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Negation affects processing of correct and incorrect information: A visual world paradigm for misinformation

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NEGATION AFFECTS PROCESSING OF CORRECT AND INCORRECT INFORMATION: A VISUAL WORLD PARADIGM FOR MISINFORMATION

by

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Abstract

The current study investigated how language changes the meaning of facts. Much is known about the acquiring of misconceptions, but little is known about how subtle changes in language affect the retrieval of accurate facts and misconceptions. Participants read vignettes and were exposed to four different kinds of texts that varied by affirmative or negated and whether the fact was true or false. After participants read several of these facts, their eye movements were tracked in a visual world paradigm with 4 written plausible answers on the screen in each corner to choose from. Fixations to each kind of response were recorded and presence of misinformation was found to temper the processing of misconceptions and led to an observed suppression of inaccurate information. Mechanisms of processing true and false concepts and the interplay between language and conceptual formation are discussed.

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We are constantly bombarded with new information from education, television, the Internet, books, and conversation. In today's modern society, where information can be retrieved at the touch of a button or the click of a mouse, it has become even more important to understand the mechanisms that underlie the assimilation and subsequent perpetuation of both accurate and inaccurate information. Especially important is to understand the primary vehicle by which inaccurate information is disseminated: language. The goal of this study was to examine the mechanisms responsible for the retrieval of false information by examining processing as it happens (via eye tracking). The core research question of the current study was whether low-level lexical (contextual) characteristics could influence how a memory trace is formed and how these characteristics interact with long-term memory during decision-making. The extent to which conceptual formation is sensitive to subtle linguistic manipulations is relatively unexplored and is predicted to have an impact on how concepts are formed and accessed.

Role of Language and Negation

Negation is a function of language commonly used to indicate semantic alternatives when contextually appropriate (Anderson, Huette, Matlock, & Spivey, 2009). A common example of negation is "The eagle is not in the sky." This sentence alone does not carry enough disambiguating information to know the location of the eagle and is therefore *underspecified*. A sentence with underspecificity requires additional context to become unambiguous. In some cases, that context can be prior associations that have been formed between word meanings. Semantic alternatives can be viewed as networks that are constructed by hearing or seeing words close together in time or space (Elman, Hare, & McRae, 2004). Clark and Chase (1972)

presented participants with either the affirmative version of a sentence (e.g., "The star is above the cross") or the negated version of the sentence (e.g., "The star is not above the cross"). The researchers found that, when questioned about the sentence, participants generally responded faster when being questioned about the affirmative version of the sentence. Macdonald and Just (1989) exposed participants to a series of sentences such as "Almost every weekend, Elizabeth baked some bread, but no cookies." When they later asked participants to verify whether or not they had seen a negated term or non-negated term, participants were slower to verify seeing negated terms—such as "cookies" in the example above— compared to non-negated terms—such as "bread" in the example above. In other work, Hasson and Glucksberg (2006) found that participants were more prone to make lexical decision errors after reading negated statements compared to affirmative statements. These findings all suggest that negation is more complex in some way, but it is still unclear why and how negation is sometimes more difficult to process. Some theorize that negation causes readers to undergo an additional step in the recall process. In order to understand the negation, the affirmative is first mentally represented and subsequently revised to an abstracted, negated form (Kaup, Yaxley, Madden, Zwaan, & Lüdtke, 2007).

Contrary to the aforementioned studies, some previous work on negation did not observe a processing delay, and whether this delay was found was a function of the semantic context in which the negation occurred. For example, an Event Related Potential (ERP) study found that when proper context is provided, affirmative and negated sentences can be processed on a very similar timescale (Nieuwland & Kuperberg, 2008). When negation was utilized in typical, everyday conversation, or when it was used to negate rational thoughts (e.g., "A whale is not a fish") no processing delay was observed. When negation was utilized in an atypical context (e.g., "A robin is not a tree") a processing delay was observed. Findings such as these appear to

suggest that low-level lexical effects like negation can have an effect on processing in the moment. At longer timescales, and with complex real-world facts (such as a quiz after reading a book chapter), it is unclear how much of an influence language has on conceptual formation.

Negated language has been used to try to dampen the activation of misinformation (i.e., mitigating the negative effects), and it has been found to slightly reduce retrieval of inaccurate information (Rapp, Hinze, Kohlhepp, & Ryskin, 2014). However, the effects have not been strong, possibly due in part to the lengthiness of texts given to participants in such studies, coupled with the rapid fading of negation over time—a fading that is only amplified as the length of the text increases (Giora, Fein, Aschkenazi, & Alkabets-Zlozover, 2007). In order to address such points, the current study employed new methods to examine if negation can indeed dampen the activation of inaccurate information. To accomplish this, the current study used eye tracking to infer levels of cognitive and perceptual activation for both accurate and inaccurate information. In designing the current study, various memory phenomena were taken into consideration with the goal of focusing on how language affects encoding and subsequent retrieval of information.

Memory Phenomena

It is important to disentangle the role that prior knowledge may play in the likelihood that inaccurate information will be retrieved as prior knowledge has been found to mitigate the effects of misinformation (Rapp, 2008). While prior knowledge is often seen as beneficial, it can be a detriment when it comes to its role in a misinformation paradigm, as individuals have been found to often rely on their prior knowledge when it is incorrect and ignore their prior knowledge when it is correct. Inaccurate information that people have already encoded as true and have stored within their prior knowledge often gets relied upon during retrieval. Conversely, people

may ignore their prior knowledge when presented with information that contradicts it and instead choose to accept the contradicting information as true because this is cognitively easier than engaging in the validation process (i.e., when readers use their prior knowledge to fact check a claim during text comprehension; Gilbert, 1991).

Prior knowledge contains a degree of flexibility via assimilation of new information that augments or supports current knowledge, or accommodation—which is a process that requires a concept to change. A third option would be to reject new information because of personal beliefs, biases, or prior knowledge to the contrary, which would involve a process of validation. However, validation is often skipped because the cognitive cost tends to be too high for readers (Gilbert, 1991). To illustrate the flexibility of prior knowledge, when asked to verify the truthfulness of well-known historical facts presented within a narrative, participants took longer to respond when the narrative contained suspenseful elements that called their prior knowledge into question (Gerrig, 1989). What this suggests is that prior knowledge contains a degree of flexibility, and as such can be prone to influence from external and internal variables.

The role of episodic traces in the flexibility of prior knowledge has been investigated in order to discern its role in memory retrieval. Goldfinger and Azuma (2004) define episodic memory traces as a collection of instances in memory. If a person is asked, "What is the capital city of New York?" they may activate prior memory traces pertaining to New York, cities, and capitals, leading to a flourish of information stored in prior knowledge that may interfere with the accurate retrieval of the correct answer (van den Broek, Rapp, & Kendeou, 2005). If these incorrect memory traces gain enough strength, it is highly likely the retrieved response will be the memory with higher activation rather than the correct information (Rapp et.al., 2014). For example, if the answer "Manhattan" has gained enough strength over various retrieval trials to

answer a question similar to “What is the capital city of New York?” then it would be highly likely that this piece of misinformation would continue to be retrieved over subsequent retrieval trials.

Marsh and Fazio (2006) presented participants with fictional stories. Prior to reading these stories in the lab, participants were asked a series of general knowledge questions, one of which discussed that Heathrow airport was located in London, England. In one example, participants read a story about fictional characters getting on a plane in Heathrow airport in Dublin, Ireland. Participants should have had stored within their prior knowledge that Heathrow was located in London, not Dublin. However, when queried after reading the short stories in the lab, participants often incorrectly responded Heathrow was located in Dublin, not London. Thus, recent memory traces appear to be stronger then information simply stored within prior knowledge.

The Knowledge Revision Components Framework (KReC) provides a way to explain prior knowledge and what happens when “previously-acquired-but-no-longer-correct-information” is encountered (Kendeou, Smith, & O'Brien, 2013). The KReC framework explains that once information is encoded and stored within long-term memory, the encoded information can never be deleted even if we later learn that information is incorrect—this inhibits the ability to simply “erase and replace” information within long-term memory. With incorrect information continuing to persist within long-term memory, it is believed that subsequent attempts to revise this information can lead to its reactivation. The KReC framework posits that the best way to decrease activation for previously-acquired-but-no-longer-correct-information is to provide a correction containing a causal explanation—causal explanations are able to provide readers with interconnections that can effectively compete for activation with incorrect information—thus

allowing participants to make the objectively correct response.

An overarching theory frameworks such as the KReC further clarify is temporal distinctiveness theory (Ecker, Lewandowsky, Cheung, & Mayberry, 2015). The premise behind temporal distinctiveness—and other time-based models of encoding—is that the most recently encoded information should be the most accessible during retrieval (Bjork & Whitten, 1974). This theory posits that information stored in long-term memory suffers from a type of degradation the more time that elapses between encoding and retrieval, therefore leaving the most recently encoded memories as the least degraded and most easily accessible during retrieval. In a study conducted by Ecker et al. (2015), it was found that when participants were given two possible causes for an event, the more recently encoded cause was the one most relied upon during later reasoning tasks.

There are still other special cases of retrieval error—such as the continued influence effect— to consider within the context of the current study. The continued influence effect describes the phenomenon in which misinformation is continually relied upon even though an attempt to weaken it has been made via a correction or retraction (Johnson & Seifert, 1994). It is believed this continued influence could in turn be due to the fact that in order for a retraction or correction to be successful, often the inaccurate information needs to be repeated (Ecker, Lewandowsky, Swire, & Chang, 2011).

