provide information about the event. Often these interviews involve asking the witness to provide a detailed account of what happened, which is typically followed by an investigator asking specific questions of the witness (e.g., Snook, Luther, Quinlan, & Milne, 2012). Thinking back to the hypothetical question first posed in the introduction (i.e., "was the baseball cap blue?"), the findings from the present studies suggest that a correct "no" response may render the witness less likely to remember that the perpetrator was wearing a baseball cap at all.

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Conclusions

The present studies offer strong evidence for a negation effect in memory. The number of alternatives associated with a tested construct proved to significantly moderate the magnitude of the impairment, suggesting that the lack of an easily accessible opposite representation increases susceptibility to the negation effect. This susceptibility may be due to inhibition of the object's representation, or due to diminished recollection for the object as a function of the type of tested feature. Future studies should assess the theoretical mechanism underlying the effect, as well as identify and examine potential moderators of the negation effect in memory. Questioning of eyewitnesses serves an important function in an investigation, so it is thus imperative that investigators are aware that some questioning styles can increase the likelihood of a complete and accurate account, while others (e.g., specific questioning) may actually lead to memory deficits.

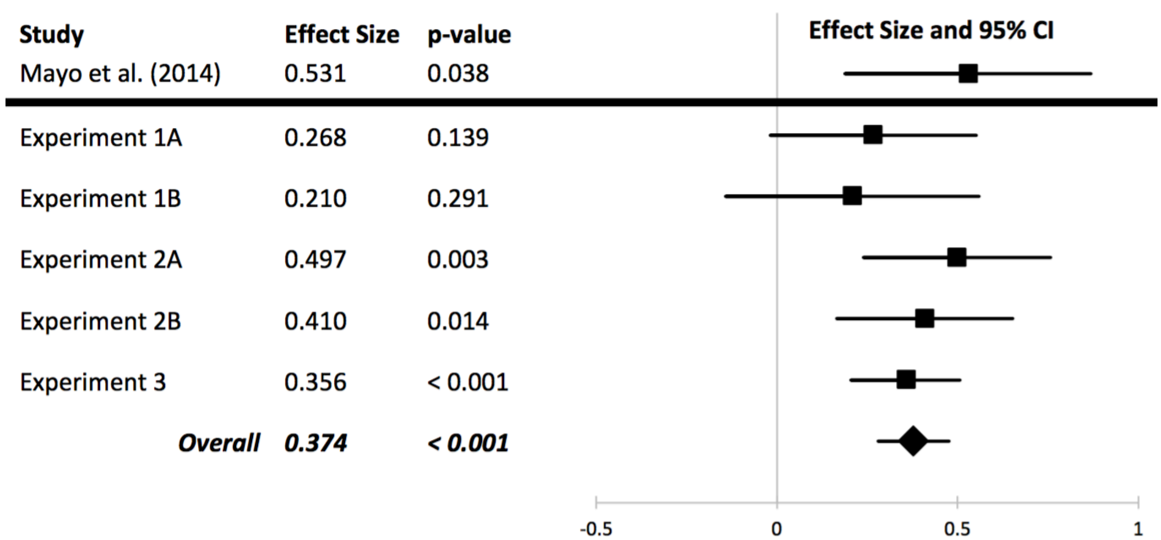

Figure 5. Forest plot of negation effect sizes for Mayo et al. (2014) Experiment 1 and the present thesis studies.

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APPENDIX A

EXPERIMENT 1 QUESTIONS

Initial Memory Test – "Yes"	**Initial Memory Test – "No"**	**Object on final test**
The umbrella was open.	The umbrella was closed.	umbrella
The flag was upright on the mailbox.	The flag was down on the mailbox.	mailbox
The cabinet door was open.	The cabinet door was closed.	cabinet
The notebook was green.	The notebook was blue.	notebook
The coffee mug was full.	The coffee mug was empty.	coffee mug
The plastic cup was red.	The plastic cup was blue.	cup
The belt was brown.	The belt was black.	belt
The cap was off of the highlighter.	The cap was on the highlighter.	highlighter
The wooden bucket was brown.	The wooden bucket was green.	bucket
The coins were silver.	The coins were bronze.	coin
The leather bag was open.	The leather bag was closed.	bag
The balloon was blue.	The balloon was red.	balloon
The anchor was red.	The anchor was black.	anchor
The stand mixer was red.	The stand mixer was green.	mixer
The cooking pot was orange.	The cooking pot was blue.	pot
The bottle was half full of liquid.	The bottle was completely full of liquid.	bottle
The canister was pink.	The canister was yellow.	canister
The chair was reclined.	The chair was upright.	chair
The tent was orange.	The tent was blue.	tent
The lock was a key lock.	The lock was a combination lock.	lock
The couch was green.	The couch was pink.	couch
The book was open.	The book was closed.	book