The repetition and subsequent backfiring of the intended purpose of a correction or retraction has been termed the backfire effect (Nhyan & Reifler, 2010). The role of the backfire effect and the continued influence effect on memory and their role in the production of misinformation were of particular interest to the current study. This interest stemmed from our belief that linguistic negation should be used to increase the effectiveness of a retraction or

correction so readers would not recall incorrect information but instead recall the correct information. If negation were used within a retraction or correction (e.g., "is not X but Y"), then we would expect a decreased rate of retrieval of incorrect information and an increased rate of retrieval of correct information. We would expect this because readers are explicitly told what is incorrect and have their attention redirected toward what the correct information is. However, when using negation to retract or correct inaccurate information, it is necessary to repeat the inaccurate information in order for the accurate information to then be presented (i.e., "is not X but Y"). It is from this repetition that the backfire effect occurs and why it is important for a reader to actively engage in validation while they are encountering new information.

Text Comprehension Theory

Readers often overlook the validation process because it requires more effort to utilize one's prior knowledge to fact check or validate a claim during real time text comprehension (Gilbert, 1991). In order for a reader to be able to validate what they are reading as accurate or inaccurate they first must be able to comprehend the text they are engaging with. It stands to reason that a reader may also be more likely to produce inaccurate information if they have had very little previous experience with, or exposure to a topic. With little to no prior knowledge to draw upon, readers tend to accept what they encounter as accurate (Rapp et al., 2014). However, when prior knowledge pertaining to a certain topic *does* exist within a reader's knowledge structure when they encounter a text, it becomes the task of the reader to engage in validation during text processing (Gilbert, 1991). In order to gain a more complete understanding of the mechanisms involved in the encoding and subsequent retrieval of inaccurate information, the relationship between texts and comprehension has been explored to better understand to what extent the characteristics of a text plays in how well a reader can comprehend and later retrieve

the information being presented (Richter & Rapp, 2012).

Several models exist which aim to characterize the relationship between text characteristics and text comprehension. The most well known and often cited of these models is the Construction-Integration (CI) model (Kintsch, 1988). The CI model focuses on two main aspects of text comprehension: construction and integration. Construction refers to the combining of information within a text and to the combining of other related knowledge, whereas integration refers to the triggering of concepts within a reader's mind (McNamara & Magliano, 2009). These concepts are encoded more strongly and clearly within the mind of a reader if they are closely linked to other related concepts in the same text or if the reader has had prior exposure to similar concepts. Having a high degree of prior knowledge and high ability to understand the text being presented makes the validation of propositions and subsequent judgments of plausibility easier to disentangle (Richter & Rapp, 2012).

Moving beyond text level processing, other accounts help explain why false information persists within long-term memory. Fuzzy memory models posit that two types of traces primarily affect false memories: gist and verbatim traces (Brainerd & Reyna, 2002). Lexical activation leaves a memory trace that can be recalled exactly as it was originally encountered (e.g., distinctly remembering encountering the word "pie" when trying to recall a list of baked goods that were on sale at the bakery). Gist traces are semantically similar traces that provide information about the overall idea attempting to be retrieved (e.g., recalling the baked goods that were on sale at the bakery included such things as cakes). Though pies and cakes are two distinct items, they contain enough semantic overlap to provide a gist of the experience attempting to be recalled without providing exact recall of the memory trace. It is within these gist memory traces the retrieval of inaccurate information would appear to be most likely because a concept or idea

may simply gain enough activation during retrieval to become encoded and subsequently recalled when queried.

Using an example from the current study, in learning about presidential assassinations, the two most well known assassinations are those of Abraham Lincoln by John Wilks Booth and the assassination of John F. Kennedy by Lee Harvey Oswald. Verbatim retrieval would distinctly retrieve these memory traces as Lincoln = Booth and Kennedy = Oswald. However, gist retrieval would provide memory traces such as Booth and Oswald = presidential assassins, providing information that these two men are linked to presidential assassinations but not providing further insight for finer details. It is where these theories of text processing end that psycholinguistic theories help to fill in the gaps when examining the persistence of inaccurate information.

Context Through Language

The current study investigated the mechanisms responsible for the retrieval of inaccurate information via the recording of eye movements. While eye tracking has indeed been used during the encoding of text information during reading (Rayner, Chace, & Slattery, 2006), the current study attempts to take a novel and more psycholinguistic approach in investigating the relationship between low-level lexical effects (i.e., negation) and misinformation. Previous research has shown negation can mediate activation for memories and that other language functions influence how and if information is encoded and retrieved (Mayo, Schul, & Burnstein, 2004; Hasson & Glucksberg, 2006; Nieuwland & Kuperberg, 2008).

Eye movements are able to provide a continuous measurement where proportions of fixations are thought of as a window into probabilistic activation for language processing. Additionally participants' overt responses can be tracked, allowing for replication while adding new depth to how concepts become active over the course of a trial. Yee and Sedivy (2006)

demonstrated that eye movements revealed proportionally more fixations to semantically associated objects during lexical selection (compared to non-semantically related items). For example, participants heard the word "piano" when viewing a screen with pictures of a piano, a trumpet, and other non-semantically related competitors such as "child" or "tree." Participants were significantly more likely to fixate on semantically similar competitors such as a trumpet compared to other unrelated competitors, suggesting eye movements reveal semantic similarities (Huettig & Altmann, 2005).

Because eye tracking is able to capture representational activation on such a fine grain timescale (i.e., milliseconds), using this measure was a fitting choice to capture the effects that negation—which also unfolds over a very fine-grained timescale—had on the retrieval of inaccurate information. Eye tracking provided a continuous measure of cognitive processing over time while participants engaged with language (i.e., multiple choice questions after reading facts), thus allowing us to examine processing as it unfolded, particularly with respect to differences in proportions of fixations to items participants do not overtly select.

The current study had two main goals. The first goal was to augment what we already know about how participates overtly respond after encountering inaccurate information via the use of online processing (i.e., eye-tracking). The second goal was to investigate if the effects of negation last long enough to affect subsequent retrieval. We had three main predictions involving response accuracy, reaction time, and fixation behavior.

First, it was predicted that: participants would respond most accurately after reading only accurate information presented in the affirmative (affirmative control), second most accurate after reading negated inaccurate information presented with the accurate alternative (negation with correct alternative), third most accurate after reading negated accurate information

presented with an inaccurate alternative (negation incorrect alternative), and least accurate after reading only inaccurate information presented in the affirmative (affirmative misinformation). The affirmative control was predicted to have the highest response accuracy as participants would only be receiving correct information and therefore should be able to easily select the correct information when overtly responding. The negation with correct alternative condition was predicted to have the second highest response accuracy, as participants would be presented with correct information. By also telling participants what information was incorrect, we believed this would activate this information in long tern memory and cause participants to occasionally select the incorrect information when overtly responding. The negation with incorrect alternative condition was predicted to have the third highest response accuracy as incorrect information would be emphasized but correct information would still be provided. Though emphasis would be placed on the incorrect information, mentioning the correct information could result in the occasional selection of correct responses. Lastly, the affirmative misinformation condition was predicted to have the lowest response accuracy as participants would only be presented with incorrect information and therefore should readily select the incorrect information when overtly responding.

Second, it was predicted participants would take longer to overtly respond after reading information containing negation. As mentioned earlier, previous literature has found that participants often take longer to process negated text (Hasson & Glucksberg, 2006; MacDonald & Just, 1989). We expected to also observe this processing delay in the current study as measured by participants' reaction times.

Last, our predictions pertaining to eye movements were that participants would fixate the longest on the correct information after reading only accurate information presented in the

affirmative (affirmative control), second longest after reading negated inaccurate information presented with the accurate alternative (negation with correct alternative), third longest after reading negated accurate information presented with an inaccurate alternative (negation with incorrect alternative), and shortest after reading only inaccurate information presented in the affirmative (affirmative misinformation). We predicted that fixations to competing information—specifically fixations to the most plausible lure (MPL)—would be high in those conditions that emphasize the MPL (i.e., affirmative misinformation condition and negation with inaccurate alternative condition). MPL's were normed as being the most commonly chosen incorrect answer and were predicted to directly compete with correct answer choices for activation. Eye-tracking was chosen as a way to measure these predicted patterns of activation.

Method

Design

This study featured a within-subjects design. The independent variable was language context and had two levels: whether the information given was accurate or inaccurate information. The four conditions present within the study were as follows: Affirmative Control (which served as baseline or control condition), Affirmative Misinformation, Negation with Correct Alternative, and Negation with Incorrect Alternative. The dependent variables were participants' fixations on areas of interest (i.e., answer selections on the questionnaire) on the computer screen during eye-tracking, as well as the correctness of overt responses on the general knowledge questionnaire (see Appendix A). The source of the information participants read came from normed responses to general knowledge recall questions (Tauber, Dunlosky, Rawson, Rhodes, & Sitzman, 2013). These were transformed into short vignettes participants read (see Appendix B). The *Affirmative Control* condition featured vignettes written in the affirmative and

contained all accurate information. The *Affirmative Misinformation* condition featured vignettes written in the affirmative and contained inaccurate information. The *Negation with Correct Alternative* condition featured vignettes written in the negated, contained inaccurate information, and contained a correct alternative. The *Negation with Incorrect Alternative* condition featured vignettes written in the negated, contained inaccurate information, and contained an incorrect alternative. It was believed the inclusion of alternatives would steal significant activation away from activated misinformation, an event that would be apparent during examination of fixations during the questionnaire portion of the study.

Participants

A total of 33 participants were recruited via the SONA subject pool system at the University of Memphis, and each received research credit as compensation for their participation. Qualifications for participation in the study were limited to right-handed native English speakers with normal or corrected to normal vision. These criteria are typical restrictions in psycholinguistic studies designed to reduce variability in the sample. Two participants were discarded from the study due to an insufficient amount of data obtained from the eye-tracking system, bringing the final number of included participants to 31.

Procedure

After obtaining informed consent, participants were seated at a computer in the lab equipped with a Tobii remote eye-tracking system. Participants were asked to read a series of 13 vignettes, each containing four sentences. The third sentence in each vignette—the target sentence—included one piece of information normed by Tauber et al. (2013) to be known by 40-60% of college students. After reading all 13 vignettes, participants were presented with a 13-item questionnaire with multiple-choice questions pertaining to the information that was

encountered in the third sentence of each vignette. Participants were explicitly told they would be quizzed on what they read and to pay attention, as not all the information presented in each vignette was accurate. A sample vignette from the Affirmative Control condition, where all information is accurate, was as follows:

> "Jonathan is an avid history buff and is a particular fan of studying The Civil War era.
> He likes to study The Civil War era and the key figures of the era.
> He learned that the last name of the man that assassinated Abraham Lincoln was Booth.
> Jonathan was interested in learning more about the events that surrounded the assassination."

The target information presented was "the last name of the man that assassinated Abraham Lincoln was Booth," and the accompanying question participants saw during the multiple choice, eye-tracked questionnaire portion of the study was, "What is the last name of the man that assassinated Abraham Lincoln?" In the Affirmative Misinformation condition, the word "Booth" was changed to the most plausible alternative "Oswald." In the Negation with Correct Alternative condition, this segment of the sentence read "not Oswald, but Booth," and in the Negation with Incorrect Alternative condition this segment of the sentence read "not Booth, but Oswald." Many of the alternatives chosen for the vignettes were generated from the same norms (Tauber et al., 2013), which included the most frequent incorrect answers or "commission errors," and these answers served as the most plausible alternatives or most plausible lures.

An example of the same vignette about Abraham Lincoln, this time containing inaccurate information and alternatives (i.e., Negation with Correct Alternative condition) was as follows:

> "Jonathan is an avid history buff and is a particular fan of studying The Civil War era.
> He likes to study The Civil War era and the key figures of the era.

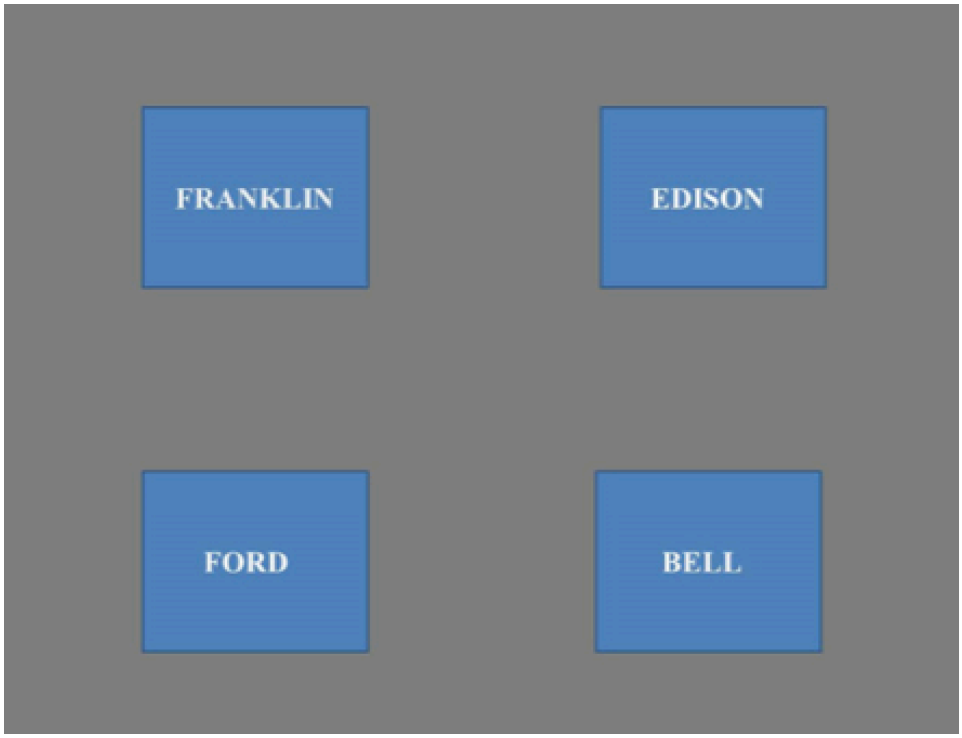
He learned that the last name of the man that assassinated Abraham Lincoln was **not Oswald, but Booth. (**bolded here for emphasis).

Jonathan was interested in learning more about the events that surrounded the assassination."

It should be noted the syntactic structure of each vignette was tightly controlled. Each vignette abided by the following structures with "X" representing correct information and "Y" representing incorrect information:

- "They learned that X was…"(Affirmative Control)
- "They learned that Y was…" (Affirmative Misinformation)
- "They learned that not Y, but X" (Negation with Correct Alternative)
- "They learned that not X, but Y" (Negation with Incorrect Alternative)

During the questionnaire portion, each question appeared in the top third of its own screen and was accompanied by a fixation cross that was situated in the center of the screen. Participants were instructed to read the question then to click on the fixation cross, thus moving to the next screen which displayed the four answer choices. The fixation cross was included so to always have participants situate their eyes on the same point before the four answer choices appeared on the following screen. Participants were instructed they were to choose one of the four answer choices by clicking on it to record their response. When a mouse click was recorded, the next question then appeared. Answer choices appeared on screen as four blocks in each quadrant of the screen with text containing each answer choice. This layout was designed to minimize error in the tracking of eye movements. The order in which the answer choices were presented was pseudo-randomized to rule out any influence of ordering effects. An example of the four answer blocks and their placement was as follows:



During the time participants were viewing the answer choice blocks, their eye movements were recorded. Each answer choice block indicated an area of interest (AOI) that served as the main dependent variable of the study. The AOIs were constructed in terms of correctness, so fixations to AOI Correct, AOI Most Plausible Lure (MPL), and AOI Other Plausible Lure (OPL) were computed as mutually exclusive categories. The proportion of time spent in each AOI was calculated via the Tobii Metric "Total Fixation Duration" (measured in seconds) and served as a measurement of activation for information and misinformation. A second Tobii metric, "Time to First Mouse Click" (measured in seconds), was also recorded and served as a measurement of participant response time and as a measurement for answer selection as participants were only allowed to make one mouse click by clicking on one of the four answer choice selection boxes. Monitoring eye movements enabled us to discern if semantically related competitors to the target information presented in each vignette gained activation and to

determine the degree of activation for each competing target on a trial-by-trial and participant-by-participant scale (Yee & Sedivy, 2006).

Participants were randomly assigned a counterbalanced list upon entering the study, which was designed such that participants never heard the same vignette twice, but between participants each vignette was presented in each of the four different possible forms.

Results

Data

Total Fixation Durations from the multiple-choice task were computed as a proportion of trial time spent looking at each of the four AOIs present within a given answer set. Each answer choice block was defined as an AOI according to whether it was the correct answer, the most plausible lure, or one of the two other lures. On each trial, the sum of time spent fixating on each of the three AOIs was calculated (i.e., fixation duration). Each AOI's fixation duration divided by the total fixation time yielded the proportion of fixation time spent on that AOI on a trial-by-trial basis. Averages by participant and by condition were computed for each of the three AOIs. Importantly, because responses were likely processed differently when participants responded incorrectly, eye-tracking data was separated by trials with correct and incorrect responses. This was also done for reaction times (see Figure 1). An independent-samples t-test was conducted to compare reaction times for when participants responded on the questionnaire after reading information presented in the affirmative or negated and for when participants responded correctly or incorrectly. For correct responses, there was a trend toward statistical significance. On average, reaction times for the affirmative (M = 2.35s, SD = 1.43s) were shorter than both negated conditions as predicted (M = 3.10s, SD = 2.43s); t (31) = -1.79, p = .08, two-tailed).

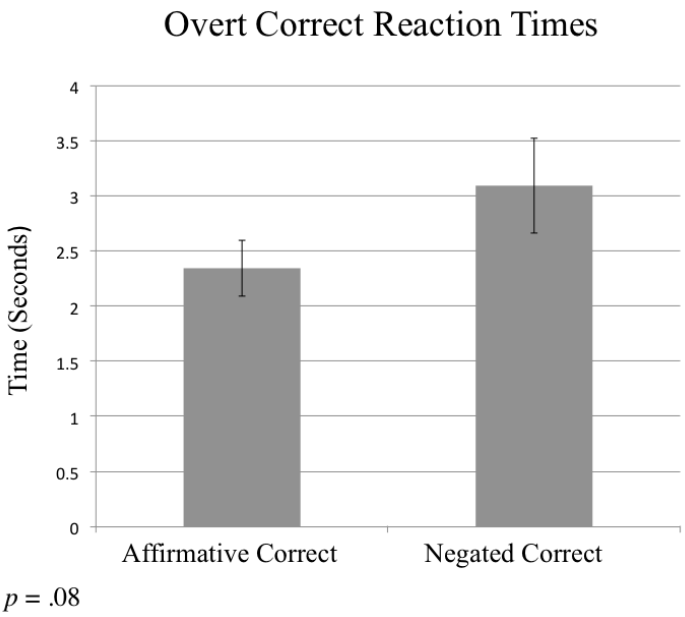


Figure 1A. Mean reaction times for when participants overtly responded correctly based on text condition. There was a trend toward statistical significance for when participants overtly responded correctly (p = .08). Error bars represent standard error of the mean.