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The sponge was purple.	The sponge was blue.	sponge
The time on the clock read 9:00.	The time on the clock read 6:00.	clock
The nail polish was green.	The nail polish was purple.	nail polish
There was a loaf of bread inside the breadbox.	The breadbox was empty.	breadbox
The bag of chips was open.	The bag of chips was sealed.	chip bag
The ice cream was in a cone.	The ice cream was in a bowl.	ice cream
The twine was white.	The twine was brown.	twine
The stapler was purple.	The stapler was silver.	stapler
There was writing on the chalkboard.	The chalkboard was blank.	chalkboard
The tennis shoe laces were untied.	The tennis shoe laces were tied.	shoes

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APPENDIX B

EXPERIMENT 1 RKG INSTRUCTIONS

You will see the following 3 options on the screen and choose the one that best describes how you remembered seeing the object.

1. I recollect seeing the object.
2. The object is familiar to me.
3. I am guessing.

Recollection means that you clearly remembered some particular detail about the object, such as the color or size of the object in question. If you used the presence of detail in your memory to decide you had studied the object, choose choice #1, "I recollect seeing the object."

In some cases, the object can feel **familiar** to you, but you cannot remember specific details about the object. If you used familiarity to decide you had studied the object, choose choice #2, "The object is familiar to me."

If you simply **guessed** that you studied the object, choose choice #3, "I am guessing."

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APPENDIX C

EXPERIMENT 2 INSTRUCTIONS

Subjects arrive to the experiment and are given instructions to watch a video:

> "In this experiment, you will view a brief film. You will then answer questions about what you saw in the film."

After viewing the video, participants receive instructions that they will complete a short memory task. The specific instructions for the test are as follows:

> "This experiment includes two apartments. You saw one of them. At this stage, you will see a series of sentences. Your task is to decide whether each sentence refers to the apartment that you have seen or to the other apartment. Please press the "yes" key if the sentence refers to the apartment that you have seen or the "no" key if the sentence refers to the other apartment."

After completing the filler task, participants are presented with a series of object labels (e.g., "chair") and asked to indicate whether the object was seen in the video. The specific instructions are as follows:

> "Your task is to indicate whether each item appeared in the apartment that you have seen or in the other apartment. Please press the "yes" key if you think that the item appeared in the apartment that you have seen or the "no" key if you think that the item appeared in the other apartment."

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APPENDIX D

EXPERIMENT 2 QUESTIONS

Initial Memory Test - "Yes"	Initial Memory Test - "No"	Object on final test
The phone on the wall was a key phone.	The phone on the wall was a dial phone.	phone
The coffee mugs hanging in the kitchen were pink.	The coffee mugs hanging in the kitchen were blue.	coffee mugs
The ashtray was full.	The ashtray was empty.	ashtray
The candleholders by the TV were golden.	The candleholders by the TV were silver.	candle holders
The shopping bag by the sink was empty.	The shopping bag by the sink was full.	shopping bag
The ceiling fan in the living room was "on."	The ceiling fan in the living room was "off."	ceiling fan
The bedside lamp was turned on.	The bedside lamp was turned off.	bedside lamp
The painting in the corridor was a picture of circles.	The painting in the corridor was a picture of squares.	painting
The window shades in the living room were closed.	The window shades in the living room were open.	window shades
The sculpture in the glass cabinet was red.	The sculpture in the glass cabinet was blue.	sculpture
The carpet in the bedroom was in shades of blue.	The carpet in the bedroom was in shades of yellow.	carpet
The pillows on the sofa were red.	The pillows on the sofa were black.	pillows
The sign on the bathroom door had a painting of a person on it.	The sign on the bathroom door had a painting of a duck on it.	sign on bathroom door
The flowerpot by the stairs was big.	The flowerpot by the stars was small.	flowerpot
The dog on the sofa was lying down.	The dog on the sofa was sitting.	dog
The laptop on the coffee table was open.	The laptop on the coffee table was closed.	laptop

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APPENDIX E

EXPERIMENT 3 QUESTIONS

TWO ALTERNATIVES (open/closed, full/empty, up/down/other)

Initial Memory Test – "Yes"	Initial Memory Test – "No"	Object on final test
The umbrella was open.	The umbrella was closed.	umbrella
The cigarette was unlit.	The cigarette was lit.	cigarette
The tennis shoe laces were untied.	The tennis shoe laces were tied.	shoes
The envelope clasp was fastened.	The envelope clasp was unfastened.	envelope
The tissue box was unopened.	The tissue box was opened.	tissue box
The cabinet door was closed.	The cabinet door was open.	cabinet
The clothes hamper was full.	The clothes hamper was empty.	hamper
The mp3 player was turned on.	The mp3 player was turned off.	mp3 player
The book was open.	The book was closed.	book
The altoid tin was open.	The altoid tin was closed.	altoid tin
The pencil cup was full.	The pencil cup was empty.	pencil cup
The dryer door was open.	The dryer door was closed.	dryer
The briefcase was closed.	The briefcase was open.	briefcase
There were letters on the chalkboard.	There were numbers on the chalkboard.	chalkboard
The ice cube tray was empty.	The ice cube tray was full.	ice cube tray
The poker chips were arranged in stacks.	The poker chips were spread out in a pile.	poker chips
The bottle was full of liquid.	The bottle was empty of liquid.	bottle
The coffee mug was empty	The coffee mug was full	coffee mug
The cover of the scanner was up.	The cover of the scanner was down.	scanner
The flag was down on the mailbox.	The flag was upright on the mailbox.	mailbox
The cap was off of the highlighter.	The cap was on the highlighter.	highlighter
The backpack was open.	The backpack was closed.	backpack
The handle was up on the pail.	The handle was down on the pail.	pail
The seat cover was down on the toilet.	The seat cover was up on the toilet.	toilet