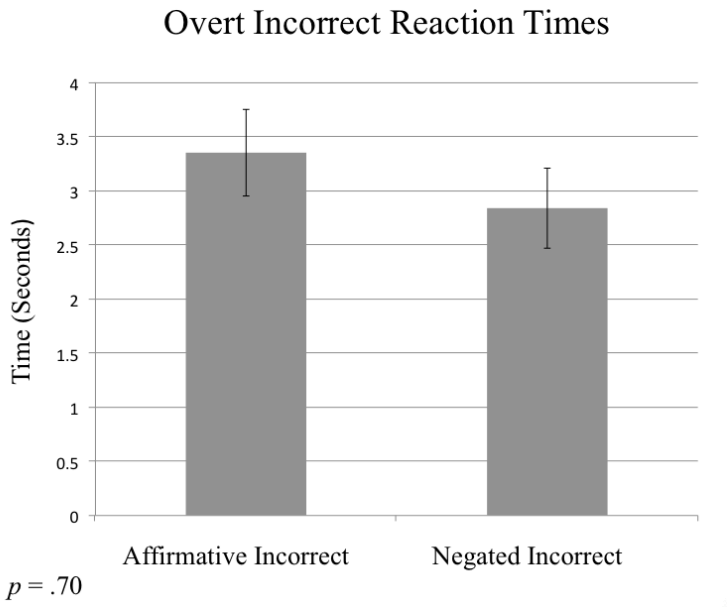


Figure 1B. Mean reaction times for when participants overtly responded incorrectly based on text condition. No significant difference was found. Error bars represent standard error of the mean.

Performance

Correctness of responses were analyzed—as recorded by participants' mouse clicks— to

discern if there was a difference between the three experimental groups, and between the experimental groups and the control condition (see Figure 2). We expected the results would vary such that the Affirmative Control condition would have the highest accuracy, the Negation with Correct Alternative condition would have the second highest accuracy, the Negation with Incorrect Alternative condition would have the third highest accuracy, and finally the Affirmative Misinformation condition would have the lowest accuracy. A one-way repeated measures ANOVA was conducted to compare response accuracy with text condition. Refer to Table 1 for response accuracy by condition for each participant. There was a significant effect for text condition, Wilks' Lambda = .22, F (3, 28) = 32.93, $p < .001$, multivariate partial eta squared = .78. A post hoc Tukey HSD revealed the Affirmative Control condition (M = .88, SD = .24) was significantly different from the Affirmative Misinformation condition (M = .21, SD = .29) and from the Negation with Incorrect Alternative condition (M = .38, SD = .29). However, no significant difference was observed between the Affirmative Control condition and the Negation with Correct Alternative condition (M = .89, SD = .27).

Table 1 and Table 2 provide descriptives of patterns observed in the data and were not quantitatively analyzed. Table 1 provides response accuracy (i.e., proportion correct) data by participant for each of the four text conditions. Table 2 provides reading times by participant for each of the four text conditions. Both tables provide insight into individual differences regarding both encoding and retrieval and will be re-examined when conducting future research.

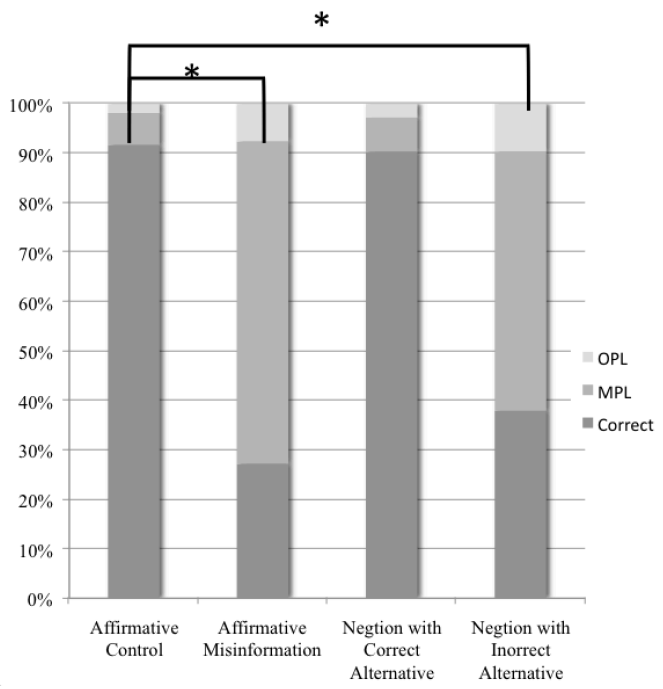


Figure 2. Correctness percentage on questionnaire by text condition and by answer type selection (Correct, MPL, OPL).

Quantitative analyses to assess statistical differences were done via two separate repeated-measures MANOVAs—one when participants overtly responded correctly on the questionnaire and the other when participants overtly responded incorrectly. Both MANOVAs had the between-subjects variables of correctness (correct vs. incorrect) and list (4 levels, not predicted to have any effect), the within-subjects variable vignette language (affirmative vs. negated), and the dependent variable overall proportion of fixation duration to the AOI types. Analyses confirmed there were significant multivariate effects for language (affirmative vs. negated) on proportion fixation duration for correct answer selections, Wilks Lambda = .02, F (15,14) = 58.56, p = .001. The second repeated-measures MANOVA confirmed there were also significant multivariate effects for type of language (affirmative versus negated) on proportion fixation duration for incorrect answer selections, Wilks Lambda = .24, F (15,13) = 2.83, p = .03. Overall, these findings suggest type of language affects encoding and retrieval of misinformation

both on the conscious and subconscious level (see Figure 3A and 3B).

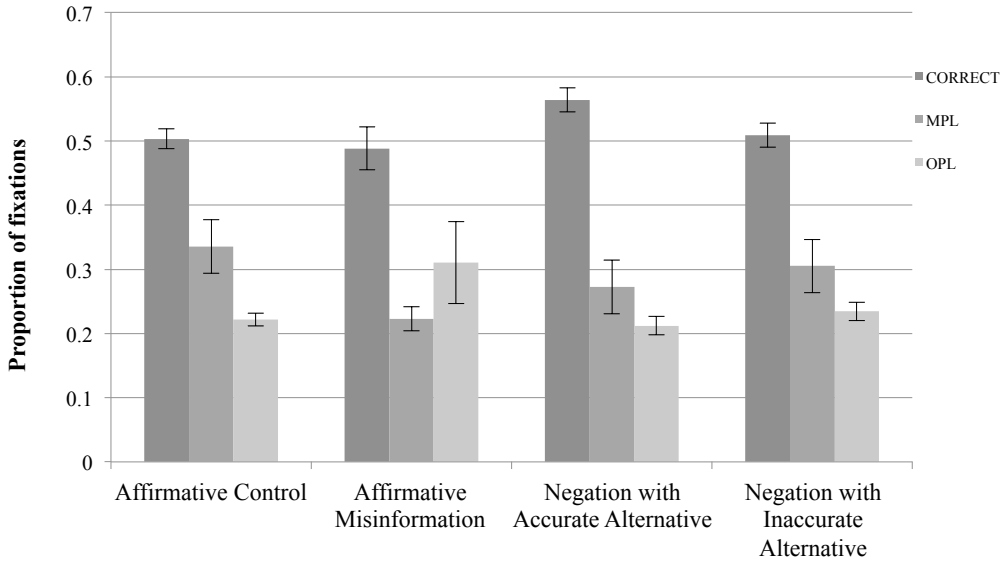


Figure 3A. Average proportion of fixation durations for each AOI and text condition for when participants overtly responded *correctly* on the questionnaire portion. When responding correctly, participants fixated the most on the Correct AOI across all four text conditions with the highest proportion of fixations to the Correct AOI coming in the Negation with Accurate Alternative condition. Error bars represent standard error of the mean.

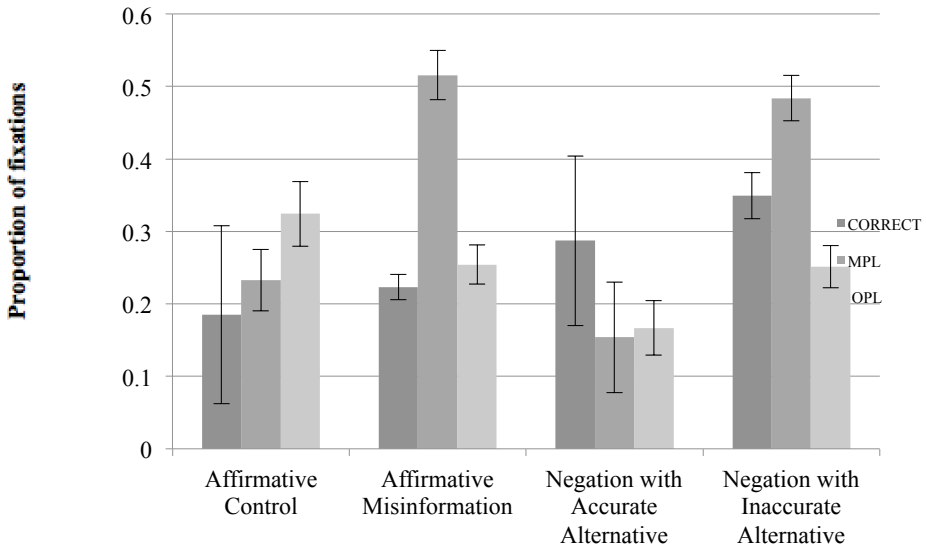


Figure 3B. Total proportion fixation durations for each AOI and text condition for when participants overtly responded *incorrectly* on the questionnaire portion. When responding incorrectly, participants tended to fixate the most on the MPL AOI across all four text conditions. Error bars represent standard error of the mean.

Table 1

Proportion of Correct Responses for Each Participant by Condition

	Proportion Correct			
Participant	Affirmative Control	Affirmative Misinformation	Negated with Correct Alternative	Negated with Incorrect Alternative
1	1	0	0	.25
2	1	.33	1	.75
3	1	.33	1	.25
4	1	.33	1	.25
5	1	.33	1	.25
6	.6	.33	1	.50
7	.75	0	1	.50
8	1	0	1	0
9	.50	.20	1	1
10	1	.40	0	1
11	1	.20	1	0
12	0	.67	.60	.25
13	1	0	1	0
14	1	0	.60	0
15	1	0	.40	.75
16	1	0	1	0
17	.67	0	1	.33
18	.67	0	1	.33
19	1	0	1	.33
20	1	0	1	.33
21	1	0	1	.33
22	1	0	1	.33
23	1	0	1	.25
24	.8	.67	1	.75
25	1	0	1	.25
26	1	0	1	.25
27	1	1	1	.50
28	1	.80	1	.50
29	1	.33	1	1
30	.33	.67	1	.25
31	1	0	1	.33
Mean	.88	.21	.91	.38
SD	.24	.29	.28	.29

Table 2

Reading Times for Each Vignette by Condition for Each Participant

	Reading Times Per Vignette (s)			
Participant	Affirmative Control Average	Affirmative Misinformation Average	Negated with Correct Alternative Average	Negated with Incorrect Alternative Average
1	10.60	23.82	16.24	16.26
2	11.88	17.77	17.52	17.81
3	8.99	17.51	14.26	15.30
4	13.81	26.54	24.65	21.20
5	34.07	22.99	66.87	12.85
6	14.16	21.80	22.58	21.29
7	19.14	14.12	29.13	19.87
8	24.04	19.15	31.36	25.11
9	23.20	18.01	39.29	37.03
10	16.51	14.51	28.13	17.56
11	20.90	15.26	30.61	27.87
12	17.97	32.26	23.22	31.36
13	9.46	16.27	14.27	24.89
14	14.66	23.82	23.02	17.93
15	4.03	9.66	7.15	12.60
16	37.50	19.85	21.27	40.26
17	35.39	17.24	41.84	13.61
18	29.95	23.05	57.89	12.15
19	39.41	31.65	64.33	12.38
20	24.47	16.20	57.69	14.48
21	28.50	22.96	38.97	12.30
22	17.46	21.93	15.77	32.32
23	25.65	34.25	8.19	10.07
24	24.02	19.58	47.55	31.98
25	41.29	26.41	63.18	14.21
26	25.21	38.49	38.06	29.46
27	16.26	13.19	23.31	21.29
28	23.38	14.87	25.68	19.43
29	16.55	17.74	16.87	27.90
30	12.47	17.77	17.62	25.32
31	14.20	21.56	17.42	15.63
Mean	21.13	20.98	30.45	21.02
SD	9.52	6.53	17.04	8.06

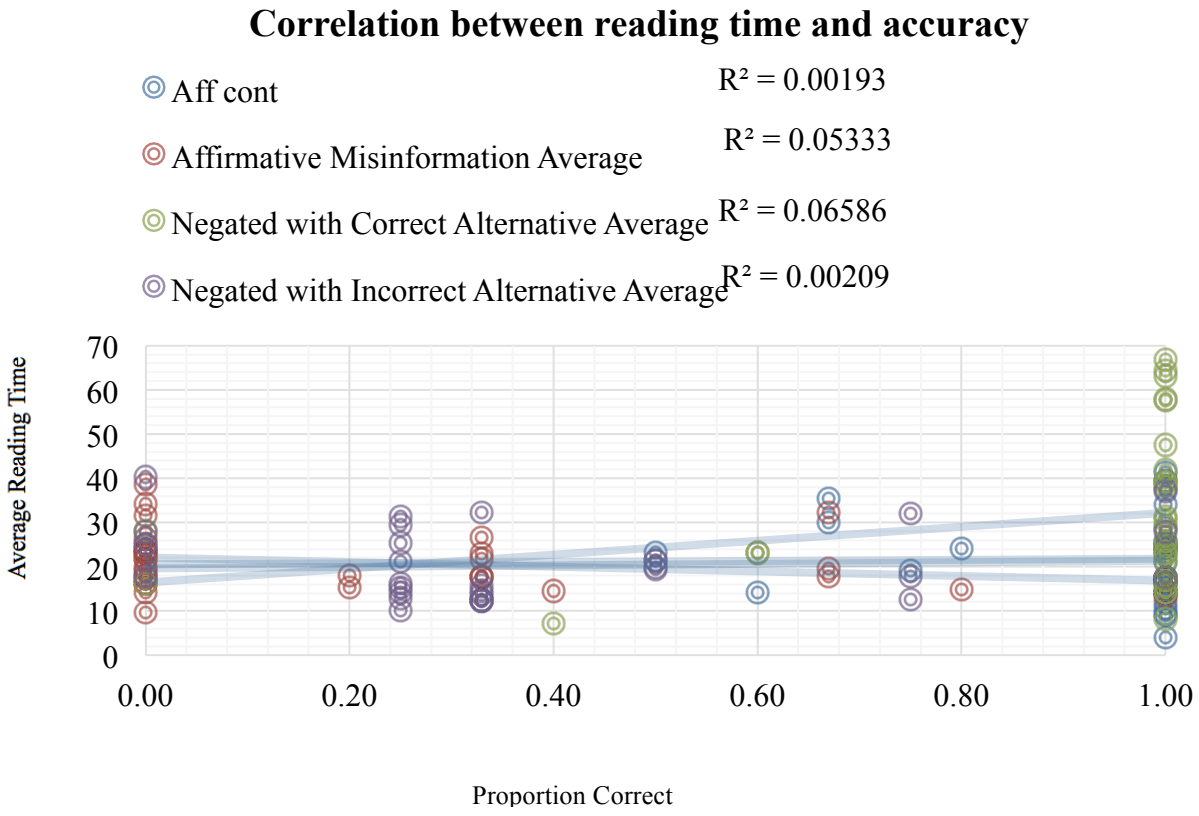


Figure 4: Correlations between average reading time for each vignette per text condition and questionnaire response accuracy. R^2 values for each condition showed relationships between reading times and correctness to be very weak.

Fixations for Correct Response Trials

We conducted three repeated-measures univariate ANOVAs to examine if the four text conditions (Affirmative Control, Affirmative Misinformation, Negation with Correct Alternative, Negation with Incorrect Alternative) had a significant effect on proportion fixation duration. All data used in these analyses were from trials where participants overtly responded *correctly* on the questionnaire. Each of the three ANOVAs examined the proportion fixation duration on one of the three AOI types: Correct, Most Plausible Lure, or Other Plausible Lure.

The first repeated-measures ANOVA examined fixation durations on the Correct AOI, and it yielded a significant overall effect of condition, Wilks Lambda = .40, F (3, 29) = 16.50, p = .001. As expected, vignettes presented in the Affirmative Control condition had the highest

average fixation duration on the correct answer choice (M = 1.50, SD = .81), followed by vignettes presented in the Negation with Correct Alternative condition (M = 1.02, SD = .78), Negation with Incorrect Alternative condition (M = .71, SD = .80), and Affirmative Misinformation condition (M = .40, SD = .70).

The second repeated-measures ANOVA examined fixation durations on the Most Plausible Lure AOI, and it yielded a significant overall effect of condition, Wilks Lambda = .55, F (3, 29) = 7.90, p = .001. A similar overall fixation duration pattern was observed as in the Correct AOI with vignettes presented in the Affirmative Control condition having the highest average fixation duration (M = .68, SD = .58), followed by vignettes presented in the Negation with Correct Alternative condition (M = .38, SD = .41), Negation with Incorrect Alternative condition (M = .35, SD = .44), and Affirmative Misinformation condition (M = .16, SD = .34).

The third repeated-measures ANOVA examined fixation durations on the Other Plausible Lure AOI, and it yielded a significant overall effect of condition, Wilks Lambda = .55, F (3, 29) = 8.10, p = .001. A slightly different overall fixation duration pattern was observed, with vignettes presented in the Affirmative Control condition having the highest average fixation duration (M = .63, SD = .49), followed by vignettes presented in the Negation with Incorrect Alternative condition (M = .38, SD = .51), Negation with Correct Alternative condition (M = .35, SD = .34), and Affirmative Misinformation condition (M = .18, SD = .29).

Fixations for Incorrect Response Trials

Next, we conducted three repeated-measures univariate ANOVAs to examine if the four text conditions (Affirmative Control, Affirmative Misinformation, Negation with Correct Alternative, Negation with Incorrect Alternative) had a significant effect on proportion fixation duration. All data used in these analyses were from trials where participants overtly responded

incorrectly on the questionnaire. Each of the three ANOVAs examined the proportion fixation duration on one of the three AOI types: Correct, Most Plausible Lure, or Other Plausible Lure.