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MULTIPLE ALTERNATIVES (color, shape, type)

Initial Memory Test – "Yes"	Initial Memory Test – "No"	Object on final test
The candle was blue.	The candle was red.	candle
The juice was orange juice	The juice was apple juice	juice
The stand mixer was green.	The stand mixer was red.	stand mixer
The belt was brown.	The belt was black.	belt
The stuffed animal was a bear.	The stuffed animal was a dog.	bear
The pitcher had a flower on it.	The pitcher had a spiral on it.	pitcher
The street sign was a diamond shape	The street sign was rectangular	street sign
The notebook was green.	The notebook was blue.	notebook
The ornament was polka-dotted.	The ornament was striped.	ornament
The ball was a baseball.	The ball was a soccer ball.	baseball
The vehicle was a truck.	The vehicle was a sports car.	truck
The cookie cutter was shaped like a bell.	The cookie cutter was shaped like a star.	cookie cutter
The mirror was round	The mirror was rectangular	mirror
The spice jar contained chives.	The spice jar contained oregano.	spice jar
The tabletop on the coffee table was round.	The tabletop on the coffee table was rectangular.	coffee table
The cooking pot was orange.	The cooking pot was blue.	cooking pot
The computer key was an E	The computer key was an A	computer key
The picnic basket had a plaid design.	The picnic basket had a gingham design.	picnic basket
The anchor was red.	The anchor was black.	anchor
The canister was pink.	The canister was yellow.	canister
The beach towels were striped.	The beach towels were solid.	beach towel
The credit card was a Visa.	The credit card was a MasterCard.	credit card
The license plate was from Texas	The license plate was from New York	license plate
The balloon was blue.	The balloon was red.	balloon

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APPENDIX F

EXPERIMENT 3 RKG INSTRUCTIONS

We'd like for you to say that you **REMEMBER** an object if you can remember any specific detail of having studied it. It could be that you remember what it looked like on the screen, or what you thought about as you studied it. If you used the presence of detail in your memory to decide that the object was PRESENT, choose choice #1, "I REMEMBER seeing the object."

At other times in your memory, you may simply **KNOW** that you saw something, but you can't remember any details about it. So an object may seem familiar, but you can't remember any details of seeing it, or any reaction you had to it.

Keep in mind that a KNOW response doesn't necessarily mean you are unsure. You can have a strong feeling that the object is familiar to you, but not remember any specific details about having studied it. If you used familiarity to decide that the object was PRESENT, choose choice #2, "I KNOW that I saw the object."

We are interested in which items you REMEMBER and which items you KNOW were present in the set of objects you studied. If you realize that your answer was just a guess, say GUESS. That is, you cannot remember any details about the object, the object doesn't seem overly familiar to you, but rather you're just hazarding a guess as to whether it was in the study phase.

As a reminder, if you say that the object was **PRESENT**, please describe your memory for that object:

REMEMBER -- I remember details about what the object looked like, or what I thought about as I saw the object in the study phase

KNOW -- I don't remember details, but I have a strong feeling that the object is familiar to me

GUESS -- I don't remember details, or have a strong feeling of familiarity; instead, I'm just
guessing that the object was in the study phase

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APPENDIX G

IRB APPROVAL FOR EXPERIMENTS

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

Date: 4/28/2015

To: Rachel Dianiska
W112 Lagomar

CC: Dr. Christian A Meissner
W112 Lagomarcino Hall

From: Office for Responsible Research

Title: Memory for Actions

IRB ID: 15-216

Approval Date: 4/27/2015 **Date for Continuing Review:** 4/26/2017

Submission Type: New **Review Type:** Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, **including the recruitment materials and informed consent documents that have the IRB approval stamp**.
- **Retain signed informed consent documents for 3 years after the close of the study**, when documented consent is required.
- **Obtain IRB approval prior to implementing any changes** to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- **Immediately inform the IRB of** (1) **all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- **Stop all research activity if IRB approval lapses**, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- **Complete a new continuing review form** at least three to four weeks prior to the **date for continuing review** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

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