The first repeated-measures ANOVA examined fixation durations on the Correct AOI, and it yielded a significant overall main effect of condition, Wilks Lambda = .52, F (3, 29) = 9.11, p = .001. The overall fixation duration patterns showed fixation durations on the vignettes presented in the Negation with Incorrect Alternative condition were the highest (M = .46, SD = .48), followed by the Affirmative Misinformation condition (M = .34, SD = .37), Negation with Correct Alternative condition (M = .10, SD = .22), and Affirmative Control (M = .06, SD = .13).

The second repeated-measures ANOVA examined fixation durations on the Most Plausible Lure AOI, and it yielded a significant overall effect of condition, Wilks Lambda = .51, F (3, 29) = 9.47, p = .001. The overall fixation duration patterns showed fixation durations on the vignettes presented in the Affirmative Misinformation condition were the highest (M = .71, SD = .83), followed by the Negation with Incorrect Alternative condition (M = .53, SD = .61), Affirmative Control condition (M = .04, SD = .14), and Negation with Correct Alternative condition (M = .03, SD = .13).

The third repeated-measures ANOVA examined fixation durations on the Other Plausible Lure AOI, and it yielded a significant overall effect of condition, Wilks Lambda = .44, F (3, 29) = 12.18, p = .001. The overall fixation duration pattern was the same as the Most Plausible Lure AOI fixation duration pattern. The overall fixation duration patterns showed fixation durations on the vignettes presented in the Affirmative Misinformation condition were the highest (M = .54, SD = .62), followed by the Negation with Incorrect Alternative condition (M = .49, SD = .45), Affirmative Control condition (M = .10, SD = .25), and Negation with Correct Alternative condition (M = .07, SD = .26).

Discussion

The current study expanded on the work of Yee and Sedivy (2006) by investigating how negated language activates semantic alternatives within the context of a misinformation paradigm and how negation affects the mechanisms responsible for the retrieval of inaccurate information. One within-subjects independent variable varied across trials was the form of language: negated or affirmative. A second within-subjects independent variable was whether the information given during encoding was correct information or incorrect information. Eye-tracking methodology was used as it provided a continuous measure of cognitive processing over time while participants engaged with language (vignettes), thus allowing us to examine processing as it unfolded—particularly with respect to information being processed but not overtly responded to.

A contribution of the current study was the finding that when encountering inaccurate information, participants appeared to suppress this information when reading inaccurate information and overtly responding during testing. This effect is shown in Figure 3A where we examined participants' fixation behaviors within the affirmative misinformation condition. In this condition, participants were presented with only incorrect information—in this case the most plausible lure or MPL was being presented—and this information was predicted to have the most fixations during analysis of fixation durations. When examining Figure 3A, we observed directly the opposite as the MPL was not the answer selection drawing the longest fixations. Instead, the answer selection that appeared to draw the most activation is the correct answer selection. The correct answer was never presented to participants in this condition, which indicated that if participants were overtly responding correctly in spite of the presentation of inaccurate information, suppression must have been occurring instead of competition.

Proportion fixation duration patterns suggested that though responses may not have been overtly responded to, a degree of activation still remained for information participants encountered within the vignettes. Overt responses were as predicted as participants exhibited the highest response accuracy on the multiple-choice questionnaire after reading only the correct information (i.e., Affirmative Control condition). Participants exhibited the next highest response accuracy after they were exposed to the negated misinformation in conjunction with the correct alternative (i.e., Negation with Correct Alternative condition). The next highest response accuracy was found after participants were exposed to negated correct information in conjunction with the incorrect alternative (i.e., Negation with Incorrect Alternative condition), and the lowest was when the correct information was not mentioned at all (i.e., Affirmative Misinformation condition).

Reaction time data showed participants tended to respond slower on a multiple-choice questionnaire when answering a question pertaining to a vignette that contained misinformation.. Participants were more likely to select correct answers on a questionnaire regarding semantic knowledge when they were exposed to negated misinformation accompanied with a correct alternative. Additionally, participants were correct more often when exposed to negated misinformation accompanied with an incorrect alternative than when provided with misinformation and no alternatives.

The overall findings show accessing conceptual information in memory may be impacted by recent lexical context, suggesting future studies that investigate misinformation should place a greater emphasis on text construction and how construction may impact conceptual formation (Kelley & Lindsay, 1993). The current research also lends support to the notion that despite steadfast beliefs in the protective nature of prior knowledge when encountering misinformation,

most people appear to assume information they encounter within a text to be true and maintain it as true moving forward without reconciling this with prior knowledge stored within semantic long-term memory (Fazio, Brashier, Payne, & Marsh, 2015; Gilbert, 1991). To the contrary, the current study found evidence for the suppression of inaccurate information during retrieval—though this effect did appear to be condition specific. This finding does not fit well into any pre-existing theory of misinformation processing and we will be conducting follow-up studies to further clarify this finding.

Future Directions

Future research could utilize a pre-test to directly assess participants' prior knowledge in the different question domains (e.g., history, science, sports, etc.) before beginning the study in order to better gauge the role prior knowledge may be playing on a participant-by-participant basis. This would allow participants to be split into high and low prior knowledge groups. This split would enable an examination of the effect that prior knowledge may play during the questionnaire task and to what degree the vignettes may influence prior knowledge and later recall.

A direct follow up to the current study is planned in which a slight alteration to the design will be implemented. The Negation with Incorrect Alternative condition will be replaced with a new condition entitled *Negation All Incorrect*. This new condition will feature negation of the most plausible lure, coupled with the presentation of the other plausible lure as an alternative (e.g., "not Oswald, but Buchannon"). Because the Negation with Incorrect Alternative condition contained the correct piece of information, it remains unclear if participants were simply recognizing the correct answer and selecting it during the questionnaire (i.e., "reverse" backfire effect). By adding this new condition—and replacing the Negation with Incorrect Alternative

condition—it will become easier to disentangle simple recognition from recall. Participants answering questions correctly after reading vignettes in the Negation All Incorrect text condition should be relying solely on prior knowledge and not succumbing to the combination of low level lexical effects and temporal recency.

Conclusions

Contrary to what the current study predicted, negation did not have a significant effect on the retrieval of information. We instead found that the presence or absence of misinformation during reading had a significant effect at testing. We observed that when encountering inaccurate information, participants appeared to suppress this information when reading inaccurate information and overtly responding during testing. We believe this suppression of inaccurate information was due to participants validating what they were reading as false and subsequently ignoring the false information at testing. Though the current study did not provide evidence that low-level lexical effects influence how information is encoded and later retrieved, we still believe that such linguistic manipulations have potential to do so. In regards to misinformation, negation has the potential to signal to a reader what information should not be attended to or should be outdated from long-term memory (Kendeou et.al., 2013). At the same time, negation could also signal to a reader where attentional resources should be redirected so correct information can be updated and attended to during recall.

References

Anderson, S., Huette, S., Matlock, T., & Spivey, M. (2010). On the temporal dynamics of negated perceptual simulations. In F. Parrill, V. Tobin & M. Turner (Ed.), *Meaning, Form, and Body*. Stanford University, CA: CSLI Publications. (pp. 1-20)

Bjork, R. A., & Whitten, W. B. (1974). Recency-sensitive retrieval processes in long-term free recall. *Cognitive Psychology, 6*, 173-189.

Clark, H. H., & Chase, W. G. (1972). On the process of comparing sentences against pictures. *Cognitive Psychology, 3,* 472-517.

Ecker, U.K.H., Lewandowsky, S., Cheung, C.S.C., Maybery, M.T. (2015). He did it! she did it! no, she did not! multiple causal explanations and the continued influence of misinformation. *Journal of Memory and Language, 85,* 101-115.

Ecker, U. K., Lewandowsky, S., Swire, B., & Chang, D. (2011). Correcting false information in memory: Manipulating the strength of misinformation encoding and its retraction. *Psychonomic Bulletin & Review, 18*, 570-578.

Ecker, U.K.H., Lewandowsky, S., Apai, J., (2010). Terrorists brought down the plane!—no, actually it was a technical fault: processing corrections of emotive information. *The Quarterly Journal of Experimental Psychology*,1-28.

Elman, J. L., Hare, M., & McRae, K. (2004). Cues, constraints, and competition in sentence processing. *Beyond nature-nurture: Essays in honor of Elizabeth Bates*, 111-138.

Fazio, L. K., Brashier, N. M., Payne, B. K., & Marsh, E. J. (2015). Knowledge does not protect against illusory truth. *Journal of Experimental Psychology*, 144, 993.

Gerrig, R. J. (1989). Suspense in the absence of uncertainty. *Journal of Memory and Language*, *28*, 633-648.

Gerrig, R. J., & Prentice, D. A. (1991). The representation of fictional information. *Psychological Science*, *2*, 336-340.

Gernsbacher, M. A., Varner, K. R., & Faust, M. (1990). Investigating differences in general comprehension skill. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*, 430–445.

Gilbert, D.T. (1991). How mental systems believe. *American Psychologist, 46*, 107-119.

Giora, R., Fein, O., Aschkenazi, K., & Alkabets-Zlozover, I. (2007). Negation in context: A functional approach to suppression. *Discourse Processes*, *43*, 153-172.

Goldinger, S. D., & Azuma, T. (2004). Episodic memory reflected in printed word naming. *Psychonomic Bulletin & Review*, *11*, 716-722.

Hasson, U., & Glucksberg, S. (2006). Does understanding negation entail affirmation?: An examination of negated metaphors. *Journal of Pragmatics*, *38*, 1015-1032.

Huette, S., Winter, B., Matlock, T., Ardell, D., & Spivey, M. (2013). Eye movements during listening reveal spontaneous grammatical processing. *Frontiers in Cognitive Science*.

Huettig, F., & Altmann, G. T. (2005). Word meaning and the control of eye fixation: Semantic competitor effects and the visual world paradigm. *Cognition*, *96*, 23-32.

Johnson, H. M., & Seifert, C. M. (1994). Sources of the continued influence effect: When misinformation in memory affects later inferences. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*, 14-20.

Kaup, B., Yaxley, R. H., Madden, C. J., Zwaan, R. A., & Lüdtke, J. (2007). Experiential simulations of negated text information. *The Quarterly Journal of Experimental Psychology*, *60*, 976-990.

Kelley, C. M., & Lindsay, D. S. (1993). Remembering mistaken for knowing: Ease of retrieval

as a basis for confidence in answers to general knowledge questions. *Journal of Memory and Language*, 32, 1-24.

Kendeou, P., Smith, E. R., & O'Brien, E. J. (2013). Updating during reading comprehension: Why causality matters. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*, 854.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction–integration model. *Psychological Review*, *95*, 163–182.

MacDonald, M. C., & Just, M. A. (1989). Changes in activation levels with negation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*, 633.

Marsh, E. J., & Fazio, L. K. (2006). Learning errors from fiction: Difficulties in reducing reliance on fictional stories. *Memory & Cognition, 34*, 1140-1149.

Mayo, R., Schul, Y., & Burnstein, E. (2004). "I am not guilty" vs "I am innocent": successful negation may depend on the schema used for its encoding. *Journal of Experimental Social Psychology*, *40*, 433-449.

McNamara, D. S., & Magliano, J. (2009). Toward a comprehensive model of comprehension. *Psychology of Learning and Motivation*, *51*, 297-384.

Nieuwland, M. S., & Kuperberg, G. R. (2008). When the truth is not too hard to handle an event-related potential study on the pragmatics of negation. *Psychological Science*, *19*, 1213-1218

Nyhan, B., & Reifler, J. (2010). When corrections fail: The persistence of political misperceptions. *Political Behavior, 32*, 303-330.

Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.

Rapp, D. N. (2008). How do readers handle incorrect information during reading? *Memory & Cognition*, *36*, 688-701.

Rapp, D. N., Hinze, S. R., Kohlhepp, K., & Ryskin, R. A. (2014). Reducing reliance on inaccurate information. *Memory & Cognition*, *42*, 11-26.

Rayner, K., Chace, K. H., Slattery, T. J., & Ashby, J. (2006). Eye movements as reflections of comprehension processes in reading. *Scientific Studies of Reading*, *10*, 241-255.

Richter, T., & Rapp, D. N. (2012). *Comprehension and validation of text information*. Unpublished manuscript.

Tauber, S. K., Dunlosky, J., Rawson, K. A., Rhodes, M. G., & Sitzman, D. M. (2013). General knowledge norms: Updated and expanded from the Nelson and Narens (1980) norms. *Behavior research methods*, *45*, 1115-1143.

van den Broek, P., Rapp, D. N., & Kendeou, P. (2005). Integrating memory-based and constructionist processes in accounts of reading comprehension. *Discourse Processes*, *39*, 299-316.

Yee, E., & Sedivy, J. C. (2006). Eye movements to pictures reveal transient semantic activation during spoken word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *32*, 1-14.

Appendix

General Knowledge Norming

What do you know? A-1

Read each question and answer the questions to the best of your ability. If you have ANY confusion on any of the questions below please let us know.

1. IN WHICH SPORT IS THE STANLEY CUP AWARDED?
    a. TENNIS
    b. HOCKEY
    c. SOCCER
    d. FOOTBALL
2. WHAT IS THE NAME OF THE CHAPEL WHOSE CEILING WAS PAINTED BY MICHELANGELO?
    a. BASILICA
    b. ST. PETERS
    c. SISTINE
    d. LOUVE
3. WHAT IS THE NAME OF THE CRIME IN WHICH A PERSON PURPOSELY BETRAYS THEIR COUNTRY?
    a. TREASON
    b. RACKETEERING
    c. EMBEZZLEMENT
    d. TRAFFICKING
4. WHAT IS THE NAME OF A DRIED PLUM?
    a. RAISIN
    b. PRUNE
    c. PAPAYA
    d. GRAPE
5. WHAT IS THE LAST NAME OF THE MAN WHO RODE HORSEBACK IN 1775 TO WARN THAT THE BRITISH WERE COMING?
    a. WASHINGTON
    b. REVERE
    c. JEFFERSON
    d. ADAMS
6. WHAT IS THE NAME OF THE SPEAR LIKE OBJECT THAT IS THROWN DURING A TRACK MEET?

a. JAVELIN
b. POLE
c. DISCUS
d. HURDLE

7. WHAT WAS THE EGYPTIAN QUEEN WHO JOINED FORCES WITH MARK ANTONY OF ROME?
    a. CALYPSO
    b. HATSHEPSUT
    c. CLEOPATRA
    d. NEFERTITI
8. WHAT KIND OF METAL IS ASSOCIATED WITH A 50TH WEDDING ANNIVERSARY?
    a. PLATINUM
    b. GOLD
    c. SILVER
    d. BRONZE
9. WHATS THE LAST NAME OF THE MAN WHO ASSASSINATED ABRAHAM LINCOLN?
    a. SIRHAN
    b. OSWALD
    c. BUCHANAN
    d. BOOTH
10. WHAT IS THE NAME OF THE POKER HAND IN WHICH ALL OF THE CARDS ARE OF THE SAME SUIT?
    a. FLUSH
    b. PAIRS
    c. ROYAL
    d. STRAIGHT
11. WHAT IS THE LAST NAME OF THE MAN WHO SHOWED THAT LIGHTNING IS ELECTRIC?
    a. EDISON
    b. BELL
    c. FORD
    d. FRANKLIN
12. WHAT IS THE LAST NAME OF THE SINGER WHO RECORDED “HEARTBREAK HOTEL” AND “ALL SHOOK UP”?

a. BROWN
b. ELVIS
c. LEWIS
d. PRESLEY

13. WHAT IS THE LAST NAME OF THE FAMOUS MAGICIAN AND ESCAPE ARTIST WHO DIED OF APPENDICITIS?
    a. HARDEEN
    b. SIEGFRIED
    c. COPPERFIELD
    d. HOUDINI
14. WHAT IS THE NAME OF THE CITY IN ITALY THAT IS KNOWN FOR ITS CANALS?
    a. VIENNA
    b. ROME
    c. VENICE
    d. FLORENCE
15. WHAT IS THE NAME OF THE LEGENDARY ONE EYED GIANT IN GREEK MYTHOLOGY?
    a. SATYR
    b. CHIMERA
    c. CYCLOPS
    d. MINOTAUR
16. IN WHICH SPORT DOES A RIDER ON HORSEBACK HIT A BALL WITH THEIR MALLET?
    a. POLO
    b. DERBY
    c. BOCCE
    d. CROQUET
17. WHAT IS THE NAME OF THE LARGEST OCEAN ON EARTH?
    a. INDIAN
    b. ATLANTIC
    c. MEDITERRANEAN
    d. PACIFIC

18. WHAT IS THE NAME FOR A CYCLONE THAT OCCURS OVER LAND?

    a. TORNADO
    b. HURRICANE

c. CYCLONE
d. TEMPEST

19. WHAT IS THE NAME OF THE BIRD THAT CANNOT FLY AND IS THE LARGEST BIRD ON EARTH?

a. PENGUIN
b. OSTRICH
c. CONDOR
d. OSPREY

20. WHAT IS THE NAME OF THE LIZARD THAT CHANGES ITS COLOR TO MATCH THE SURROUNDINGS?

a. CHAMELEON
b. GECKO
c. IGUANA
d. KOMODO

21. WHAT IS THE NAME OF THE THICK LAYER OF FAT ON A WHALE?

a. FLUBBER

b. PEDUNCLE

c. BLUBBER

d. ROSTRUM

22. WHAT IS THE NAME OF A YOUNG SHEEP?

a. FOAL

b. DOE

c. LAMB

d. CALF

23. WHAT IS THE LAST NAME OF THE AUTHOR WHO WROTE “ROMEO AND JULIET”?

a. EMERSON

b. YEATS

c. WHITMAN

d. SHAKESPEARE

Accuracy Table of Norming Questions

Average of Accuracy	
Items	Total
blubber	0.794117647
booth	0.676470588
chameleon	0.852941176
cleopatra	0.735294118
cyclops	0.941176471
flush	0.588235294
franklin	0.676470588
gold	0.411764706
hockey	0.676470588
houdini	0.794117647
javelin	0.823529412
lamb	0.735294118
ostrich	1
pacific	0.647058824
polo	0.823529412
presley	0.705882353
prune	0.941176471
prunes	0.941176471
revere	0.823529412
shakespeare	1
sistine	0.735294118
tornado	0.705882353
treason	0.970588235
venice	0.647058824
Grand Total	0.769820972

Stimuli

Vignette 1
Sandy loves to study ancient Egyptian history.
She recently bought a large collection of books on ancient Egypt.

She learned the Egyptian queen who joined forces with Mark Antony of Rome was not Cleopatra, but Nefertiti.
She learned the Egyptian queen who joined forces with Mark Antony of Rome was Nefertiti.
She learned the Egyptian queen who joined forces with Mark Antony of Rome was Nefertiti, but Cleopatra.
She learned the Egyptian queen who joined forces with Mark Antony of Rome was Cleopatra.
According to Sandy, Egypt had the most fascinating ancient civilizations.

Vignette 2
When researching famous artists, AJ has clear cut favorites.
He always finds himself checking out books on Italian artists in particular.
He learned that the name of the chapel whose ceiling was painted by Michelangelo was not Sistine, but Basilica.
He learned that the name of the chapel whose ceiling was painted by Michelangelo was not Sistine, but Basilica.
He learned that the name of the chapel whose ceiling was painted by Michelangelo was Basilica.
He learned that the name of the chapel whose ceiling was painted by Michelangelo was Sistine.
AJ hopes to become an artist himself one day so he reads all that he can on the topic.

Vignette 3
Rhonda is what you could call a sports fanatic.
She lives, eats, and breathes sports and likes to teach her little sister about it.
Her little sister learned that the sport the Stanley Cup is awarded in is hockey.
Her little sister learned that the sport the Stanley Cup is awarded in is soccer.
Her little sister learned that the sport the Stanley Cup is awarded in is not hockey, but soccer.
Her little sister learned that the sport the Stanley Cup is awarded in is not soccer, but hockey.
To say that Rhonda is excited to continue to teach her sister is a giant understatement.

Vignette 4
Emily is an advanced biology student at Houston Levee High.
She is highly interested in marine biology.
In her recent biology lesson, she learned that the name of the thick layer of fat on a whale is called blubber.

In her recent biology lesson, she learned that the name of the thick layer of fat on a whale is called flubber.
In her recent biology lesson, she learned that the name of the thick layer of fat on a whale is not called flubber, but blubber.
In her recent biology lesson, she learned that the name of the thick layer of fat on a whale is not called flubber, but blubber.
Emily is grateful she has a great teacher who is also interest in marine biology.

Vignette 5
Cindy recently watched a TV special on famous inventors.
She didn't know very much about famous inventors so she was really interested in this special.
She learned that the last name of the man that showed that lightning was electric was Franklin.
She learned that the last name of the man that showed that lightning was electric was not Franklin, but Edison.
She learned that the last name of the man that showed that lightning was electric was Edison.
She learned that the last name of the man that showed that lightning was electric was not Edison, but Franklin.
Cindy was glad she watched the special because she learned a lot that she had never known before.

Vignette 6
Maura decided to enter a contest on Facebook to wi a collection of books on the history of magic.
She put in a ton of entries and wound up winning the collection.
She learned that the last name of the famous magician and escape artist who died of appendicitis was Hardeen.
She learned that the last name of the famous magician and escape artist who died of appendicitis was Houdini.
She learned that the last name of the famous magician and escape artist who died of appendicitis was not Houdini, but Hardeen.
She learned that the last name of the famous magician and escape artist who died of appendicitis was not Hardeen, but Houdini.
Maura continued to go through the collection and learn many more interesting facts on magic.

Vignette 7
Mr. Finn took his sixth grade science class to the local petting zoo.
He wanted to make sure his students knew the names of the different baby animals.
For example, his class learned a young sheep is not called a calf, but a lamb.

For example, his class learned a young sheep is called a calf.
For example, his class learned a young sheep is not called a lamb.
For example, his class learned a young sheep is not called a lamb, but a calf.
The trip helped Mr. Finn's students do well on their next test on zoo animals.

Vignette 8
Jonathan is an avid history buff an is a particular fan of studying the Civil War era.
He likes to study the Civil War era and the key figures of the era.
He learned that the last name of the man that assassinated Abraham Lincoln was Booth.
He learned that the last name of the man that assassinated Abraham Lincoln was not Oswald, but Booth.
He learned that the last name of the man that assassinated Abraham Lincoln was not Booth, Oswald.
He learned that the last name of the man that assassinated Abraham Lincoln was Oswald.
Jonathan was interested in learning more about the vents that surrounded the assassination.

Vignette 9
Monty loves watching television shows about geography.
One of his favorite shows to watch is one about large fishing boats going out into the largest oceans on earth.
He learned that the name of the largest ocean on the earth is not the Pacific, but the Atlantic.
He learned that the name of the largest ocean on the earth is not the Atlantic, but the Pacific.
He learned that the name of the largest ocean on the earth is the Atlantic.
He learned that the name of the largest ocean on the earth is the Pacific.
Monty hopes to one day go and see it.

Vignette 10
Eric has always loved storms.
He recently attended a conference in Arkansas that was discussing what caused different types of storms.
While there, he learned that the name of a cyclone that occurs over land is called a hurricane.
While there, he learned that the name of a cyclone that occurs over land is called a tornado.
While there, he learned that the name of a cyclone that occurs over land is not called a hurricane, but a tornado.
While there, he learned that the name of a cyclone that occurs over land is not called a tornado, but a hurricane.

Eric was glad he went to the conference.

Vignette 11
Andy went on a trip to Italy and while he was there he visited many popular cities.
He particularly likes to visit and explore unique cities.
He learned that the name of the city in Italy that is known for its canals was not Venice, but Florence.
He learned that the name of the city in Italy that is known for its canals was Venice.
He learned that the name of the city in Italy that is known for its canals was not Florence, but Venice.
He learned that the name of the city in Italy that is known for its canals was Florence.
Andy really enjoyed his trip to Italy and visiting all the different attractions.

Vignette 12
Allie was digging through her closet last week and foud her old CD collection.
She was surprised to find that her whole collection was mainly early rock n roll.
She learned that the last name of the singer that recorded "Heartbreak Hotel" and "All Shook Up" was Elvis.
She learned that the last name of the singer that recorded "Heartbreak Hotel" and "All Shook Up" was Presley.
She learned that the last name of the singer that recorded "Heartbreak Hotel" and "All Shook Up" was not Elvis, but Presley.
She learned that the last name of the singer that recorded "Heartbreak Hotel" and "All Shook Up" was not Presley, but Elvis.
Allie decided to spend the rest of the day listening to her collection.

Vignette 13
Betty went on a trip to a casino for her 21st birthday.
Before she went, she read and took notes on a few books on poker so she could understand it better.
She learned that the poker hand in which all the cards are the same suit was called a flush.
She learned that the poker hand in which all the cards are the same suit was called a straight.
She learned that the poker hand in which all the cards are the same suit was not called a flush, but a straight.
She learned that the poker hand in which all the cards are the same suit was not called a straight, but a flush.
She made sure to write down everything that the book said in her notes.

Questionnaire

List 1

What is the last name of the singer who recorded "Heartbreak Hotel" and "All Shook Up"?

A. Brown B. Elvis

C. Lewis D. Presley

Who was the Egyptian Queen who joined forces with Mark Antony

A. Hatshepsut B. Cleopatra

C. Calypso D. Nefertiti

What is the name of the largest ocean on Earth?

A. Indian B. Artic

C. Pacific D. Atlantic

What is the name of the poker hand in which all of the cards are the same suit?

A. Flush B. Straight

C. Royal D. Pairs

What is the last name of the man who assassinated Abraham Lincoln?

A. Oswald B. Buchanan

C. Booth D. Sirhan

In which sport is the Stanley Cup awarded?

A. Soccer B. Football

C. Hockey D. Tennis

What is the name of the city in Italy which is known for its canals?

A. Vienna B. Rome

C. Venice D. Florence

What is the last name of the famous magician and escape artist who died of appendicitis?

A. Siegried B. Houdini

C. Hardeen D. Copperfield

What is the last name of the man who showed lightning is electric?
A. Franklin B. Edison
C. Ford D. Bell

What is the name for the thick layer of fat on a whale?
A. Peduncle B. Blubber
C. Rostrum D. Flubber

What is the name of a young sheep?
A. Lamb B. Foal
C. Calf D. Doe

What is the name of a cyclone that occurs over land?
A. Cyclone B. Tempest
C. Tornado D. Hurricane

What is the name of the chapel that has a ceiling painted by Michelangelo?
A. St. Peter's B. Basilica
C. Sistine D. Louve

List 2

What is the name of a cyclone that occurs over land?
A. Cyclone B. Tempest
C. Tornado D. Hurricane

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List 4

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Stephanie Marie Huette (shuette)

From: Christopher Wayne Whitehead (cwhitehd) on behalf of Institutional Review Board
Sent: Friday, June 19, 2015 12:27 PM
To: Stephanie Marie Huette (shuette)
Subject: IRB Approval 2810

Hello,

The University of Memphis Institutional Review Board, FWA00006815, has reviewed and approved your submission in accordance with all applicable statuses and regulations as well as ethical principles.

PI NAME: Stephanie Huette
CO-PI:
PROJECT TITLE: Perception of language
FACULTY ADVISOR NAME (if applicable): N/A
IRB ID: #2810
APPROVAL DATE: 06/19/2015
EXPIRATION DATE: 06/19/2016
LEVEL OF REVIEW: Expedited

Please Note: Modifications do not extend the expiration of the original approval

Approval of this project is given with the following obligations:

1. If this IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.

2. When the project is finished or terminated, a completion form must be completed and sent to the board.

3. No change may be made in the approved protocol without prior board approval, whether the approved protocol was reviewed at the Exempt, Exedited or Full Board level.

4. Exempt approval are considered to have no expiration date and no further review is necessary unless the protocol needs modification.

Approval of this project is given with the following special obligations: