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Anger and memory: Misleading people is easy when they are mad

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Michael Jay Greenstein

We, the dissertation committee for the above candidate for the

Doctor of Philosophy degree, hereby recommend

acceptance of this dissertation.

Dr. Nancy Franklin – Dissertation Advisor
Associate Professor, Department of Psychology

Dr. Christian Luhmann- Chairperson of Defense
Assistant Professor, Department of Psychology

Dr. Aprajita Monhanty
Assistant Professor, Department of Psychology

Dr. Paul Connell
Assistant Professor, Marketing, College of Business

This dissertation is accepted by the Graduate School

Charles Taber
Interim Dean of the Graduate School

Abstract of the Dissertation

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Previous work has shown that different discrete emotional states (e.g. anger) affect cognitive processing differently. Anger has been associated with simplifying cognition to promote rapid action-related processes. For example, anger promotes an increased tendency to rely on preexisting cognitive biases. Such a processing style may have been advantageous in evolutionary history, but it can also lead to increased memory errors. The present study examined the simplifying effects of anger on memorial processing, using three different misinformation paradigms. The first experiment, using a classic three-phase misinformation paradigm, showed that anger directly affects memory performance and that anger increases acceptance of misinformation in situations involving both memory suppression and updating. Experiment 2 expanded upon this finding, suggesting that anger may specifically impair one's ability to suppress false information that is later retracted. Finally, Experiment 3 presented a potential boundary condition for the effects of anger on memory. Anger did not affect participants' metamemorial responses after false feedback, nor did anger lead people to alter their interpretation of ambiguous feedback. Together, these experiments showed that angry

people may be more susceptible to misinformation effects than non-angry people. They also provide evidence that anger may alter memorial processing in this manner because people tend to engage in simpler forms of processing when angry. Therefore, this has implications for both an understanding of memory and real-world application.

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I. Introduction

The effect of anger on cognition

People often feel angry when they are the victim of a crime or when they hear about events like the 2012 Sandy Hook Elementary School Shooting and the 2013 Boston Marathon bombing. While events such as these are rare, they elicit anger because they involve either the infliction of intentional harm or the violation of a social norm (Berkowitz & Harmon-Jones, 2004; Carver & Harmon-Jones, 2009; Frijda, 1988; Quigley & Tedeschi, 1996). Since anger is elicited in such situations, it is one of the most frequently experienced emotions (Frijda, 1988). Moreover, the experience of an emotion, like anger, affects the way a person processes information (Labar, 2007; Lundqvist & Ohman, 2005; Reisberg & Hertel, 2004), even when the information is unrelated to the experience of the emotion (Bower, 1981; Isen, Shalker, Clark, & Karp, 1978; E. J. Johnson & Tversky, 1983; Loewenstein & Lerner, 2003; Nielson & Powless, 2007). Since anger is so frequently experienced, it may greatly affect the way a person experiences the world.

Emotions are generally characterized by the processing style and action tendencies that they promote (Barrett, 1998; Ekman & Friesen, 1971; Ekman et al., 1987; Izard, 1992), which are related to the circumstances that elicit them (Ekman, 1992; Frijda, 1988; Levine & Burgess, 1997). Anger-inducing situations often involve interpersonal conflict (Berkowitz & Harmon-Jones, 2004; Sell, Tooby, & Cosmides, 2009), and anger promotes processes that assist in surviving such situations. Because of this, anger leads to a rapid action-related processing style rather than slow deliberative processing style (Bodenhausen, Sheppard, & Kramer, 1994; Frijda, 1988; Harmon-Jones, Sigelman, Bohlig, & Harmon-Jones, 2003; Mackie, Devos, & Smith, 2000). Evidence for this can be seen in anger's effects on attention (Finucane, 2011; Ford et al.,

2010), memory (Levine & Burgess, 1997; Talarico, Berntsen, & Rubin, 2009), and decision making (Bodenhausen et al., 1994; Lerner & Keltner, 2001).

Attention. One of anger's effects is to narrow processing by promoting goal-relevant and inhibiting goal-irrelevant cognition. This goal-based focus is evidenced in the effects of anger on selective attention (Ford et al., 2010; Wilkowski & Robinson, 2008). For example, angry people detect hostile images faster than neutral people (Van Honk, Tuiten, de Haan, vann de Hout, & Stam, 2001). Detecting hostility is a goal-based element of anger because it promotes survival by allowing a person to respond faster to potentially hostile stimuli. Further evidence for goal-directed processing can be seen in how angry people interpret ambiguity. Specifically, angry people are more likely than neutral people to interpret ambiguous situations and images as hostile (Goldberg, Lerner, & Tetlock, 1999; Quigley & Tedeschi, 1996; Wilkowski, Robinson, Gordon, & Troop-Gordon, 2007). An increased sensitivity to both hostile and potentially hostile threats can increase the person's ability to survive a potentially dangerous situation. Anger, however, is also elicited in situations that do not involve hostility. For example, anger may be elicited when goal-attainment is unfairly blocked (Berkowitz & Harmon-Jones, 2004). Therefore, anger also narrows attention toward reward-relevant stimuli, and angry participants spend greater amounts of time attending to rewarding images than to neutral images (Ford et al., 2010). Furthermore, because emotions affect unrelated cognition, anger also narrows attention in selective attention tasks that don't involve anger-relevant stimuli (Finucane, 2011).

Risk perception. The narrowed focus of anger can be further seen in its effects on risk perception. Angry people judge events related to the main eliciting factors of anger (i.e. norms violations) as more likely than do people experiencing other emotions (DeSteno, Petty, Wegener, & Rucker, 2000). This may occur because angry people interpret a greater range of actions as

intentionally hostile than people who are not angry (Quigley & Tedeschi, 1996). This effect is specific to hostile actions, possibly because anger focuses attention on such events. In contrast, angry people perceive less risk of being involved in potentially dangerous events (e.g. tornadoes) than people who are not angry (Fischhoff, Gonzalez, Lerner, & Small, 2005; Lerner, Gonzalez, Small, & Fischhoff, 2003). These optimistic risk appraisals may be associated with another element of anger's effect on cognition. Specifically, while anger is associated with negative events, angry people feel confident that they can affect the outcome of the event (Ortony, Clore, & Collins, 1988). This confidence may lead people to make optimistic risk-assessments for events unrelated to the eliciting factors of anger.

Anger may affect risk estimates for reasons other than increased confidence or an altered attentional focus. Anger is also associated with an increased tendency to engage in simplified decision strategies such as heuristic use (Bodenhausen et al., 1994; Lerner, Goldberg, & Tetlock, 1998; Tiedens & Linton, 2001). Heuristics are simple cognitive shortcuts that people tend to use (Tversky & Kahneman, 1973). Using heuristics to make decisions can lead to rapid, accurate responses, but heuristics may also lead to increased errors (Macleod & Campbell, 1992). For example, Bodenhausen et al. (1994) presented angry and neutral participants with an essay about banning meat from campus. Supposedly, either the Student Vegetarian League or the Student Government wrote the essay. Neutral participants rated the two essays as roughly equally persuasive, but angry participants rated the essay by the group with the perceived bias as less persuasive than the presumably unbiased group. Since the essays were the same, this suggests that angry participants were more likely than neutral participants to base their judgments on superficial cues like source credibility or stereotypes (Bodenhausen et al., 1994). While information like source credibility or expertise can be important when evaluating arguments

(Tiedens & Linton, 2001), overuse of such information represents a quicker, but sometimes less accurate, way of thinking about the material.

Overreliance on heuristic processes could explain the optimistic risk assessments observed in angry participants. Research suggests that people use the availability heuristic when making risk assessments. This can lead to both the over and underestimated risk assessments (E. J. Johnson & Tversky, 1983). If anger increases the tendency to use such a process, then angry people should show more biased risk assessments than neutral people, as they do. Specifically, anger may make incidents of interpersonal harm more available, but reduce access to other forms of harm, such as natural disasters. Furthermore, because the availability heuristic is related to memory search, any direct effects of anger on memory may also bias judgments.

Memory. Anger is particularly likely to affect memory because it alters a person's internal context, which can affect memory during either encoding or retrieval (Bartling & Thompson, 1977; Morris, Bransford, & Franks, 1977; Tulving & Thomson, 1973). People are more likely to retrieve information when the context at retrieval matches the context during encoding. Therefore, information encoded while angry is easier to retrieve while angry than while in another emotional state (Blaney, 1986; Brown & Kulik, 1977; Christianson, 1992; Laney, Heuer, & Reisberg, 2003; E. F. Loftus, Miller, & Burns, 1978). This emotion-related state-dependence effect may alter risk assessment. Someone who is making risk judgments while angry may base their judgments on relatively more anger-related memories than they would in another emotional state. This form of memory retrieval may account for the increased belief in the risk of hostile actions by another. Therefore, in addition to increasing the likelihood of engaging in relatively simplified judgment processes, anger may bias the results of memory

search toward anger-related information (Bower, 1981; Mayer, Gaschke, Braverman, & Evans, 1992; Robinson & Rollings, 2011).

Anger's effects on attention may similarly alter memory. People experiencing anger are more likely to remember anger-related stimuli (Blaney, 1986), which may be a consequence of an increased tendency to attend to anger-related stimuli. Furthermore, just as people attend to goal-relevant information when angry (Ford et al., 2010; Wilkowski & Robinson, 2008), angry people are more likely than neutral people to remember goal-relevant information (Levine & Burgess, 1997).

Anger also reduces a person's response threshold. When making memory decisions, a person must set a criterion that for the amount of information required to decide that a memory is old. If anger reduces a person's response threshold, then angry people would be more likely to indicate that information was old than neutral people. For example, angry people are more likely than neutral people to false alarm to the critical lure in a Deese/Roediger–McDermott (DRM) task (Corson & Verrier, 2007). Since the critical lure is not presented in DRM tasks, this tendency would occur if an angry participant's criterion for responding were lower than a neutral participant's. Greenstein and Franklin (2012) further explored this by presenting angry and neutral participants with a lineup task. They found that angry participants were more likely than neutral participants to identify someone in the lineup as having been present during the encoding phase. This occurred both when there was a picture from the encoding phase and when there were no pictures from the encoding phase in the lineup. Therefore, anger increased both participants' hits and false alarms, while reducing misses and correct rejections.

A reduced response threshold may be an element of anger's broader effects on cognition. Generally, anger seems to increase type I errors while decreasing type II errors. This may occur

because the consequences of a type I error are evolutionarily less severe than a type II error. Falsely believing someone was acting in a hostile manner may result in the need to apologize. In contrast, failing to recognize that someone was acting in a hostile manner may result in injury or death. Similarly, narrowed attention toward anger-relevant stimuli may speed up responding to them. Since anger may have evolved specifically to deal with hostility and other situations where type II errors are particularly dangerous, anger may broadly promote processes that reduce the likelihood of such error, like a reduced response threshold.

Surprisingly, given the broad effects of anger on cognition, little research has been done examining the mechanisms through which anger affects cognition. This dissertation expands upon the literature examining anger's effects on memory by examining how anger affects false memories. False memory research provides a potential avenue for understanding the mechanisms through which anger alters the reconstructive process of memory. By both creating and altering a memory in the laboratory, the mechanisms through which anger alters the memory can be directly examined. Use of such methods allows for direct examination of the predicted mechanisms through which anger may affect memory. As anger has been associated with increased heuristic use and a reduced response threshold, examining the effects of anger on false memory can help to determine the circumstances through which these different processes alter memory. Since people rely on memory when making judgments, examining anger's effect on memory may provide insight into how anger broadly affects the cognitive system.

False Memory

False memory research both reflects a real-world phenomenon, and can be used to examine underlying processes in memory that may otherwise be difficult to examine. Memory intrusions from the altered information provide insight into the factors that generally affect

memory. Because of this, many false memory paradigms examine aspects of memory's reconstructive nature. Some of the more commonly used paradigms are the Deese/Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & Mcdermott, 1995), the three-phase misinformation paradigm (E. F. Loftus, 1979; E. F. Loftus et al., 1978; Tousignant, Hall, & Loftus, 1986), the continued influence effect (Ecker, Lewandowsky, & Tang, 2010; H. M. Johnson & Seifert, 1994), and the false feedback effect (Wells & Bradfield, 1998). These examine how people use their prior knowledge to create false beliefs, how newly presented information can affect recall of original information, the role of suppression in memory, and the malleability of metamemory judgments.

Anger may affect false information processing in several ways. Heuristic use (McCabe, Presmanes, Robertson, & Smith, 2004), response bias (Hekkanen & McEvoy, 2002; Miller & Wolford, 1999; Payne, Toglia, & Anastasi, 1994), executive function (Jaschinski & Wentura, 2002; Zaragoza & Lane, 1998), and the false information's plausibility (Ackil & Zaragoza, 1995; Garry, Gerrie, & Belcher, 2006; Perez-Mata & Diges, 2007) have all been implicated in affecting susceptibility to false information effects. Anger has been shown to affect heuristic use (Bodenhausen et al., 1994; Tiedens, 2001) and response bias (Greenstein & Franklin, 2012), both of which may make a person more susceptible to false information effects. Therefore, anger's effect on heuristic use or response bias may affect false information processing.

As discussed earlier, when experiencing anger while making a decision, people are more likely to use a heuristic processing style. Increased heuristic use would increase the likelihood of engaging in relational or fluency-based processing, both of which have been implicated in increasing susceptibility to false information effects (Garry et al., 2006; McCabe et al., 2004; Pierce, Gallo, Weiss, & Schacter, 2005). For example, Garry et al. (2006) presented participants

with videos of stereotyped actions, like making a sandwich. They edited the videos to have either low or high fluency elements of the scenario missing. An element's fluency was defined based upon its relevance to the schema of making a sandwich. Putting peanut butter on the bread was considered high fluency because of its relevance to the schema of peanut butter sandwich, while washing the knife was low fluency because of its relevance to the schema. They found that people were more likely to falsely recall missing high than low fluency film sections. Therefore, information's fluency, or schema relevance, affects the likelihood of a person's believing it was present. If anger increases a person's tendency to use this heuristic, then angry people would be particularly susceptible to this form of false information effect. Thus, angry people may be especially likely to report remembering highly plausible or schematic false information.

In addition to affecting heuristic use, anger has been shown to reduce a person's response criterion (Greenstein & Franklin, 2012). Hekkanen and McEvoy (2002) found participants who had a lower response criterion were more likely to accept misinformation than were participants with a higher response criterion. If anger reduces a person's response criterion, then anger may increase susceptibility to false memories. As angry participants were more likely than neutral participants to false alarm to a critical lure in a DRM task (Corson & Verrier, 2007), it suggests that anger's tendency to reduce one's response criterion does affect acceptance of false information. However, due to the nature of DRM experiments, it is not possible to rule out anger's effects on heuristic use. Specifically, if anger increased a person's likelihood of engaging in relational processing, then angry participants would show increased acceptance of critical lures in a DRM task.

A person's working memory capacity is negatively correlated with the likelihood of their accepting misinformation (Jaschinski & Wentura, 2002; Waring, Payne, Schacter, & Kensinger,

2010). There is, however, little evidence that anger directly affects executive function. Emotional stimuli have been shown to affect feature binding in working memory (Hadley & Mackay, 2006; Mather et al., 2006; Mather & Nesmith, 2008; Talmi, Luk, McGarry, & Moscovitch, 2007). In a memory task involving updating a photo's location, participants were impaired for emotional compared to neutral pictures. This impairment occurred only when emotionally arousing pictures changed locations. In fact, people were better at binding object to location for emotionally arousing images than neutral images when the images did not move. Similarly, the effects of an experienced emotion on working memory tasks involving neutral stimuli are similarly mixed (Joormann, Levens, & Gotlib, 2011; Levens & Gotlib, 2010). Thus, in addition to there being no direct examinations of anger's effects on executive function, work examining emotional arousal provides no clear predictions for the effects of anger on working memory.

In contrast, many studies have shown a relationship between executive function and anger expression (McDonald, Hunt, Henry, Dimoska, & Bornhofen, 2010; Sprague, Verona, Kalkhoff, & Kilmer, 2011). Instead of examining the effects of anger on working memory, these studies have examined the effect of working memory on anger expression. Increased executive function is associated with decreased amounts of anger expression. This relationship between executive function and anger expression suggests that there is effort involved in displaying and controlling anger. Because of this, anger may impair executive function tasks. If executive resources are used to hide anger expression, then those resources may not be available to engage in other executive tasks. Furthermore, the remaining executive resources may be engaged in promoting anger-related processing. Since anger promotes action-related processes, anger may guide executive function resources away from inaction-related processes. Suppression, for

example, is a complex executive task related to inaction. Since suppression is an active process of inaction, it may be difficult task for an angry person to perform.

Executive function abilities have been shown to affect one's susceptibility to false information. A person's ability to recollect specific information can aid in recognizing information as false and then in suppressing the result (Brainerd, Stein, Silveira, Rohenkohl, & Reyna, 2008). Thus, when someone knows information is false, the false information must be suppressed when responding. If anger were to impair one's ability to suppress information, then it could increase susceptibility to false information effects involving the suppression of known false information.

Overview of the Current Experiments

The current dissertation attempted to examine the mechanisms through which anger affects memory using three false information paradigms. Many of the known effects of anger on cognition suggest that anger should increase a person's susceptibility to false information effects compared to neutral participants. Thus, it is important to determine whether anger's effects on false memory acceptance may be due to working memory, heuristic use, response threshold changes, or, alternatively, some combination of these processes.

The first experiment examined how anger affects the likelihood of incorporating false information using a classic three-phase misinformation paradigm (E. F. Loftus et al., 1978). As the fluency of processing a piece of information affects the likelihood of falsely remembering it, people should be more likely to accept schematic false information than schema-irrelevant false information (Garry et al., 2006). Knowing this, the first experiment examined anger's effect on schematic and schema-irrelevant false information to determine whether it affects heuristic use, response thresholds, or both. Both increased heuristic use and a criterion shift should increase a

person's susceptibility to false information. If anger increased a person's tendency to engage in heuristic use, then angry participants would be particularly susceptible to schematic misinformation and relatively less susceptible to non-schematic misinformation. In contrast, if anger reduced a person's response criterion, then angry participants would be more susceptible to misinformation than neutral participants, but not especially susceptible to schematic misinformation.

The second experiment tested whether anger affected a person's ability to suppress known false information in a continued influence (CIE) paradigm (Ecker et al., 2010). Suppression is an active process relating to inaction (i.e. actively stopping a response). As anger generally enhances action-related processes, it may impair inaction-related processes. If that were the case, then angry participants would be more likely than neutral participants to report known false information was true. Additionally, angry participants may be more likely than neutral participants to draw inferences from known false information. This would reflect an effect of anger on one's ability to suppress known false information.

Finally, the third experiment examined whether anger would lead one to distort one's memories to conform to one's beliefs. Research examining the hindsight bias and knew-it-all-along effect has shown that people generally have a tendency to distort their memory to reflect their knowledge (Arnold & Lindsay, 2007; Bradfield & Wells, 2005). Angry people may be particularly likely to distort their memories because anger promotes optimistic beliefs in one's abilities (Lerner & Keltner, 2001). Alternatively, it is possible that anger may increase a person's tendency to engage in predisposed actions to speed up responding. For example, when making lineup decisions, people have a general tendency to choose a person (Wells, 1984). If anger increases the likelihood of engaging in predisposed actions, then anger may increase one's

tendency to engage in the tendency to distort memories based upon new information. To test this, participants were presented with a false feedback paradigm (Wells & Bradfield, 1998) that involved positive, negative, and ambiguous feedback. If anger increases one's confidence in one's cognition, then angry participants would be generally more confident than neutral participants, and especially more confident following positive or ambiguous feedback. In contrast, if anger increases one's tendency to engage in predisposed processes, then angry participants would be more confident than neutral participants following positive feedback and less confident than neutral participants following negative feedback.

II. Experiment 1: Anger and False Information Detection

Method

Participants:

Eighty-three Stony Brook University undergraduates (42 female) participated in this experiment for partial course credit. All were native English speakers between the ages of 17 and 29 (M=19.33, SD=1.96). The participants were randomly assigned to an experimental condition (Angry and Neutral) and version. All participants were run individually because the experiment involved an emotion induction.

Materials:

All of the materials for the study were presented on a Dell computer using the Superlab presentation software. The participants were given two measures of inhibition: a modified Stroop task and a Go/No-Go task.

During the modified Stroop task, participants were presented with words in the center of the computer screen. The word stayed on the screen until the participant pressed the correct key corresponding to the color in which the word appeared. The 48 trials of the Stroop task were divided into 18 color-name consistent trials and 30 color-name inconsistent trials.

During the Go/No-Go task, participants saw letters appear in the center of the screen. Any time a letter appeared on the screen, the participant was to press a key as fast as possible. However, if the letter that appeared was the letter ‘x, ’ then the participant was not supposed to do anything (Miyake et al., 2000). There were 180 go trials and 60 no-go trials. During the go trials, participants were presented with distractor letters (z, b, c, n, h, o, m, t, and e).

These working memory tasks were used to examine whether there were any preexisting differences in participants’ ability to inhibit or suppress information (Miyake et al., 2000). Any

preexisting executive function differences between angry and neutral participants could account for the potential differences in the participant's susceptibility to misinformation.

The initial stimulus for the experiment was an edited series of clips depicting three scenes from the film Defending Your Life (1991). The first scene showed the first meeting of the two characters, the second showed the end of their first date, and the third showed a second date at a nice restaurant. Because the clips were presented out of the context of the full film, the participants were given a short narrative explaining a fictional context to them (Appendix A). In addition to providing context, the narrative anchored the events within the schema of a first date.

The participants were presented with five self-report questionnaires: the General Self-Efficacy (GSE) scale (Schwarzer, Bäßler, Kwiatek, Schröder, & Zhang, 1997), the Self-Monitoring scale (Snyder, 1974), the Clinical Anger Scale (CAS) (Snell, Gum, Shuck, Mosley, & Hite, 1995), the State-Trait Anger Expression Inventory (STAXI) (Moscoso & Spielberger, 1999), and a subset of the Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988). Each of these self-report scales was presented on the computer using the Superlab presentation software. The items were presented one at a time on the computer screen and the participants were not given the option of skipping questions.

Self-efficacy is a measure of how well a person believes they can perform in a given situation. Because anger is associated with an optimistic belief in one's ability to successes, it could affect a person's self-efficacy. However, because of the nature of the anger induction, it is also possible it could reduce a person's self-efficacy. If the anger induction affected self-efficacy, then the reduced self-efficacy may affect their confidence or memory. This could mean that any observed effects of anger could be an artifact of the method of anger induction rather than a true effect of anger on cognition. To test this, the GSE is a 10-item scale that measures

how people cope with adversity. Participants were presented with statements like “If I am in trouble, I can usually think of a solution” and were asked to rate how true they found the statement to be on a 4-point scale (1=not at all true, 4=exactly true).

The 25-item self-monitoring scale measures the degree to which a person changes their actions based upon the situation they are in. The participants were asked to indicate whether the presented items were related to them by answering true or false. People who are high in self-monitoring have been shown to be more likely than people who are low in self-monitoring to incorporate misinformation into their memory for an event (Geiselman, Haghighi, & Stown, 1996; Hosch, Marchioni, Leippe, & Cooper, 1984).

The 4-alternative forced choice CAS measures state and trait elements of anger. The participants were presented with statements describing their experience of anger. They chose one of the options that described how they felt (e.g. I don’t feel angry enough to hurt someone; Sometimes I am so angry that I feel like hurting others, but I would not really do it; My anger is so intense that I sometimes feel like hurting others; I'm so angry that I would like to hurt someone).

The STAXI measures state anger, trait anger, and the ways in which people express their anger (Moscoso & Spielberger, 1999). When completing the state portion of the inventory, participants were asked to respond on a four-point scale (Not at all to Very much so) about the degree to which they currently felt the described statements (e.g. I feel like breaking things). The trait portion of the inventory also involved a four-point scale (Almost never to Almost always) that asked participants to respond about how they generally felt rather than their current state (e.g. I have a fiery temper). Finally, the expression element of the scale used the same scale as

the trait section, but asked people to respond to statements about how they express or control their anger when they are feeling angry.

The abridged PANAS presented participants with a series of emotion words and asked them to rate the degree to which they felt the emotion over the course of the experiment using a 5-point Likert scale. Some of the items included in the scale asked about the participant's experience of anger, while others ask about unrelated emotions like guilt or excitement.

Together, the PANAS, the CAS, and the STAXI examined state and trait elements of the participant's anger. It is important to measure state elements of anger as both a manipulation check and because it is not possible to control a participant's pre-experiment emotional state. Participants in the neutral condition who entered the experiment in a state of high anger may have responded similarly to participants in the anger condition. In contrast, the STAXI: Trait measure and CAS were included to show that the observed differences between the conditions of the experiment were not due to trait differences before entering the lab. The purpose of the experiment was to examine whether differences in state, not trait, anger affected processing. Therefore, trait measures were included to determine whether there were preexisting trait differences between participants in the two conditions. Also, people who have high ratings of trait anger may differ significantly from people who have high ratings of state anger in both their general response patterns and their responses to the anger induction.

Procedure:

Participants were presented with the Stroop and Go/No-Go tasks. These measures were given at the beginning of the experiment because they may have otherwise been affected by the anger manipulation. Following the working memory tasks, participants were presented with a

short pre-video narrative that provided some context for the encoding phase, followed by the clip from the movie Defending Your Life (1991).

After the 8:17 film clip, the participants were given either a neutral or an angry emotion induction. The emotion induction served the dual purpose of inducing an emotion and creating a delay between the encoding and the misinformation phases. Both inductions were made up of same three tasks: The number-letter task (Rogers & Monsell, 1995), a trivia test (Greenstein & Franklin, 2012), and an interview, but the experimenters acted differently depending upon the condition. The difference in the experimenter actions (below) and the general difficulty in the tasks served to induce anger or to keep the participants in a neutral state.

The first task of the emotion induction phase was the number-letter task (Rogers & Monsell, 1995). Participants were presented with number-letter pairs (e.g. 5B) in one of four quadrants on the screen (i.e. upper right, upper left, lower right, lower left). If the pair appeared on the top of the screen, the participant's job was to indicate if the letter was a consonant or a vowel by pressing the 'S' or 'L' keys. If the pair appeared on the bottom half of the screen, the participant's job was to indicate if the number was even or odd by pressing the 'S' or 'L' keys. If the participant responded correctly, a new number-letter pair would appear in the next quadrant on the screen clockwise from the current location. If the participant responded incorrectly, a blank screen would appear for 500ms and then a new pair would appear. If the participant did not respond within two seconds, the next number-letter pair would appear on the screen. The task lasted for exactly four minutes before a screen appeared instructing the participant to inform the experimenter that it had ended.

After the number-letter task, the participants were given a trivia test (Greenstein & Franklin, 2012). There were two types of questions in this trivia test: 4-alternative forced choice

questions and fill-in-the-blank questions. Questions ranged from easy (e.g. What is the name of the character on Sesame Street who likes cookies? A: Big Bird, B: Elmo, C: Oscar the Grouch, D: The Cooking Monster) to difficult (e.g. What is the word used to describe the irrational fear of alcohol? A: Ethylphobia, B: Alcophobia, C: Methyphobia, D: Parthenophobia). The forced choice questions had to be answered correctly before the experiment would allow participants to continue to the next question. The fill-in-the-blank questions similarly ranged from easy (e.g. Who was America's first President?) to difficult (e.g. What network, aimed at kids, was founded in 1977 as "Pinwheel," until adopting its current name in 1981?). Like the number-letter task, the trivia task ended after four minutes had elapsed.

The final element of the emotion inductions was called the Cognitive Skills Interview. During this interview, the participants were asked to explain, as though explaining to a young child, how to tie their shoes. The participants were asked a series of scripted questions to help flesh out their descriptions and to extend the length of the interview. Like the other elements of the emotion induction, the interview lasted for exactly four minutes before the experimenter ended the interview.

As discussed, the difference between the angry and neutral conditions of the experiment was in the scripted actions of the experimenter. In the angry condition, the experimenter pretended to be disorganized and uncaring about wasting the participant's time. This began with the experimenter being unable to find the experiment's instructions after the film. The experimenter would start the number-letter program (which was ambiguously named 2.2) and told the participants that it was an intelligence test. The participants were given no further verbal instructions for the task. Following completion of 2.2, the experimenter pretended to find the instructions, and told the participant that not only was the task not the intelligence test, which

was obvious because it didn't ask any questions, but it was also for a different experiment that the experimenter was running. The participants were then told that the next task was the actual intelligence test. During the trivia task, the forced choice questions were locked so that participants must press a capital letter to answer them. The participants were not told this information. After the participant failed to answer the first question (i.e. Cookie Monster) four times, the experimenter asked them why they were on the first question. Upon seeing the participant fail to use a capital letter, the experimenter "reminded" the participant that capital letters must be pressed. When the trivia task timed out after four minutes, it seemed to freeze on an easy question. After the participants realized the computer was frozen, the experimenter told them that they would need to switch computers and redo that portion of the experiment. After switching, the experimenter pretended to decide that finishing was not important. The experimenter then loaded the next portion of the experiment, but just before starting it, the experimenter "remembered" the cognitive skills interview. During the interview, the experimenter interrupted the participants with questions about very specific details (e.g. "please explain the concept of laces"). The experimenters were instructed to time the questions to be in the middle of thoughts to be as disruptive as possible. The experimenter would also get visibly caught up in the interview, and would obviously not write down the participant's answers. After two minutes of the interview, the experimenter would pretend to notice that nothing was written. After noticing this, the experimenter would tell the participant to return to one of the earliest questions. This paradigm is a modified version of a harassment paradigm that has been shown to induce anger reliably (Greenstein & Franklin, 2012; Lobbestael, Arntz, & Wiers, 2008).

In contrast to the anger induction, the experimenter in the neutral induction acted professionally. Like in the angry condition, the experimenter pretended to lose the instructions,

but instead of being unable to find them, the experimenter found them quickly. There were no specific instructions for how to perform the number-letter task, but the participants were told the actual name of the task and were warned that it was difficult. Following the number-letter task, the instructions for the trivia task were the same, but the task was not key-locked to accept only capital letters. After the four minutes of the task elapsed, the ending screen for the trivia task explained that the task was over rather than being frozen in on an easy question. The participants were also shifted to another computer before the cognitive skills interview, but the interview was not antagonistic. Instead of pretending not to write down the participant's responses, the experimenter pretended to write everything the participant said. The experimenter asked the participant the same questions as in the angry condition interview, but instead of interrupting the participant, the experimenter held the questions until the end. The experimenter also gave the participants time to come up with answers rather than acting as if delays were a problem.

Following the emotion induction, the participants began the misinformation phase. The participants were given a 40-question multiple-choice test based upon the movie. Each multiple-choice question contained a parenthetical element that did not alter the question's answer. These parenthetical elements were unrelated to the multiple-choice questions (e.g. **When Julia objects to leaving** what does she say about the food portions?). Half of the parenthetical elements contained information that was consistent with the scene the participants had seen, and half of them contained misinformation that did not directly contradict information from the film (E. F. Loftus et al., 1978). The misinformation was placed parenthetically within the question so that it could be answered even if the participant objected to the presence of the information that was not from the film (e.g. **When Julia tastes one of Daniel's shrimp** what does she say about the food portions?). Other than containing information not present in the film, the misinformation did not

directly contradict any film elements. Half of the misinformation was schema-consistent (concerning the sorts of details people would normally expect given their prior knowledge of similar situations), and half was schema-irrelevant (concerning details that people would normally have no expectations about given their prior knowledge of similar situations).

After the misinformation phase, the participants were given a second emotion induction to reinforce their experience of the previously induced emotion. The second emotion induction was a cued autobiographical writing task. Participants in the angry condition were asked to write about a time they felt betrayed by a friend, family member, or loved one, and participants in the neutral condition were asked to write about a time they visited a park, museum, or historic place. The participants were given 12 minutes to write about their events before moving on. If the participants finished before 12 minutes had elapsed, they were either cued to write about another event, or were asked to read over their current one to see if there were any elements about their feelings, experiences, or memory that they could add. Participants who had more than four minutes remaining in the writing task were asked to write about a second event, while those with fewer than four were asked to reread their initial story.

After 12 minutes, the participants received the same 80-item source memory test. The source test consisted of presenting the participants with the parenthetical elements from the earlier test and asking the participants to indicate whether it was from one of four potential sources: the film, the questions, the film and the questions, or whether the information was completely new (M. K. Johnson, Hashtroudi, & Lindsay, 1993). The 20 items they had previously been misinformed about made up the critical items, but there were an equal number of questions from each of the four potential sources. The 20 new items were the same as the 20 items that participants in the other version of the experiment had been misinformed about.

Immediately after making their indication of the source of the information on the screen, the participants were asked to indicate how confident they are about their answer. Confidence ratings were made using a 7-point Likert scale.

After the testing phase, all of the participants were given the self-report scales followed by the debriefing. The self-report scales were always presented in the same order: GSES, PANAS, STAXI, CAS, Self-Monitoring. During the debriefing, the participants were asked whether they had ever seen the movie Defending Your Life, and the experiment's deception was explained.

Results

As accepting misinformation is a form of source error, only responses where a participant correctly indicated that the item was old were considered in the source analysis. Therefore, differences between participants in their tendency to recognize items as old could affect misinformation acceptance. Generally, participants were reliably able to discriminate between new and old items during the final test. The six participants who were unable to do so (proportional corrected recognition scores below 45%) were removed from the analysis, as were the three participants who had seen the movie before, and the five who voluntarily left the experiment during the anger induction. This left 18 participants in each condition.

Individual Differences Measures

The participants completed two measures of working memory before the emotion induction, and the self-efficacy and self-monitoring scales at the end of the experiment. If angry and neutral participants differed on any these measures, then it could account for the effects of anger on false information acceptance. There were, however, no differences between angry and neutral participants on the Stroop task ($t(70)=.482$, n.s.), Go/No-Go task ($t(70)=.821$, n.s.), or the

self-monitoring scale ($t(70)=.029$, n.s.). According to the self-efficacy scale, angry participants were marginally less self-efficacious than neutral participants ($t(70)=1.844$, $p=.069$). This difference may have been a product of the emotion induction procedure rather than being a result of the experience of anger. Because of this, participant scores on the self-efficacy scale were centered to reduce effects of multicollinearity and used as a covariate.

Emotion Validation

Participants' scores on the self-report measures of emotion were highly correlated (Table 1). Independent samples t-tests were conducted comparing participants in the angry and neutral conditions on the self-report measures of anger. Participants in the angry condition self-reported greater levels of anger than neutral participants on the STAXI: State measure $t(70)=2.451$, $p<.05$ $d=0.558$, and the PANAS items irritable $t(70)=3.355$, $p<.05$ $d=0.739$ and annoyed $t(70)=4.634$, $p<.001$ $d=0.962$. This suggests that the anger induction successfully induced anger in the participants. Furthermore, while there were differences between angry and neutral participants on the CAS, which measures both state and trait elements of anger ($t(70)=2.312$, $p<.05$, $d=0.529$), there were no differences between angry and neutral participants on the STAXI: Trait measure ($t(70)=1.581$, n.s.). Thus, the differences in anger observed throughout the experiment should be attributed to state rather than trait effects of anger on cognition.

Misinformation Acceptance

Because anger affects both the likelihood of using a heuristic processing style (Bodenhausen, et al., 1994) and a person's response threshold (Greenstein & Franklin, 2012), angry participants were predicted to be more susceptible to misinformation effects than were neutral participants. It is possible that either or both of these factors could affect a person's susceptibility to misinformation. In order to disambiguate between these two factors, participants

were misinformed about schematic and schema-irrelevant information. Previous work has shown that people are more likely to be misinformed about plausible, or schematic, misinformation than schema-irrelevant misinformation (Ackil & Zaragoza, 1995; Garry, Gerrie, & Belcher, 2006). So, all participants were predicted to be more likely to be misinformed about schematic misinformation than schema-irrelevant misinformation. If anger affects misinformation acceptance by increasing heuristic use, then angry participants would have been especially likely to be misinformed about schematic misinformation. In contrast, if anger did not increase heuristic use, but reduced a participant's criterion for accepting the memory as having been presented during the initial encoding, then angry and neutral participants should not be especially likely to be misinformed about schematic misinformation.

I conducted a 2 (emotion condition: anger vs. neutral) x2 (information type: schema consistent vs. schema-irrelevant) x 2 (experiment version) analysis of covariance (ANCOVA), using the centered GSES scores as a covariate, to test these predictions. Because there were no differences between the versions of the experiment in either recognition *(*$F(1, 67)=0.018$, n.s.) or misinformation acceptance *(*$F(1, 68)=0.228$, n.s.), all further analyses were done collapsing across this variable. As predicted, angry participants were more likely than neutral participants to be misinformed $F(1, 69)=4.827$, $p<.05$, $\eta_p^2=0.065$ (Figure 1). Participants were more likely to be misinformed about schematic than schema-irrelevant misinformation ($F(1, 69)=9.604$, $p<.01$ $\eta_p^2=.122$). There was, however, no interaction between the emotion condition of the experiment and the type of information the participant was misinformed about ($F(1, 69)=0.017$, n.s.).

Source Accuracy

As being misinformed is a form of source error (i.e. falsely attributing information from the misinformation phase to the movie), it is possible that anger generally impaired source ability

rather than specifically affecting acceptance of misinformation. In fact, angry participants were generally more likely to make source errors than neutral participants $F(1, 69)=5.494$, $p<.05$, $\eta_p^2=.074$. Further analyses examining this phenomenon were conducted treating each of the three sources (i.e. film, film and questions, and questions only) as different types of information. These analyses found that there was an effect of the original source of the information $F(1, 69)=75.487$, $p<.001$, $\eta_p^2=.522$. The results followed a linear trend, with people being more accurate at identifying the source for film only items than questions and film items, which they were better at than questions only items $F(1, 69)=148.780$, $p<.001$, $\eta_p^2=.683$ (Figure 2).

Making a source error for the misinformed material may represent a different type of error than source errors for material the participants were not misinformed about. The participants were deliberately led to make an error for the misinformed material, while there was not such deliberate attempt to create errors for the non-misinformed material. Because of this, a post-hoc analysis was conducted to see if angry and neutral participants differed on their source accuracy for non-misinformed material. This analysis showed that the observed effects of emotion on source memory was driven by the tendency for angry people to be misinformed rather than a general source monitoring impairments ($F(1, 69)=.449$, n.s.).

Interestingly, when making source errors for items that appeared in both the film and questions, participants were more likely to report that the item appeared in only the film (86% of the time) than that the item was from only the questions $t(70)=21.48$, $p<.05$ $d=2.53$. In contrast, when making source errors for misinformed items (i.e. questions only items) participants were non-significantly more likely to indicate the item was from both the film and the questions (56%) than only the film ($t(70)=1.91$, $p=.078$).

Confidence

In addition to affecting the likelihood of using heuristics or a person's response criterion, anger has been shown to increase a person's confidence in their cognition. If this occurred, then angry participants should be more confident about their memory than neutral participants. Angry participants were not more confident about their memory than neutral participants ($t(70)=1.465$, n.s.). Further analyses examining this prediction could not be done using ANCOVA because of the correlation between self-efficacy and confidence ($r(70)=.429$, $r^2=.184$, $p<.001$), which meant that self-efficacy violated the assumption of homogeneity of regression slopes. Therefore, a regression analysis was done to examine whether a person's emotion condition and self-efficacy was predictive of their confidence. Because outliers can greatly affect the validity of regression analysis, mahalanobis distances were computed. One participant's data constituted a bivariate outlier (i.e. a mahalanobis distance greater than three standard deviations from the mean) so the analyses were conducted after removing the outlier's data. As expected, the regression found an effect of emotion and self-efficacy on confidence $F(2, 68)=13.937$, $p<.001$. Both a person's emotion condition ($\beta=.270$, $t(67)=2.595$, $p<.05$), and a person's general self-efficacy ($\beta=.519$, $t(67)=4.996$, $p<.001$) accounted for differences in the participants' confidence (Figure 3). Furthermore, this pattern existed even when only examining trials in which a person was misinformed ($F(2, 68)=6.069$, $p<.01$) with both the emotion condition ($\beta=.247$, $t(67)=2.169$, $p<.05$), and a person's general self-efficacy ($\beta=.350$, $t(67)=3.078$, $p<.01$) predicting their confidence. In contrast, neither self-efficacy ($\beta=.051$, $t(67)=0.427$, n.s.) nor emotion condition ($\beta=-.201$, $t(67)=-1.666$, n.s.) were predictive of a person's confidence on trials for which they were not misinformed ($F(2, 68)=1.665$, n.s.).

Secondary analyses examining the effects of the information's original source, and schema-relevance on confidence judgments were conducted as within-subject ANOVAs without

using self-efficacy scale as a covariate. These found that participants were more confident about schema-irrelevant information than schematic information ($F(1, 70)=32.378$, $p<.001$, $\eta_p^2=.316$) and that confidence was greatly affected by the original source of the to-be-remembered material $F(2, 140)=34.312$, $p<.001$, $\eta_p^2=.329$ (Figure 4). Generally, participants were more confident about their responses for information presented in both the film and the questions than for items that were presented in either the film or questions only ($F(1, 70)=55.650$, $p<.001$, $\eta_p^2=.443$). It is likely that information presented in both the film and the question was responded to with greater confidence because participants saw the items twice rather than once, and increased exposure can increase confidence. It is, however, worth noting that this increased confidence was in spite of the lower source accuracy for these items compared to film only items.

Finally, there was no relationship between confidence and source accuracy ($r(72)=-.006$). This likely occurred because neutral participants showed the traditional relationship between confidence and accuracy ($r(35)=.468$, $p<.01$) and angry participants showed the opposite relationship ($r(35)=-.461$, $p<.01$). Post-hoc regression analyses were conducted examining this relationship. Because outliers may greatly affect regression analysis, mahalanobis distances were again computed and two participants removed as bivariate outliers. When examining the predictive relationship between emotion and confidence on source accuracy, there was a marginally significant effect $F(2, 67)=2.803$, $p=.068$ (Figure 5). The participant's confidence was not predictive of their accuracy (β=.-.043, $t(66)=.356$, n.s.), which was likely because of the effect of anger (β=.-.283, $t(66)=2.365$, $p<.05$). This analysis provided further evidence that angry participants' confidence unrelated to their accuracy on the memory task.

Response Time

If anger promotes a rapid, action-related processing style, then it would imply that anger should speed up a person's responding. There were, however, no differences between angry and neutral participants in the time it took them to respond in the memory task ($t(70)=1.573$, n.s.). There was, however, a negative correlation between a person's self-reported anger score and their response time ($r(70)=-.287$, $p<.05$). To examine this further, I conducted a regression analysis examining the relationship between a person's self-reported anger, emotion condition, and their response time. Two of the participants were removed as bivariate outliers. The regression suggested that there was no relationship between a person's self-reported anger (β=.-.153, $t(66)=1.238$, n.s.) and emotion condition (β=.-.115, $t(66)=0.931$, n.s.) on their response time ($F(2, 67)=1.583$, n.s.). The difference between the regression and correlations was likely due to the removal of the outliers.

Test 1 Accuracy

The participants in Experiment 1 were induced to experience anger before both the misinformation test and the source test. Because of this, anger's attention narrowing effects during the misinformation phase may have altered their ability to recognize the presented misinformation. There were, however, no differences between angry and neutral participants in their accuracy during the misinformation test ($t(70)=.105$, n.s.). Also, a person's accuracy on a specific question during the misinformation phase was not predictive of their source accuracy during the source test ($F(1, 70)=.684$, n.s.). This suggests that anger did not affect a person's ability to process the information presented during the misinformation phase.

Recognition

The two predicted effects of anger on memory, that anger increases heuristic use or that anger reduces a person's response criterion, predict different effects of anger on recognition

memory. Specifically, a reduced response criterion would predict increased false alarms, while increased heuristic use would predict increased false alarms for only schematic information. Interestingly, there was no effect of emotion on recognition accuracy ($F(1, 69)=.050$, n.s.). Participants were more likely to recognize schema-irrelevant (M=.591, SD=.128) items as old than they were to recognize schematic (M=.488, SD=.132) items as old $F(1, 69)=19.507$, $p<.001$, $\eta_p^2=.220$. As with the previous analyses, there was an effect of the item's original source on the participant's likelihood of indicating that it was old $F(2, 138)=179.192$, $p<.001$, $\eta_p^2=.722$. Participants were more likely to indicate items that were presented multiple times were old than items that were only presented once. Among those that were only presented once, participants were more likely to recognize items from the film than items from the misinformation phase $F(1, 70)=256.372$, $p<.001$, $\eta_p^2=.788$ (Figure 4). Importantly, there were no differences between participants in the angry or the neutral condition on their tendency to false alarm to newly presented items ($F(1, 69)=.039$, n.s.). People were generally more likely to false alarm to schematic than schema-irrelevant new items $F(1, 69)=11.961$, $p<.001$, $\eta_p^2=.148$, which is consistent with the existing literature on false recognition for expected situational details.

Item Analysis

An item analysis was conducted to see if participants were more likely to attribute items to the film when they were misinformed about the item than when the item was new to the testing phase. Generally, the participants were more likely to respond that an item had been present during initial encoding if they were misinformed about the item than if they were not $F(1, 70)=94.249$, $p<.001$, $\eta_p^2=.574$. However, 12 of the 40 items were equally likely to be misattributed to the film regardless of whether the person was misinformed about them. For one of the items, people were disinclined to report that it was old, with only five participants

reporting it as having occurred in any of the film, film and questions, or questions only. The other 11 items were very likely to be reported as having occurred in the film. There were no differences between the two experimental conditions on the likelihood of having such an item, and there were no differences between angry and neutral participants on the likelihood of being misinformed about these items. As such, recalculating the misinformation analyses without including these items non-significantly strengthened the effects of anger on memory $F(1, 67)=5.071$, $p<.05$, $\eta_p^2=.070$.

Discussion

The purpose of Experiment 1 was both to show that anger affected a person's susceptibility to misinformation, and to determine the mechanism through which anger affected memory. As predicted, anger increased a person's susceptibility to the misinformation effect. Participants were also more susceptible to schematic misinformation than schema-irrelevant misinformation. There were no differences between angry and neutral participants in their relative susceptibility to schematic and schema-irrelevant misinformation. Had anger's tendency to increase heuristic use been the reason behind angry participants' misinformation acceptance, then angry participants should have been particularly susceptible to schematic misinformation. Because angry participants were not especially more susceptible to schematic misinformation than neutral participants, it suggests that anger's tendency to increase heuristic use may not affect misinformation processing. Instead, it suggests that anger reduced a participant's response criterion for accepting that misinformation had been presented during the initial encoding.

In addition to finding evidence for a criterion shift, Experiment 1 also showed that anger affected a person's confidence in their memory. When taking into account the effect of anger on a person's general self-efficacy, the angry participants showed an increased level of confidence

in their memory judgments compared to the neutral participants. In fact, angry participants' increased confidence in their memory occurred even though angry participants had less accurate memories. Since the participants were specifically instructed that the confidence judgments were related to their belief in the accuracy of their source judgments, it implies that the less accurate, angry, participants were more confident than were the more accurate, neutral, participants. Additionally, angry and neutral participants' confidence ratings followed the same general pattern for each item type. Therefore, it seems as though anger broadly increased a person's confidence in their memory, which is consistent with previous work (Levine, & Pizarro, 2004).

Since angry participants showed increased levels of confidence even as their memory was less accurate, it was not surprising that there was no general relationship between source accuracy and confidence. Interestingly, when splitting the confidence-accuracy analysis to examine neutral and angry participants separately, opposite effects are shown. The neutral participants a similar confidence accuracy-accuracy relationship to what has been previously seen (Bothwell, Brigham, & Deffenbacher, 1987; Holmes, Waters, & Rajaram, 1998; Tomes & Katz, 2000). In contrast, the angry participants showed almost the opposite relationship between confidence and accuracy. As angry participants got more confident in their memories, the accuracy of their judgments declined. While both of these partial correlations were significant, the complete regression analysis was marginal, which was likely due to the nearly opposite effects of the conditions. Regardless, this is particularly troublesome because it suggests that an angry person's confidence may be more suspect than originally thought. Additionally, it is worth noting that participants had a tendency to remember information as having been presented in the initial encoding phase, and reported higher levels of confidence for such judgments.

Because the participants in the experiment were induced to experience anger before both the misinformation and retrieval phases, the time that anger affected could not be determined. Angry participants were no less accurate than neutral participants during the misinformation phase, suggesting that anger did not impair memory for details of the film. Since anger has been shown to narrow attention and memory toward goal-relevant aspects of a stimulus (Finucane, 2011; Levine & Burgess, 1997), it is possible that anger affected memory during the misinformation phase. Since explicit recollection of misinformation has been shown to reduce one's tendency to be misinformed (Tversky & Tuchin, 1989; Zaragoza & Koshmider, 1989), it is possible that anger during the misinformation phase focused attention toward the task, impairing the angry participants' ability to recollect having experienced the misinformation. As people are more likely to be misinformed under conditions of divided attention (Zaragoza & Lane, 1998), this could account for the effect of anger on memory. If narrowed attention during encoding increased susceptibility to misinformation, then during the testing phase it would look similar to a criterion shift. While the null effects of memory accuracy during the misinformation test on later memory suggest that this was not the case, it is still possible that it affected memory.

Furthermore, the predicted effect of anger on memory was that it would reduce a person's decision criterion during retrieval. It is, however, possible that anger reduced a person's decision criterion during both the misinformation and the retrieval phases. Specifically, if angry participants were less likely to note the misinformation as having been aberrant during the misinformation phase, they may be more likely to report it later. While people still incorporate misinformation when they explicitly know it to be false (Lane & Zaragoza, 2007; Zaragoza, Payment, Ackil, Drivdahl, & Beck, 2001), they do so to a lesser extent than people who do not recognize it to be false. If anger led participants to be more likely to believe that the

misinformation represented items they missed during the encoding rather than items that were not present during encoding, they may have been more inclined to incorporate and later report them as having been in the film. Since participants were not explicitly asked whether they noticed the misinformation, the only measure of this would be their answers during the source test. Interestingly, equal numbers of angry and neutral participants (5 each) spontaneously objected to the misinformation during the misinformation phase. Because of the different emotional and motivational situations experienced by the angry and neutral participants, it is not possible to determine whether this reflects that equal numbers of people in each condition noticed the misinformation or whether equal numbers of people in each condition felt comfortable saying something about it.

Experiment 2: Anger and the Suppression of False Information

Regardless of the exact mechanisms through which anger affected misinformation, Experiment 1 established that anger increases susceptibility to such effects. The misinformation from Experiment 1 was presented after the encoding of the initial event, leading to the assumption that all information from the initial event reflects "true reality," as should be reported. Thus, Experiment 1 modeled situations where a person's memory of an event is important and anything learned after the event should be considered suspect. Presentation of misinformation in this manner both examines the effects of anger on elaborative memory updating processes and models a form of misinformation that occurs in the world (Frenda, Nichols, & Loftus, 2011; E. F. Loftus, 1975). Due to the nature of Experiment 1, it was impossible to determine the mechanisms through which anger affected false information acceptance. Furthermore, it did not provide a direct examination of executive function, which could also account for the effects of anger on memory. Because of this, Experiment 2 examined the effect of anger on executive function as it relates to the acceptance of misinformation.

Experiment 2 examined situations where a person is presented with information that they later learned to be false. Upon learning that the previously presented information was false, a person must suppress the known false information so that it does not intrude upon their recollection. The ability to suppress known false information can be extremely important to daily life. In the modern media climate, it is not uncommon to hear something about an event, only to later hear that the earlier information was incorrect or incomplete (Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012). For example, initial reports about the 2012 Sandy Hook Elementary shooting indicated that the gunman's mother worked at the school. Later reports retracted this information. Because of the retraction, any further speculation about the reason behind the

shooting must be done without the idea that the gunman was connected to the school. Whether the initial false reports affect the public memory for the event has yet to be examined, but research suggests that it may (H. M. Johnson & Seifert, 1994). Suppressing known false information is therefore an important element in understanding and remembering certain types of events. For example, in a courtroom it is not uncommon for a jury to be asked to ignore information that they heard. Often these warnings come without explicit instructions about why to ignore the information or newly presented information to explain the hole created by the to-be-ignored information. Since someone who must engage in this form of memory suppression may be forced to do so while angry, the effect of anger on the executive abilities that underlie such actions can be important.

Unlike eyewitness situations, which the three-phase misinformation paradigm models, the Continued Influence Effect (CIE) models situations where initially presented information is incorrect and is retracted (H. M. Johnson & Seifert, 1994). When using a CIE paradigm, participants are presented with information, some of which is retracted, and then given a memory test (Ecker et al., 2010; H. M. Johnson & Seifert, 1994). The memory test asks participants to draw inferences based upon the presented information. Generally, people who were presented with retracted information are more likely to use the known false information when answering related questions than participants who were presented with no such false information. This likely occurs because of a failure of the participants to monitor their memories as they report the information during the test (Zwaan, 2008; Zwaan, Langston, & Graesser, 1995; Zwaan, Radvansky, Hilliard, & Curiel, 1998). Experiment 2 used a modified CIE paradigm, where participants were tested using a plausible/implausible test rather than cued recall. Therefore, acceptance of retracted information may present either as an increased likelihood of finding such

information plausible or as slower responding to deny retracted information. People may respond relatively more slowly to retracted than non-retracted information because of the extra time required to suppress the response related to having heard the information. If angry participants were impaired in their ability to suppress false information, then they should have been more likely to accept known false information and inferences related to known false information. Previous CIE experiments have shown that participants can usually recall the retractions, so it is possible that there will be no differences between angry and neutral participants in their tendency to respond to known false information as plausible. If that occurs, then the strongest effects may be the in more the subtle measure of response time, with angry participants showing relatively increased response times to retracted information compared to neutral participants.

Method

Participants:

One hundred and three Stony Brook University undergraduate students (54 female) participated in this experiment for partial course credit. All participants were native English speakers between the ages of 18 and 30 (M=21.03, SD=3.21). The participants were randomly assigned across the two emotion conditions of the experiment. As with Experiment 1, all participants were run individually because of the emotion manipulation.

Materials and procedure:

Upon entering the lab, participants were presented with the same Stroop task that was used in Experiment 1. This Stroop task served as a baseline measure of the participant's response time and suppression ability. Following the Stroop task was the encoding phase, which consisted of three stories. The participants read a story about a bus accident (28 sentences 515 words), some stolen jewelry (28 sentences and 527 words) (Ecker et al., 2010; H. M. Johnson & Seifert,

1994), and a senator (29 sentences 519 words (Appendix B). Each story was presented in 16 (15 for the senator story) sections of one to three sentences. Each section of a story remained on the screen for 350ms per word and 75ms per additional syllable (e.g. a 20 word section with 20 syllables was presented for 8500ms). The shortest section contained a single sentence of 20 words and 28 syllables that remained on the screen for 7600ms and the longest section contained three sentences totaling 65 words and 95 syllables that remained on the screen for 25000ms. Each story was presented as a whole, without interruption, from beginning to end. The participants read the stories in a random order.

The participants were told that they were going to read three stories that came from local and national headlines over the last few months. They were instructed that they were going to be tested on the stories later, so they had to be sure to read the stories carefully. Finally, the participants were also told that the slides would be presented at a fixed speed. Because of this, they were admonished to pay close attention so as to not miss any elements of the story. Once a section had passed, there was no returning to it.

All three stories followed the same general pattern. The initial section framed the story (e.g. On Saturday, January 23rd, multiple national news networks ran a story about a scandal involving Senator John Wolfe of Utah). The next few sentences presented information about the events depicted in the story. Some of the information presented in the initial few sentences provided important explanatory information regarding some of the events in the story (e.g. The reporter waited outside of the hotel and saw the woman leave the senator's room two hours later). The middle section of the story presented a number of events that made sense both with and without the to-be-retracted information. Near the end of the story, a correction regarding some earlier explanatory information was presented (e.g. The reporter lied about seeing Starr

leave the senator's room and has since retracted his story). All three stories contained two elements of misinformation that were retracted near the story's end. The retractions did not provide an alternative explanation to replace the previous information. Previous experiments using the CIE paradigm have shown that providing an alternative explanation along with the retractions drastically reduces reported false information (Ecker et al., 2010).

The participants underwent the same emotion induction task as in Experiment 1 (i.e. disorganized or neutral). Because the experience of anger could affect attention as well as memory, the emotion induction followed rather than preceded the encoding phase (Finucane, 2011; Ford et al., 2010). The emotion induction also served the additional purpose of providing a delay between the encoding task and the testing phase of the experiment.

The participants' memory was tested using a plausible/implausible test. They were instructed to respond plausible if the tested item referred to information that, based upon their reading of the story's events, the participant believed to be plausible at the end of the story. Any item that referred to information that either contradicted a story element or had been explicitly retracted should have been considered implausible. The participants were informed that this was a timed test and that they should respond plausible or implausible as fast as possible.

The participants' memory was tested using short, two to three word statements. Each statement was presented one at a time in the middle of the screen. They were grouped together so that multiple statements referring to the same story element were presented in succession. Above each statement, a sentence provided the required context for understanding the statement. For example, the statements "is from Utah," "stayed at hotel," and "is a lawyer" all referred to Senator Wolfe of the senator story. Before a series of related statements were presented, the participants read the context-related sentence that was the necessary for understanding the

statements. The three example statements about Senator Wolfe were preceded by a sentence saying, “The next series of statements refer to Senator Wolfe.” The sentence stayed on the screen throughout the relevant trials to avoid confusion. Each block of trials was initiated by pressing the spacebar, after which the statements would begin to appear on the screen.

The participants encountered five different types of statements during the testing phase. Three types of questions directly asked about the facts of the stories, and the other two asked about information that could reasonably be inferred based upon their reading of the story. There were 24 true facts, 12 false facts, and six retracted facts presented during the testing phase. These facts were evenly divided across the three stories. The true facts involved information that was mentioned during the studies and was therefore definitively true (e.g. referring to the senator: Stayed at hotel). The false facts directly contradicted information presented in the story and were definitively implausible. For example, the senator story said he was a senator from Utah, and one of the false facts stated he was a senator from Colorado. The retracted facts were facts that directly queried memory for the retractions that were in the story. For example, the early stages of the senator story said that $10,000 was missing from the campaign accounts, but later retracted the fact. One of the retracted facts was in the section related to the senator’s campaign and stated that it was missing $10,000. Participants should have responded implausible to the retracted facts if they were able to suppress the original information.

The final two types of statements were the inference statements. There were 30 inference and 30 retracted inference statements (10 each per story). An inference statement tested information that the participants could reasonably infer based upon the events of the story. For example, one of the senator story sentences mentions that the woman who left the senator’s room (Starr) got into a cab and went to the poor section of the city. Therefore, one of the inference

questions was “is poor” in reference to Starr. Nowhere did the story say that Starr lived in the poor section of the city, or that she herself was poor, but, given the context of the story, it was reasonable to infer that Starr is poor. Retracted inference statements were similar to the inference statements. They differed only in that they required the participants to have encoded and believed the retracted information. If the participant remembered the retraction, and was able to suppress the related information, then the retracted inference statements should be considered implausible. For example, the statement “Was unfaithful” required the participant to have either forgotten or not believed the retraction about Starr leaving the senator’s room.

Following the testing phase, participants were given a second Stroop task. This Stroop task was identical to the first and examined whether anger directly affected working memory (Kiefer, Marzinzik, Weisbrod, Scherg, & Spitzer, 1998). Finally, the participants were given the same set of self-report scales as in Experiment 1, with the addition of a scale involving a single response about the participant’s highest level of anger felt during the experiment. This new click-location scale presented participants with a line on the screen with “Not at All” and “Extremely” on the two ends. The participants were asked to indicate the location along the line that corresponded to their angriest point during the experiment.

Results

Experiment 2 examined two related predictions regarding the effects of anger on false memory: Anger impairs a person’s ability to suppress known false information, and anger increases acceptance of known false information. To examine this, the participants were presented with five statement types: true facts, false facts, retracted facts, inferences, and retracted inferences. For the factual questions, there was a definitively correct answer, plausible for true facts and implausible for both false and retracted facts. In contrast, while inferences

should be considered plausible and retracted inferences should be considered implausible, it is more likely that participants would make errors for inference-related statements. Therefore, factual and inferential statements were separated for analysis purposes.

The false facts were used as a measure of whether the participants were paying attention during the encoding phase of the experiment. Most participants false alarmed to fewer than four of the false facts because they directly contradicted elements of the stories. Two participants, however, were removed from analysis for false alarming to more than half of the false facts, and one participant left the experiment during the anger induction. All analyses were conducted using the remaining 100 participants.

Unlike Experiment 1, the emotion induction did not reliably produce anger as reported by the self-report measures of anger (all *t*s>.05). Even though the induction may have failed to produce anger, the analyses were conducted based upon the assumption that the delay between induction and self-report was long enough for the induced anger to dissipate.

Accepting Known False Information

A 2 (emotion condition: angry/neutral) x 2 (statement type: true/retracted) repeated measures ANOVA was conducted to examine the prediction that angry participants were more likely than neutral participants to accept known false information. Generally, participants were more likely to accept true information than retracted information as plausible $F(1, 98)=95.133$, $p<.001$, $\eta_p^2=.493$, but there were no effects of the emotion manipulation on misinformation acceptance ($F(1, 98)=.217$, n.s.). The same pattern was found for the inference related questions with people being more likely to say plausible for inferences than retracted inferences $F(1, 98)=208.114$, $p<.001$, $\eta_p^2=.680$, but no differences in their tendency to do so based upon the condition of the experiment that they were in ($F(1, 98)=.607$, n.s).

That anger did not affect a person's likelihood of believing that known false information was plausible was not surprising. There was only a short delay between encoding and test, meaning that memory accuracy was relatively high (True Facts: M=.83, SD=.09). It is, however, possible that anger impairs one's ability to suppress known false information. If suppression were affected, then angry participants should show impairments in their ability to arrive at an answer relative to neutral participants. This would occur regardless of a participant's acceptance of the plausibility of said information.

Suppressing Known False Information

To examine this prediction, the data was again split into separate repeated measures ANOVAs based upon the type of information. A 2 (emotion condition: angry/neutral) x 2 (information type: true/retracted) x 2 (participant response: plausible/implausible) ANOVA found no effects of emotion on the speed at which a person responded to the inferential questions ($F(1, 98)=0.132$, n.s.). As predicted, participants were faster at responding to inference than retracted inferences questions $F(1, 98)=7.650$, $p<.01$, $\eta_p^2=.072$ and faster at responding plausible than implausible $F(1, 98)=60.581$, $p<.001$, $\eta_p^2=.382$. The increased speed of responding to inference questions was likely due to the increased tendency for people to respond to inference questions as plausible compared to retracted inference questions. Additionally, there was an interaction between the type of information (inference/retracted) and the participant response (plausible/implausible) such that participants were faster to respond plausible to inference questions than retracted inference questions, but were slower to respond implausible to inference questions than retracted inference questions ($F(1, 98)=13.639$, $p<.001$, $\eta_p^2=.122$). This showed that, as predicted, participants treated inference and retracted inference questions differently. For the inference questions, where the correct answer is to respond plausible, participants replicated

previous findings showing that people are faster to respond in the affirmative than the negative (Figure 6). In contrast, the correct response to a retracted inference question was implausible, which is likely why participants were faster to respond implausible to retracted than non-retracted inferences.

As with inferential statements, participants were faster to respond that a factual statement was plausible than implausible $F(1, 81)=52.954$, $p<.001$, $\eta_p^2=.395$. Unlike the inference statements, participants responded slower to true facts (M=1971.81, SD=796.73) than to retracted facts (M=1837.87, SD=734.70) $F(1, 81)=7.217$, $p<.01$, $\eta_p^2=.082$. This likely occurred because participants were particularly slow when they responded implausible to true facts (M=2309.33, SD=812.07) $F(1, 81)=12.633$, $p<.001$, $\eta_p^2=.135$ (Figure 7). Importantly, angry participants were marginally faster than neutral to respond to true facts, but marginally slower than neutral to respond to retracted facts $F(1, 81)=3.151$, $p=.08$, $\eta_p^2=.037$.

Since an impaired ability to suppress information can be most readily seen in the participant responses to retracted information, a separate ANOVA was conducted examining only participant responses to the six retracted facts. As with the other analyses, participants were faster to respond plausible (M=1741.26, SD=706.29) than implausible (M=2016.10, SD=762.82) $F(1, 83)=7.866$, $p<.01$, $\eta_p^2=.087$, but angry participants (M=1988.4, SD=778.11) were marginally slower to respond plausible than neutral participants (M=1760.94, SD=694.97) $F(1, 83)=3.314$, $p=.072$, $\eta_p^2=.038$. There was, however, no interaction between the participant's response type (plausible and implausible) and the participant's emotion condition.

Because there were so few retracted facts (6), a significant portion of the participants (15) either responded plausible to all six items, or responded implausible to all six items. This response pattern resulted in their data being lost to the response time analysis because of the

mixed design. Furthermore, an additional 29 participants responded with either plausible or implausible only once, meaning that the stability of their response time was low. Because of this, a second analysis, collapsing across the participant response dimension, was conducted. This analysis showed that angry participants were slower to respond to retracted than true facts, while neutral participants were equally as fast to respond to the two types of facts $F(1, 98)=4.531$, $p<.05$, $\eta_p^2=.044$ (Figure 8). This supports the prediction that anger impairs a person's ability to suppress known retracted information because the angry participants were slower than neutral at responding when information was retracted (Figure 7).

Self-Reported Anger

Because participants in the angry condition did not self-report greater levels of anger than those in the neutral condition, a person's level of self-reported anger may be a better measure of whether the person was experiencing anger than their condition. Therefore, correlations examining the relationship between self-reported anger and the likelihood of accepting misinformation were conducted (Table 2). There was no relationship between self-reported emotion and likelihood of accepting information as plausible. This followed the same pattern as the condition-based analyses, so correlations were also conducted to examine the relationship between response time and anger (Table 3). These found that as self-reported anger increased, a person's response time generally decreased.

Because of the negative relationship between self-reported anger and response time, regression analyses were conducted to examine how a participant's emotion condition affected their responding. There was no predictive relationship between a participant's self-reported anger and emotion condition on the time it took them to respond to inferences ($F(2, 97)=1.964$, n.s.), retracted inferences ($F(2, 97)=1.782$, n.s.), or true facts ($F(2, 97)=2.643$, $p=.076$). However,

there was a significant predictive relationship between a participant's self-reported anger, emotion condition, and the time it took them to respond to a retracted fact $F(2, 97)=5.078$, $p<.01$ (Figure 9). Higher levels of self-reported anger were associated with faster responding to retracted inferences (β=.-.231, $t(97)=2.239$, $p<.05$), but participants in the angry condition were generally slower to respond than participants in the neutral condition (β=.208, $t(97)=2.156$, $p<.05$). This followed the pattern established by Experiment 1 where participants who self-reported higher levels of anger were faster to respond. However, as predicted, being induced to experience anger reduced a person's ability to respond to retracted information.

Working Memory

To test whether anger directly affected the ability to suppress information, participants were given the modified Stroop task twice. Due to practice effects, the participants were expected to improve from the first to the second test, but if anger impaired a person's ability to suppress information, then angry participants should improve less than neutral participants. The participants replicated the classic Stroop finding of responding faster for color word consistent than color word inconsistent trials $F(1, 98)=141.537$, $p<.001$, $\eta_p^2=.591$. The participants' proficiency also tended to improve between the first and second tests $F(1, 98)=101.544$, $p<.001$ $\eta_p^2=.509$. There was not, however, an interaction between the condition of the experiment and a person's performance in the Stroop task between the first and second attempts ($F(1, 98)=1.457$, n.s.). This meant that angry participants improved roughly the same amount as did neutral participants. Since the predicted effect of anger was specific to suppression, a second analysis was done just examining responses on inconsistent trials where participants must suppress the natural response of reading the inconsistent color word. This analysis found no effect of anger on the ability to suppress responding in the Stroop task ($F(1, 98)=0.143$, n.s.).

Discussion

In contrast to Experiment 1, Experiment 2 did not find that angry participants were more likely to be misinformed than were neutral participants. Instead, Experiment 2 found that angry participants were slower to make complex memory decisions regarding known false information. Specifically, Experiment 2 found that angry participants responded more slowly than neutral participants in trials that involved retracted information that had to be suppressed. This impairment was particularly pronounced when the angry participants were able to correctly suppress the retracted information, but was also present when angry participants failed to suppress the retracted information. Given what anger has previously been shown to do, it makes sense that anger would impair suppression. Anger generally promotes active processes that promote responding to actions (Bless & Fiedler, 2006; Forgas, 2008). In contrast, suppression is an active process that reduces responding (Anderson & Spellman, 1995).

While this result is suggestive of an impaired ability to suppress known false information, the experiment also examined suppression through use of the Stroop task. All participants were given a pre-encoding Stroop task and a post-test Stroop task. The difference between a person's responses in the first and second Stroop tasks therefore reflected both improvement at the task and the effects of anger. Had angry participants shown less improvement than neutral participants from the first test to the second, it would have provided converging evidence that anger impairs suppression; however, there were no differences between angry and neutral participants in the amount of improvement showed in the Stroop task. This implies that anger may not affect suppression as measured by the Stroop task.

It is worth noting that the effects of the emotion induction may have dissipated by the time the second Stroop task was given, which could account for the lack of any observed

differences between angry and neutral participants. Further evidence for this can be seen in that there was no effect of the emotion manipulation on the self-report questionnaires, which were presented after the second Stroop task. Therefore, the lack of a direct effect of anger on the Stroop task may not constitute strong evidence against anger affecting suppression, but it does suggest caution.

In addition to examining the effects of anger on factual statements, Experiment 2 examined how participants responded to inferential statements. The inferential statements, like factual statements, were split between plausible inferences and retracted, or implausible, inferences. However, unlike factual statements, angry and neutral participants did not differ in their responding to inferential statements. As with the null effect regarding the Stroop data, this null effect could have occurred for any number of reasons from differences in the relative complexity of the various statements to the variability of the length and syllabation of the words across the statements. Therefore, the only conclusion that can be drawn from the null result is that further investigation is required.

While the success of the emotion manipulation and conclusions regarding the emotion-relevant analysis of Experiment 2 are uncertain, Experiment 2 also represents the first examination of the continued influence effect using recognition rather than free recall measures (Ecker et al., 2010; H. M. Johnson & Seifert, 1994). Generally, participants were more likely to accept both true facts and non-retracted inferences as plausible than they were to accept retracted facts or retracted inferences as plausible. This result replicates previous work examining the CIE and shows that the retractions reduced the likelihood of a person's responding that the retracted information was plausible. Like previous work examining the CIE, participants drew inferences from retracted facts and were unable to suppress all of them during the testing phase. In addition

to being less likely to report that retracted facts and inferences were plausible, participants' response times to retracted facts and inferences followed a different pattern. This pattern suggested that even when participants made an error and reported that retracted information was plausible, it took them longer to do so because they had to suppress the retractions.

The only major divergence in the current findings from previous CIE work was that participants in Experiment 2 reported high levels of plausibility to retracted facts. Previous CIE experiments have found that people incorporate the retracted information into their memory and draw inferences from it, but can also accurately report that the information had been retracted (Ecker, Lewandowsky, Swire, & Chang, 2011; Lewandowsky et al., 2012). Participants in Experiment 2, however, frequently reported that the retracted factual information was plausible, which implies that they either forgot it was retracted or still believed it was plausible given the retraction. This may have occurred because the participants may not have understood what was meant by plausible and implausible. A lack of understanding these terms may have led them to believe erroneously that something retracted could still be plausible. It is possible that future work examining this question should attempt to provide further training for participants before the testing phase. Though would ensure that participants would understand the distinction between plausible and implausible judgments. While other forms of judgments (e.g. correct/incorrect) may also be used, any such judgment used would either have similar problems as the plausible/implausible judgments, or different issues created by the defined judgment.

Assuming the participants understood the instructions regarding plausible and implausible, the participants may not have believed the retractions. This may have occurred for many reasons. Unlike previous CIE work, the stories contained multiple retractions, which may have undermined participants' belief in the veracity of the presented information. These

retractions were generally sourced from the police or a newspaper. If people do not believe that the police or the newspaper was being accurate, they may also have been less likely to believe the retractions. Since each story had multiple retractions from these sources, they may have been viewed as less reputable than they should have been. As the participants progressed further through the encoding phase, they would have encountered more instances of the reporting being less than accurate. Each further retraction may have reduced their belief in information being presented to them because the sources were unreliable. To fix this issue, further investigation should reduce the number of retractions and increase the number of stories. This would increase the overall belief in the reliability of the narrator, in contrast to having only three stories containing a combined six retractions. An additional three stories containing no retractions may increase the participants' belief in the reputability of the narrator and sources within the stories, without adding to the issue of too many retractions.

In addition to unreliable sources, it is possible that the method of retraction itself played a role in reducing belief in the retractions. Specifically, the retractions presented in the stories all reported that previously presented information was wrong without providing any new explanatory information. This is a particularly weak form of retraction (Ecker et al., 2010). This was chosen deliberately because angry participants may be particularly likely engage elaborative updating mechanisms (Experiment 1), so it was necessary to avoid corrections. The stories were written so that participants were led to make inference about the information that was to be retracted. This meant that the retracted information was a particularly compelling story element, without which there was a large hole in the participant's understanding of the story. In order to resolve this issue, participants would have needed to generate their own ideas for what occurred in the story, or actively suppress anything related to the retracted information. Since both are

difficult tasks, people have a demonstrated tendency for retracted information to have a continued influence on their understanding of a narrative. Furthermore, because of the leading nature of the stories (e.g. the senator story suggests he was doing something illicit even after the retractions), the participants may have chosen to disregard the retractions in favor of a coherent story. Previous CIE work has suggested that this could partially explain the continued influence of the retracted information (Ecker et al., 2010). To combat this, future work should examine whether providing an alternative explanation along with the retraction reduces levels of responding to the retracted information. If anger increases a person's tendency to update information, then anger may paradoxically reduce reliance on the originally presented information; however, if anger affects suppression, then anger may still increase response time for retracted facts.

Since the retractions themselves may not have been believed, it is possible that the participants did not respond to the retracted inferences in the manner that had been predicted. If a participant reported believing that a retracted fact was plausible, then any inferences related to that retracted fact may arguably also become plausible. The status of retracted inferences as implausible was only true as long as the retracted fact was implausible. Furthermore, even when a participant reported that a retracted fact was implausible, they may not have interpreted it in the same manner as was intended. For example, one retraction statement was that "the bus was not full of elderly people heading to a nursing home." If the participants interpreted the statement to mean that the bus was full of elderly people, but they were not going to a nursing home, then they would have responded to the related inferences and facts differently than if they read that it was not a bus full of elderly people and it was not going to a nursing home. Thus, it is possible

that the participants read ambiguity where none was intended, leading them to respond in a manner other than that which was expected of them.

While Experiment 2 was not designed to be a direct examination of whether experiments using recognition measures could model continued influence situations, it did show that such measures could work. To further validate such a method, future work should examine whether participants would respond differently to the retracted inferences or retracted facts when they are not retracted. By presenting half of the participants with a story without retractions and the other half a story with retractions, one can directly test whether the retractions affected the participant's responding. Given the results of Experiment 2, and the questions regarding the believability of the retractions, such an experiment could be important to understanding whether the observed effects of anger were due to an anomalous effect resulting from the weak or multiple retractions. Even if the retractions reduced responding to retracted information, participants believed that more than half of the retracted facts and retracted inferences were plausible. This can be compared to the true facts and inferences, which participants believed were plausible approximately 80% of the time. While significantly lower than the true information, the levels of responding to retracted information was high compared to levels of responding seen in CIE experiments using cued recall measures. Therefore, it is possible that the high levels of responding to retracted information among all participants left little room for anger to increase responding without response levels becoming unrealistically high for participants who paid attention during the encoding phase.

Experiment 3: Anger and Self-Created False Information

Experiments 1 and 2 showed that anger affects how people process false information presented during or after an event. Each experiment modeled different real-world situations where false information can affect memory. Experiment 1 modeled what occurs when someone is asked to recall their memory for an event, but the person has learned more about the event after their initial encoding. The new information, false or otherwise, was not part of their initial memory and should not be recalled as such. Experiment 2 modeled situations when some of the initially learned information about an event is false and should be ignored. The to-be-ignored information should not influence a person's memory because the person knows it is false. In addition to modeling different situations that exist in the world, Experiments 1 and 2 examined different ways in which anger may affect false information. Experiment 1 examined whether anger altered heuristic use or a person's response criterion, and Experiment 2 examined whether anger affects suppression. Both experiments showed that anger affected false information processing and examined the mechanisms through which anger affected memory.

The purpose of Experiment 3 was to expand the previous work by examining whether angry people distort their memory to confirm their beliefs. Information presented after an event's recall should not affect judgments about the recalled information, but it has been shown to do so (Bradfield, Wells, & Olson, 2002; Douglass, Neuschatz, Imrich, & Wilkinson, 2010; Douglass & Steblay, 2006; Hafstad, Memon, & Logie, 2004; Jou & Foreman, 2007; Wells & Bradfield, 1998). Post-identification feedback affects future recall of the material, suggesting that the false information becomes tagged along with the memory (Palmer, Brewer, & Weber, 2010). While people are generally prone to this form of a hindsight bias, the cognitive effects of anger may make a person particularly susceptible to this form of memory distortion.

Many of the effects of anger on cognition could be explained as an increased tendency to engage in processes people were already predisposed to engage in. Anger increases a person's tendency to make an ID in lineup tasks (Greenstein & Franklin, 2012), the rate of their acceptance of critical lures in DRM tasks (Corson & Verrier, 2007), and their tendency to engage in heuristic use (Bodenhausen, et al., 1994). Neutral participants already show a tendency to use these forms of processing (Roediger & Mcdermott, 1995; Tversky & Kahneman, 1973; Wells, 1984), with anger seemingly increasing this tendency. Therefore, if angry participants are engaged in a task that predisposes them to distort their memories (Palmer, et al., 2010), they may show a greater tendency to do so than would neutral participants. In contrast, it is possible that anger does not bias people towards predisposed actions, but does reduce a person's response criteria. If anger simply shifts a person's response criterion, then angry participants would not be expected to distort their memories to a greater extent than neutral participants. Finally, it is also possible that anger simply increases a person's confidence in their cognition (Tiedens & Linton, 2001). If anger increases confidence, then angry participants may distort their memories to reflect their relatively increased confidence.

To test these predictions, participants in Experiment 3 were presented with a lineup identification task accompanied by false post-identification feedback. Previous work using the post-identification feedback paradigm has shown that positive feedback increased subjective memory judgments relative to no feedback and that negative feedback decreased subjective memory judgments relative to no feedback (Douglass & Steblay, 2006). If anger increases a person's confidence in their cognition, then angry participants should be more confident than should neutral participants following both positive and negative feedback. In contrast, if anger increases use of pre-existing cognitive biases, then angry participants should be more confident

than neutral participants following positive feedback and less confident than neutral participants following negative feedback. Finally, if anger affects a person's response threshold without distorting memory, then anger should not affect retrospective memory judgments.

To further examine these predictions, participants in Experiment 3 were also presented with ambiguous feedback. If angry people are particularly likely to distort their memory to reflect their beliefs, then angry participants may be more likely to interpret ambiguous feedback as though it were positive. The reason for this is that people show a general tendency to seek confirmatory information (Nickerson, 1998). Since the participants would be hearing the feedback following an identification, it is likely that they will already believe that they were correct. Therefore, the ambiguous feedback may be more likely to be perceived as positive, thereby increasing the tendency for an angry person to distort their memory positively. In contrast, if anger either increases one's general sense of confidence or affects one's decision threshold, the ambiguous feedback may be treated as the same as no feedback.

Method

Participants and design:

One-hundred and forty-eight Stony Brook University undergraduate students (83 female) participated in this experiment for partial course credit. All participants were native English speakers between ages 17 and 30 (M=19.61, SD=2.09). The participants were equally split between the two emotion conditions and each of the four versions of the photo sets. An additional 10 participants (6 female) were run in a short study to norm the audio files.

Materials:

The stimuli presented during this experiment consisted of a series of photos taken from the FERET database of facial images collected under the FERET program, sponsored by the

DOD Counterdrug Technology Development Program Office (Moon & Phillips, 2001; Phillips, Moon, Rizvi, & P.J., 2000; Phillips, Wechsler, Huang, & P., 1998). The photos depicted people looking at the camera smiling. Each photo was cropped at the neck to remove closing bias (Freire, Lee, Williamson, Stuart, & Lindsay, 2004) and was resized to be 300 pixels in height. In order to keep the aspect ratio of the photos the same, they ranged 181 and 289 pixels in width (M=235.35, SD=14.96). Within a photoset, photos were generally similar in width with a minimum range of eight pixels and a maximum of 71 pixels. The photos original backgrounds were removed and a new, simple wallpaper background was added. Each photo presented during the encoding phase was edited to have unique wallpaper background, which served as a memory cue during the testing phase. Each photo in a lineup was edited to have the same background as the photo of the lineup's target from the encoding phase. The photos presented during the encoding phase were also processed using a low pass filter to simulate the degraded conditions that occur when viewing a person's face at a distance (G. R. Loftus & Harley, 2005). Two levels of distortion were used to create images that were either mildly or moderately degraded. All of the images used during the testing phase were of high quality without any blurring. Participants never saw the exact same image twice. When a person's photo was used during both the encoding and testing phases, a similar but different photo was used for each phase (e.g. mouth open smile during encoding and mouth-closed smile during test).

Of the 36 photos presented during the encoding phase, 14 depicted females and 22 depicted males. Most depicted young adults (approximately aged 18 – 25), but 11 of the photos depicted middle-aged people, and four of the photos depicted elderly people. Previous studies using this dataset have found no differences in the participant's ability to remember the faces of

younger or older people at similarly short delays (Greenstein & Franklin, 2012). The majority of the photos depicted people of Caucasian descent, but 30% of them were of other ethnicities.

Throughout the experiment, the participants heard some short audio clips. A research assistant for whom English was a second language recorded all of the clips. The research assistant was recorded in a soundproof booth saying a few short sentences. One of the sentences was used throughout the experiment to indicate the end of a section. The other sentences were cut to leave only the words "mmcorrect" and "incorrect." The "mmcorrect" and "incorrect" recordings were then edited to remove the word "correct" leaving only the "mm" or "in." Using a sound blending software (Kraljic & Samuel, 2005), the "mm" and "in" sounds were blended together to create a series of sounds that were different combinations of "mm" and "in." Finally, the sound file "correct" was added back into each sound blend to create a series of sound files that were mixes of "mmcorrect" and "incorrect."

Norming Study

Ten participants were presented with the sound files as part of a short norming study. Each participant was asked to listen to the sound and indicate if the sound was the person saying "mmcorrect" or "incorrect." Following each sound presentation, the participants heard a short (5 second) clip of background music by Enya or Narada. The music clips were used to remove the influence of the previous trial on the participant's perception of the next trial. The participants heard seven different sound blends that ranged from 75% "mmcorrect" 25% "incorrect" to 25% "mmcorrect" and 75% "incorrect." Using the data from the norming study, blends that were identified as "mmcorrect" ~90% of the time, were identified as "incorrect" ~90% of the time, and were identified as both "mmcorrect" and "incorrect" ~50% of the time. The files that were determined to be "mmcorrect" and "incorrect" ~90% of the time were used in Experiment 3 as

unambiguous positive and unambiguous negative feedback. The file that was used as the ambiguous sound was created from 25% of the negative "in" sound, and 75% of the positive "mm" sound. This bias towards perceiving the sounds as incorrect was likely because incorrect is a word people have experience with, while "mmcorrect" is not.

Procedure

Before beginning the encoding phase, the participants were deceived about the reason that the experiment was being conducted. They were told that it was being done in collaboration with a graduate student at the University of Tokyo and that the purpose of the experiment was to examine eyewitness identification under non-ideal conditions. Because of the collaboration, they were told that the experimental stimuli were created collaboratively between the two labs. Between each phase of the experiment, the participants heard an audio clip of the collaborator instructing the participants to tell the experimenter that they had finished the portion of the experiment. From the audio clip, it was clear that the collaborator did not speak English as her primary language and she was uncertain about what she was saying because she frequently used the verbal hedge "mm." This served the purpose of acclimating the participant to the collaborator's non-native speech pattern and teaching the participant that the collaborator frequently uses "mm" during her speech.

During the encoding phase, the participants were presented with photos of 36 different people. Every photo was distorted using either a mild or moderate level of distortion. Since the participants were told that the purpose of the experiment was to examine eyewitness memory under poor perceptual and memorial conditions, they believed that distortion was supposed to simulate a degraded perceptual condition. The photos were presented for two, five, or seven seconds, which was supposed to simulate poor memorial conditions. The photos were split

across the conditions such that there were six photos with minor distortion presented for each of two, five, and seven seconds. The same was true of the 18 photos with moderate distortion.

Following the encoding task, the participants were given the same emotion induction as Experiments 1 and 2. During the instructions for the testing phase, the participants were told that our collaborators decided that for some of the trials they would receive feedback regarding their performance. After learning about the feedback, they were then given a short feedback training session, which randomly presented the participants with the unambiguous positive and unambiguous negative feedback. They had to be able to correctly identify the feedback as "correct" or "incorrect" before continuing the experiment. After each trial of the feedback training session, the participants were told whether or not they identified the sound correctly. The participants were unable to continue until they had identified each sound correctly three times. The feedback training session neither alluded to nor included ambiguous feedback. Following the feedback training, the participants were given the rest of the test instructions.

The participants were led to believe that their memory for the people they had seen during the encoding phase was being tested using a lineup identification paradigm. Each lineup presented during the testing phase contained six photos of people who had been previously normed as looking similar to the photo of the person presented during the encoding phase (Greenstein & Franklin, 2012). Of the 36 lineups, 12 contained a second photo of the person who had been initially presented and 24 did not. The participants were forced to identify one of the people in the lineup as having been a person they had seen earlier. For half of the target present (TP) lineups, the participants received positive feedback. For the other half of the TP lineups the participants received no feedback. The 24 target absent (TA) lineups were equally divided between positive, negative, ambiguous, and no feedback. Each version of the experiment

presented a different type of feedback for each lineup. Therefore, across the four versions of the experiment, each TP lineup was equally likely to receive positive or no feedback and each TA lineup was equally likely to receive each type of feedback.

Immediately following the feedback, or lack thereof, the participants were asked to make three memory judgments. First, the participants were asked to judge how confident they were when they made their identification on a 1 (certain I was wrong) to 8 (certain I was right) scale. Second, they indicated how clear they believed the initial picture was on a scale ranging from very clear (a) to completely blurry (f). Third, they were asked about the length of their view of the initial picture (one to nine seconds). These memory judgments were similar to questions asked about in previous experiments examining post-identification feedback (Wells & Bradfield, 1998).

Following the feedback phase, the participants were given the same self-report inventories as in Experiment 2. In addition to the self-report inventories, the participants were given a second feedback discrimination task. Unlike the feedback training, the feedback discrimination task was modeled after the norming study. The participants heard five trials each of the positive, negative, and ambiguous feedback. A short music clip followed each trial to remove the influence of previous trial on a participant's perception of the next trial. The participants used the same 2-alternative forced choice test as the first task. After the feedback discrimination task, participants were asked whether they believed that the feedback was accurate and whether they had any difficulty in interpreting the feedback. Finally, the participants were informed that some participants had received ambiguous feedback, and they were asked whether they believed that they were one of the participants who had received such feedback.

Results

Because of the nature of the false feedback manipulation, belief in its veracity was important. Therefore, the 54 participants who did not believe that the feedback accurately reflected their accuracy were removed from the analysis. It was also important to be able to reliably discriminate between positive and negative feedback, so the 10 participants who were unable to consistently discriminate between them during the feedback discrimination task were also removed. Two participants were removed from analysis because they were unable to identify any of the photos in the target present trials suggesting that they failed to pay attention during encoding. Finally, two participants left the experiment during the anger induction. These exclusion criteria left 80 participants (10 per condition) to be analyzed.

As with the first two experiments, the participants' scores on the emotion self-report scales were used to validate the emotion manipulation. Participants in the anger condition self-reported higher levels of anger than participants in the neutral condition using the PANAS measures of annoyed $t(78)=2.012$, $p<.05$ and irritable $t(78)=2.243$, $p<.05$. Participants in the anger condition also reported non-significantly higher ratings of anger using the PANAS measure of frustrated $t(78)=1.525$, $p=.131$, upset $t(78)=1.908$, $p=.06$, the click scale $t(78)=1.826$, $p=.07$, and the STAXI: state $t(78)=1.540$, $p=.128$. This implied that the anger induction increased a person's level of state anger. Also as expected, there was no effect of a person's emotion condition on their levels of trait anger as reported by the STAXI: trait $t(78)=.143$, n.s. or the CAS $t(78)=1.530$, $p=.130$.

As expected, there was no effect of emotion on a participant's ability to identify the correct image in a TP lineup $t(78)=.000$, n.s., suggesting that angry and neutral participants were equally likely to pay attention to the encoding phase. Also, there was no effect of emotion on a

participant's response time for the lineups ($t(78)=.482$, n.s.). This was likely due to the generally slow response rate among all participants (M=4.96s, SD=3.24s). Finally, angry and neutral participants were equally likely to perceive the ambiguous feedback as positive, suggesting that anger did not alter a person's perception of ambiguous information ($t(78)=.540$, n.s.).

Because it was possible for a participant's actual memory for the target to interfere with their response patterns in the TP lineups, all remaining analyses were done examining only responses to TA lineups. To simplify interpretability of the analyses, each analysis was collapsed across the other factors, so the effects of feedback type, length of initial presentation, and quality of initial presentation were analyzed separately.

Feedback Type

Repeated measures multivariate analyses of variance (MANOVA) were conducted examining the effects of positive feedback, negative feedback, and ambiguous feedback on participants' confidence, length of initial presentation, original image quality judgments. It was predicted that anger would either generally increase a person's confidence compared to the neutral participants, or that anger would increase a person's retrospective memory judgments following positive feedback and decrease a person's retrospective memory judgments following negative feedback. Multivariate analyses showed no effects of a participant's emotion condition on their response pattern $F(3, 76)=2.418$, $p=.073$ $\eta_p^2=.087$ with angry participants responding with slightly elevated estimates of length and quality of initial presentation, but slightly reduced confidence compared to neutral participants. There was an effect of feedback type $F(9, 70)=24.079$, $p<.001$, $\eta_p^2=.756$ such that following positive feedback a person's estimate increased relative to no feedback, and following negative feedback a person's estimate decreased relative to no feedback. Generally, estimates following ambiguous feedback were no different

than estimates following no feedback (Figure 10). Confidence and quality estimates met the assumption of sphericity, but the length estimates did not, so the Greenhouse-Geisser correction was used for the relevant analyses. Univariate analyses showed that each of confidence $F(3, 234)=71.004$, $p<.001$, $\eta_p^2=.477$, length of initial presentation $F(3, 222.99)=8.685$, $p<.001$, $\eta_p^2=.100$, and quality of initial presentation $F(3, 234)=16.761$, $p<.001$, $\eta_p^2=.177$ judgments followed the same general pattern. Importantly, there were no interactions between a person's emotion condition, type of feedback received, on estimates of confidence, length, or quality.

Length of Initial Presentation

Since the photos were presented for different lengths of time during the encoding phase, it was possible that length of exposure could have affected memory judgments. The longer a participant was exposed to a person's face, the longer a participant should have judged their initial exposure. Additionally, longer exposure durations could also has increased estimates of confidence and quality of initial exposure.

A second repeated measures MANOVA was conducted testing these predictions. As with the feedback analysis, the MANOVA found there to be no effects of emotion condition on estimates $F(3, 76)=2.247$, $p=.09$, $\eta_p^2=.081$, but it did find that there was an effect of the length of initial presentation on participants' estimates $F(6, 76)=612.459$, $p<.001$, $\eta_p^2=.981$. As predicted, participants showed elevated estimates of exposure duration for images that had been presented for a longer duration during the initial encoding task. Confidence and length estimates met the assumption of sphericity, but the quality estimates did not, so the Greenhouse-Geisser correction was used for the relevant analysis. Univariate analyses showed no effects of the length of an object's exposure on estimates of quality ($F(2, 153.087)=1.678$, n.s.), though there was a non-significant tendency for participants to estimate higher levels of initial quality for objects initially

presented for longer than objects presented for less time ($F(1, 78)=3.267$, $p=.075$). Participants estimated longer durations ($F(1, 78)=1906.201$, $p<.001$, $\eta_p^2=.961$) and were more confident ($F(1, 78)=1510.543$, $p<.001$, $\eta_p^2=.951$) about objects presented for longer durations than objects presented for shorter durations

Quality of initial Presentation

During the encoding phase, the participants were not explicitly told that there were only two levels of image distortion. Because of this, it was possible to ask the participants about their belief of the relative quality of the images across a continuum rather than asking them to make binary decisions. Participants should have been able to note the image's relative quality and estimate higher levels of initial quality for images where were of higher initial quality. It is also possible that the level of distortion of the initial image could have affected judgments of confidence, or length of exposure, in addition to estimates of quality.

As with confidence and length estimates, the MANOVA examining image quality found that the quality of the initial image affected the participants' responses to the images $F(3, 76)=13.139$, $p<.001$, $\eta_p^2=.342$. Generally, participants estimated higher levels of confidence, length of initial presentation, and quality for images of higher quality than lower quality. As with the feedback and length of initial presentation analyses, there was a marginal effect of the participant's condition on responding $F(3, 76)=2.532$, $p=.063$, $\eta_p^2=.063$. There was also an interaction between a participant's emotion condition and the quality of the presented image $F(3, 76)=3.261$, $p<.05$, $\eta_p^2=.114$ with angry and neutral participants responding differently to high and low quality images. Univariate analyses showed that participants were more confident $F(1, 78)=33.908$, $p<.001$, $\eta_p^2=.303$ when an image was of high than low quality. Similarly, participants estimated greater lengths of initial exposure for high than low quality images $F(1,$

78)=18.306, p<.001, η_p^2=.190. Interestingly, when making quality judgments, participants were not sensitive to the initial image's actual quality (*F*(1, 78)=.705, n.s.). Univariate analyses also showed that the interaction between emotion and actual image quality was driven by differences between confidence, length, and quality judgments. Angry participants were more sensitive to low levels of quality than neutral participants, being less confident than neutral participants at low levels of quality but equally confident at high levels of quality (*F*(1, 78)=4.179, p<.05, η_p^2=.051). In contrast, for both length (*F*(1, 78)=2.120, p=.149, η_p^2=.026) and quality (*F*(1, 78)=.292, n.s.) judgments, neutral participants were more sensitive to the actual image's quality than angry participants, though for neither was this significant.

Feedback Perception

Although anger did not affect the way the participants responded to the ambiguous feedback, their perception of the feedback affected their responding to it. Each participant was presented with a sound identification task where they were required to identify the ambiguous feedback as either positive or negative. Participants who showed an increased tendency to see the ambiguous feedback as positive were more likely to respond as such during the subjective memory judgments. This tendency was only significant for confidence judgments *r(*78)=.396, p<.001, but a similar relationship was observed for length judgments *r(*78)=.210, p=.061 as well. Estimates of quality also followed a similar, non-significant, pattern (*r(*78)=.155, n.s.).

Power

Post-hoc power analysis using the observed effect size of $\eta_p^{2=}$.087, the sample size of 80, and alpha of .05 found that the experiment had the power required to find an effect of anger if one existed (β=.99).

Discussion

Experiment 3 replicated previous work examining the post-identification feedback effect (Douglass & Steblay, 2006). The longer a participant saw a person's picture, the longer they estimated that they had seen it. Longer durations of exposure also increased a person's confidence in their memory and their estimates of the initial image's quality. Similar effects occurred for pictures that were presented at the low level of image distortion compared to images presented at high levels of image distortion. More importantly, positive feedback led to increased confidence judgments, estimates of duration of exposure, and estimates of image quality compared to no feedback. Similarly, negative feedback reduced confidence judgments, estimates of duration of exposure, and estimates of image quality compared to no feedback. However, anger did not affect the way that participants responded when making retrospective memory judgments. A post-hoc power analysis, using the observed effect size of anger from the experiment, found there to be sufficient power to find an effect if one existed.

Interestingly, participants responded to ambiguous feedback as though it were neither positive nor negative. I had predicted that participants would show a tendency to respond to the ambiguous feedback as though it were more positive than negative because people have a general tendency to seek out confirmatory information (Nickerson, 1998). While not confirmatory, the ambiguous sound used was perceived as positive ~56% of the time by participants in the norming study and ~62% of the time by participants included in experiment 3. Therefore, the ambiguous sound was perceived as more similar to the confirmatory than disconfirmatory sound. Also, using the statistics from the sound creation program, the sound that was used included statistically more of the "mm" sound than the "in" sound. Regardless, both angry and neutral participants seemed to respond to the ambiguous feedback on a trial-by-trial basis rather than categorizing it as either positive or negative. The participants who interpreted

the ambiguous feedback as more positive than negative tended to respond as such, and participants who interpreted the ambiguous feedback as more negative than positive also responded as such. Therefore, the participants who responded to the ambiguous feedback as though it were positive and the participants who responded to the ambiguous feedback as though it were negative averaged out to look similar to the no feedback condition. Similarly to positive, negative, and no feedback, anger had no effect on a participants' subjective memory judgments following ambiguous feedback. The participants' idiosyncratic interpretation of the feedback seemed to drive their responding, as was expected. However, anger did not affect a participant's perception of the feedback, suggesting that anger did not bias judgments regarding perception to back up preexisting beliefs.

Anger neither generally increased a person's confidence nor increased a person's tendency to use preexisting biases like the hindsight bias (Bradfield & Wells, 2005). This could mean that the observed effects of anger on confidence in Experiment 1 were related to anger's effects on a person's memory criterion (Stretch & Wixted, 1998; Van Zandt, 2000). Since the memory task in Experiment 3 did not include an option to say that the initial person was not present, it was not possible to see whether anger affected a person's criterion for making a choice. This choice was deliberate because the feedback was predetermined, and a participant's perception of the meaning of positive and negative feedback should be different if the participant said that the person was not present in the lineup. Because there was no option for not present, participants may have been more likely to figure out that the feedback was false. If a participant strongly believed that the photo of the person who fit the background wasn't present, but they didn't have the option of saying it, then they may have been more likely to discount any

feedback that they received, which may explain why a third of the participants reported not believing the feedback.

While the null effects tentatively support the prediction that the effects of anger on confidence in Experiment 1 were due to a criterion shift, it also has implications for anger's effects in general. Most of the previous work examining anger has found that it exacerbates preexisting cognitive tendencies (Corson & Verrier, 2007; DeSteno, Petty, Rucker, Wegener, & Braverman, 2004; Fischhoff et al., 2005; Lerner & Tiedens, 2006). The post-identification feedback paradigm has been essentially shown to be an effect of the hindsight bias on immediate event memory (Bradfield & Wells, 2005; Hafstad et al., 2004). Since previous work has shown that anger can affect the hindsight bias (Lerner et al., 2003), if anger increased a person's tendency to engage in preexisting cognitive tendencies, then it should have affected susceptibility to the hindsight bias. Since angry participants neither exaggerated their responding positively following positive feedback nor exaggerated their responded negatively following negative feedback, it seems as though this explanation for the effects of anger on cognition is unlikely. Furthermore, angry and neutral participants were equally likely to interpret the ambiguous feedback as positive, suggesting that anger did not increase one's tendency to seek out confirmatory information.

Even though the experiment had sufficient power to find an effect if one existed, the marginal effects of emotion suggest that it is possible that anger could affect retrospective confidence judgments. This would imply that other issues with the experiment could have prevented the effects of anger from being shown. The fact that quality judgments were not sensitive to the quality of the image suggests that there may have been an issue with these judgments overall. Additionally, unlike previous experiments examining post-identification

feedback (Douglass et al., 2010), the participants in Experiment 3 viewed many faces during the encoding phase and were tested on all of them. Because of the dearth of information presented during the encoding phase (i.e. a face for 2 – 7 seconds followed by another face), it is possible that the many young Caucasian faces could have become virtually indistinguishable in memory. Of the 12 TP trials, participants averaged only 4.45 correct identifications, which is only slightly better than chance. This extremely low level of accuracy suggests that the participants may have been were presented with too many faces during the encoding. Future work examining this question should potentially reduce the number of trials the participants view, or increase the information that the participants have so that the many faces are easier to remember later.

General Discussion

Across three experiments, I examined the effects of anger on false memory. Each experiment examined different predictions regarding the mechanisms through which anger may affect memory. Experiment 1 showed that anger increased susceptibility to misinformation and increased confidence by lowering a person's decision criterion. Experiment 2 expanded upon this by showing that angry people were slower than neutral to respond to retracted information, suggesting impairments in their ability to suppress known false information. And, Experiment 3 examined whether angry people are prone to distort their memory to reflect their beliefs, finding that they were not especially prone to do so. Taken together, these results show that anger affects the memory in a manner consistent with its effects on attention and decision making.

The purpose of the three experiments was to examine the mechanisms through which anger affects memory. The results of Experiments 1 and 3 suggest that anger affects a person's criterion for making memory decisions. The angry participants in Experiment 1 were more likely to report that false information had occurred during the initial encoding phase than were neutral participants. Furthermore, angry participants in Experiment 1 were more confident in their responses than neutral participants. While neither Experiments 2 or 3 specifically examined whether anger affected a participants' memory criteria, Experiment 3 showed that two alternative explanations for the effects of anger on confidence were unlikely. Therefore, these experiments provide some evidence that anger reduces a person's decision threshold.

Because the participants in Experiment 1 were induced to experience anger before being presented with misinformation, it is possible that anger could have affected memory during the initial misinformation presentation. The misinformation phase involved a memory test that asked the participants to access their memory for the information from the encoding. While recalling

the information, they were exposed to irrelevant misinformation. Participants may have integrated this misinformation into their memory for the initial event. Thus, anger could have increased the likelihood of a person's incorporating misinformation into memory. While Experiments 2 and 3 did not specifically examine this form of memory updating, the results of Experiment 2 suggest that anger may affect memory during encoding. The angry participants in Experiment 2 showed impairments when suppressing known false information. Thus, if anger impairs a person's ability to suppress false information, it may have made the participants of Experiment 1 more susceptible to the misinformation presented during the misinformation test.

It is, however, equally possible that anger alters the way a participant responds to information during retrieval. Specifically, anger may reduce a person's criterion for accepting information as old. If this occurred, then the angry participants may have been more likely than neutral participants to recognize old items and false alarm to new items. Neither of these effects occurred, which suggests that anger did not affect memory during retrieval. Interestingly, the strongest effects of anger were seen during Experiment 1, where anger was induced before the misinformation phase and before the retrieval phase. Experiments 2 and 3 only induced anger before retrieval meaning that the effects of anger on suppression were retrieval-related. Other observed effects of anger on memory also suggest that anger affects memory during retrieval (Corson & Verrier, 2007; Greenstein & Franklin, 2012). Therefore, while Experiment 1 suggests that anger's strongest effects may occur during elaborative memory updating, anger may also affect memory during retrieval. Regardless, the present dissertation could not disambiguate between the effects of anger while updating a memory or retrieving it.

Because the present experiments provided evidence that anger may affect both memory updating and retrieval, future work should attempt to disambiguate between these possibilities.

The results of Experiment 1 could be due to a reduced criterion for accepting the information presented during the misinformation phase as being accurate (i.e. a memorial criterion shift), or a reduced criterion during the retrieval phase for deciding that an object had been presented (i.e. a decision criterion shift). This can be examined by inducing anger before either the misinformation phase or the retrieval phase. If only participants who are angry during the misinformation phase show increased false memory acceptance, then anger reduces a person's ability to reject post-event information. If only participants who are angry during the retrieval phase show an increased misinformation effect, then the results may be due an anger lowering a person's decision threshold. Theoretically, these results imply very different effects of anger on memory, while practically they both result in reduced accuracy and increased acceptance of post-event information.

While none of the data from Experiment 1 supports the prediction that anger affects memory by increasing heuristic use, not all of the data supports the prediction that anger affects a person's response criterion. Future work attempting to determine the mechanisms through which anger affects cognition should directly test whether anger alters a person's criterion for making a response (Greenstein & Franklin, 2012). Because of the complexity of the memory task in Experiment 1, it was not a direct test of whether anger actually altered a participant's response criterion. To test this directly, future work should examine simpler memory tasks. Instead of asking participants a complex source task or presenting them with a six-image photo lineup, participants should be given a simple recognition judgment. This way differences in old/new recognition could provide a direct test of whether angry participants show memorial criterion shifts. Specifically, if angry participants are more likely than neutral participants to accept items as old, then they have lowered their threshold for such responses.

In addition to testing the effects of anger on a person's susceptibility to misinformation, these experiments also examined the effects of anger on response time, working memory, confidence, and other metamemory judgments. Anger's effects on these measures could explain why anger affects susceptibility to misinformation, and could provide converging evidence that anger speeds up processing to promote survival. Across the experiments, higher levels of self-reported state anger were associated with faster response times. However, none of the experiments found that participants in the angry condition were faster to respond than participants in the neutral condition. Thus, while anger may promote faster responding, the effect's magnitude was related to a person's level of experienced anger. Experiments 1 and 3 both examined the effects of anger on a confidence. Experiment 1 showed that anger increased a person's confidence in their memory, but Experiment 3 did not. If anger directly affects a person's confidence, then Experiment 3 should have been able to detect an effect. It is, however, possible that anger's effects on confidence were related to the criterion shifts observed in Experiment 1 (Stretch & Wixted, 1998). If anger increased confidence by altering a person's response criterion, it could explain why Experiment 3 did not find an effect of anger on confidence. Though, given the issues involved in Experiment 3 (e.g. high preexisting confidence, failures to believe the feedback, and the generally null results etc.), it is difficult to draw conclusions from its results.

The effects of anger on working memory were even less conclusive than the results regarding confidence. As expected, angry and neutral participants did not differ on measures of executive abilities before the emotion manipulation. While the response time results of Experiment 2 suggest that angry participants may have been impaired in their ability to inhibit information, neither the accuracy nor the working memory results provided converging evidence.

Because the Stroop task is a complex suppression task, the level of induced anger may not have been enough to affect responding. Regardless, the results of the experiment did not show direct effects of anger on working memory.

These experiments represent one of the few examinations of the effects of emotion on false memory (Brainerd, et al., 2008; Gallo, Foster, & Johnson, 2009; Ruci, Tomes, & Zelenski, 2009; Storbeck & Clore, 2005, 2011). Previous work examining the effects of emotion on false memory has often found conflicting results (Corson & Verrier, 2007; Storbeck & Clore, 2011). This may have occurred because different there are many different ways to examine the effects of emotion on cognition. In these experiments, participants were presented with neutral to-be-remembered stimuli, and induced to experience anger. This differed from much of the previous work in two respects: First, many experiments examine false memory for emotional material (Gallo, 2010; Gallo, Roediger, & McDermott, 2001); and second, many previous experiments have looked at differences between positive and negative rather than discrete emotions (Brainerd et al., 2008).

By examining the effects of an experienced emotion on neutral stimuli, the present dissertation represents a more controlled examination than research examining the effects of emotional stimuli. Emotional stimuli directly affect a person's response to the stimuli. Emotional stimuli capture attention (Christianson, 1992; Easterbrook, 1959; Laney, Campbell, Heuer, & Reisberg, 2004; Laney, et al., 2003; Schmidt, 1994, 2002) and make people experience an emotion (Lobbestael, et al., 2008; Riskind, Rholes, & Eggers, 1982; Rottenberg, Ray, & Gross, 2007). Because emotional stimuli both induce an emotion and alter processing of the to-be-remembered stimuli, this may have led to inconsistent results. Experiments where the emotional stimuli altered a person's emotional state may have found different results from experiments the

emotional stimuli did not alter a person's emotional state. The effects of the emotional stimuli on attention and memory may have also competed with the effect of the experienced emotion on attention and memory. Therefore, by separating the two, the results of the present dissertation should more consistently represent the effects of anger on cognition.

By examining anger, rather than a negative affect in general, the present dissertation accounted for motivational differences between valenced emotions that can result in different effects on cognition (Lerner & Keltner, 2000). For example, negative emotions enhance the likelihood of engaging in gist processing at the expense of specific details (Gallo, 2010; Gallo, Roediger, & McDermott, 2001). This would imply that anger, a negative emotion, should have affected memory for specific details within the experiments. While not explicitly looking for effects of the emotion induction on specific aspects of scene or event memory, none of the present experiments suggested that anger impaired participants' ability to remember specific details of the stimuli. In fact, angry and neutral participants did not differ in their accuracy for details of the video in Experiment 1, the true inferences and facts in Experiment 2, or the target present lineups of Experiment 3. The only observed effects of anger were to increase susceptibility to misinformation and impair the ability to suppress known false information. This finding is not consistent with a valence-based model for the effects of emotion on cognition. While a valence-based model would have predicted that angry participants would have been more likely than neutral participants to accept misinformation, such a model would not have also predicted increased confidence or impaired suppression (Brainerd et al., 2008; Dehon, Laroi, & Van der Linden, 2010).

Therefore, future work examining false memories should make predictions based upon the motivational state elicited by the studied emotions. For example, sadness is associated with

avoidance and increased rumination, so sad participants may be less likely than neutral participants to accept false information while also being slower to respond (Joormann, Teachman, & Gotlib, 2009; Storbeck & Clore, 2005). In contrast, fear is associated with threatening situations that people choose to avoid or evade (Lerner & Keltner, 2000). If fear, like anger, promotes rapid, action-related processes to survive threatening situations, then fear may similarly increase false memory acceptance. However, because fear is an avoidance rather than approach-related emotion, it may decrease rather than increase confidence (Lerner & Keltner, 2001). While outside the scope of the present dissertation, future work can help to disambiguate between the different models of emotion by examining these motivation-based predictions.

In addition to attempting to examine the mechanisms through which anger affects memory, the present dissertation modeled three real-world situations where emotion may affect memory. Since anger is one of the most frequently experienced emotions in response to being a witness or victim of a crime (Orth & Maercker, 2009; Orth & Wieland, 2006), its effects on memory can have real-world consequences. If, as Experiment 1 suggests, people are more likely to incorporate post-event information into their memory for an event, then anger may reduce the veracity of eyewitness testimony. Without taking the effects of emotion into account, eyewitness testimony is already known to be fraught with issues (Echterhoff, Hirst, & Hussy, 2005; Garry, French, Kinzett, & Mori, 2008; Jaschinski & Wentura, 2002; Thomas, Bulevich, & Chan, 2010). When including the possibility that anger increases a person's tendency to incorporate leading questions, co-witness information, intentional lies, and other forms of post-event information into their memory for an event, it suggests that one must be careful when dealing with a crime's witness. Since people who witness a crime may be more similar to angry than neutral participants, it is possible that angry participants are a closer laboratory analogue to a crime's

witness than neutral participants. This would suggest that previous work modeling the effects of post-event information on the memory for witnesses to crimes could actually underestimated the magnitude of the effects as they exist outside of the lab. Because of this, it is even more important to emphasize the recommendations that police interrogators use non-biased interrogation techniques. An angry witness or victim of a crime may show greater susceptibility to leading interrogation techniques, which may lead to an innocent person's being targeted as a crime's suspect.

Independent of importance for eyewitness testimony, anger can also affect memory for information presented in the news. The 2012 Sandy Hook Elementary School Shooting in Newtown, Connecticut, and the 2013 Boston Marathon Bombing were extremely emotion laden events. People across America responded with angered outrage that such things could have occurred. Furthermore, these events were covered by news agencies that reported many "facts" that were later retracted. The job of the Newtown shooter's mother, the early capture of the Boston Marathon bombers, and the relevance of a convenience store robbery to the Marathon Bombers were only some of the events that were reported and then retracted. The results of Experiment 2 suggest that people who were angry about these events may have trouble suppressing some of these retracted facts. Since anger is a frequently experienced emotion in response to such events, this could represent a problem for the collective memory of Americans (Lerner, et al., 2003). Thankfully, national tragedies such as these are uncommon, but they reflect a bigger problem regarding the way that people learn about events. In the modern news world, news agencies frequently report about events before knowing all of the facts (Kull, Ramsay, & Lewis, 2003). This often leads to information about event coming out over time, which means that newly learned facts may invalidate older information. Experiment 2 suggests

that an angry person may be impaired relative to a non-angry person when remembering information learned in this manner.

To complicate the issue further, the information used in Experiment 2, while recently learned, was semantic in nature. This suggests that anger's effect on memory for information learned over time may occur for both episodic and semantic material. This is particularly important because the American education system sometimes teaches through correction of information. For example, elementary students are often taught that Christopher Columbus discovered America. Later in their education, people learn that Leif Erickson and the Vikings had a settlement in North America 500 years before Columbus. If anger impairs the ability to suppress known false semantic information, then it may be more difficult for an angry participant to suppress Columbus as the "person who discovered America" than a non-angry person.

In conclusion, while these experiments show that anger increases a person's susceptibility to the misinformation effect, further research is required. These experiments established that anger affects susceptibility to the misinformation effect, but not why anger affects susceptibility to the misinformation effect. Anger could increase a person's tendency to update their memory, reduce a person's response criterion, or impair the ability to suppress information. Anger's effects on each of these processes would have different implications on general cognition. Theoretically, these experiments suggest that future research should be done examining the effects of discrete emotions, like anger, rather than general negative emotions.

Considering the applied aspects of memory, these experiments paint a potentially dangerous picture of the world. As people gain faster access to information that is increasingly being fact checked after print (Lewandowsky, et al., 2012), people are being exposed to false

information more frequently. This is especially the case with extremely emotional events, like 9/11 and the 2013 Boston Marathon Bombing because people are particularly likely to seek information early and often for such events (Hirst et al., 2009). This leads to the possibility that large numbers of angry people may learn false information that they must later suppress, but may be impaired in doing so. While this is a frightening proposition regarding the spread of knowledge, it is dwarfed in comparison to the problems presented to the criminal justice system. Even as the system has become more accepting of the unreliability of eyewitness testimony, these experiments provided evidence that the current work may underestimate its unreliability. While this does not change the recommendations made to investigators of crimes, these results underlie how important it is to follow them.

Table 1: The self-report measures of anger from Experiment 1 were highly correlated with each other.

	STAXI State	STAXI Trait	CAS	Irritable	Frustrated	Annoyed
STAXI: State	1					
STAXI: Trait	.472***	1				
CAS	.555***	.613***	1			
Irritable	.333**	.260*	.353**	1		
Frustrated	.341**	.232*	.386***	.565***	1	
Annoyed	.299*	.141	.171	.474***	.448***	1

*p<.05 **p<.01 ***p<.001

Table 2: While the self-report measures of anger were highly correlated, no such relationship existed between anger and the likelihood of reporting that information was plausible.

	Anger Click	STAXI State	STAXI Trait	CAS	Inferences	Retracted Inferences	True Facts	Retracted Facts
Anger Scale	1							
STAXI State	.385**	1						
STAXI Trait	.331**	.368**	1					
CAS	.267**	.252**	.410**	1				
Inferences	-.106	.058	-.030	.016	1			
Retracted Inferences	-.015	.175	.028	-.111	.619**	1		
True Facts	.014	.036	.003	-.066	.397**	.277**	1	
Retracted Facts	.041	.153	.062	.028	.081	.572**	.022	1

*p<.05 **p<.001

Table 3: A participants' response time was not related to their level of self-reported anger for inferential statements. For factual statements, there was a negative relationship such that increased levels of anger were related to decreased response time.

	Anger Click	STAXI State	STAXI Trait	CAS	Inferences	Retracted Inferences	True Facts	Retracted Facts
Anger Scale	1							
STAXI State	.385**	1						
STAXI Trait	.331**	.368**	1					
CAS	.267**	.252**	.410**	1				
Inferences	-.184	-.146	-.133	-.047	1			
Retracted Inferences	-.186	-.107	-.172	-.097	.801**	1		
True Facts	-.222*	-.123	-.179	-.086	.802**	.771**	1	
Retracted Facts	-.227*	-.228*	-.123	-.079	.552**	.549**	.576**	1

*p<.05 **p<.001

Figure 1: Angry participants were more likely to incorporate misinformation into their memory for the original event than were neutral participants.

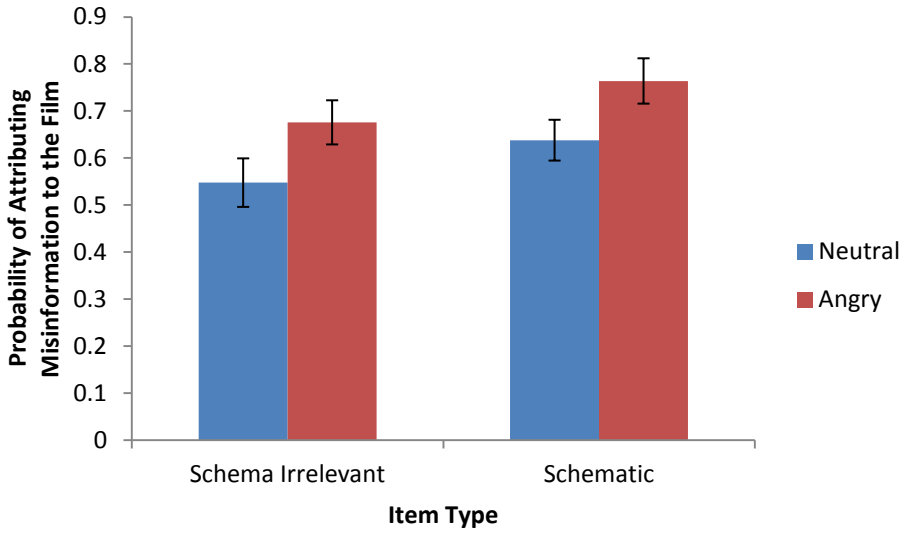


Figure 2: Participants were more likely to correctly identify the source of items that appeared only in the film than items that were in both the film and questions. They were also more likely to correctly identify the source of items appearing in both the film and the questions than items that were new to the first test (i.e. misinformation).

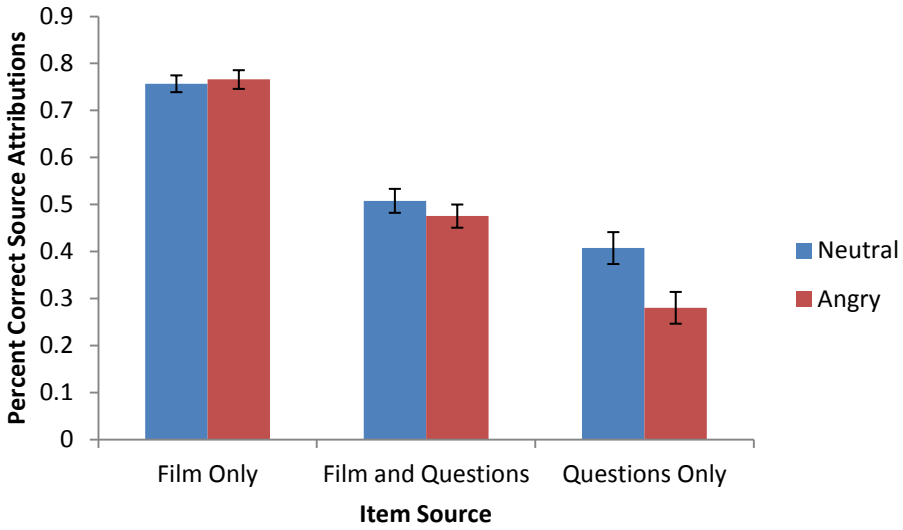


Figure 3: The effects of anger and self-efficacy on a person's confidence in their memory.

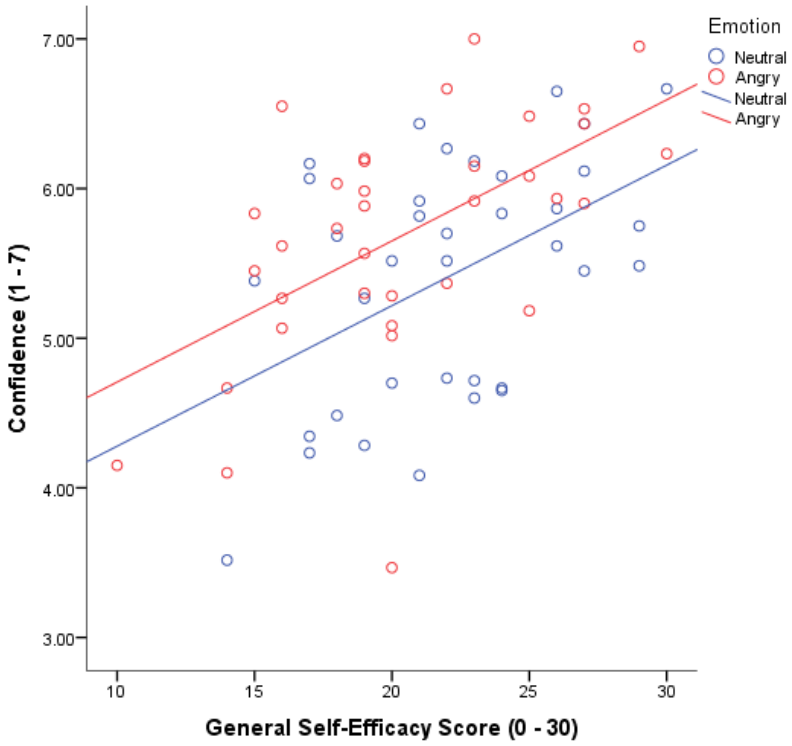
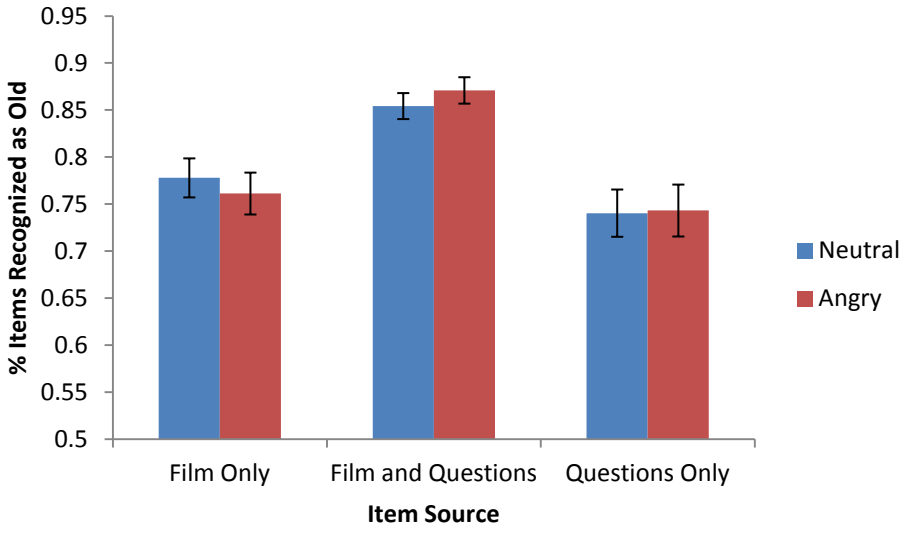


Figure 4: Items presented in both the film and misinformation test were the most likely to be recognized as old, and items presented in only the misinformation test were the least likely to be recognized as old. A similar pattern was observed regarding confidence data.



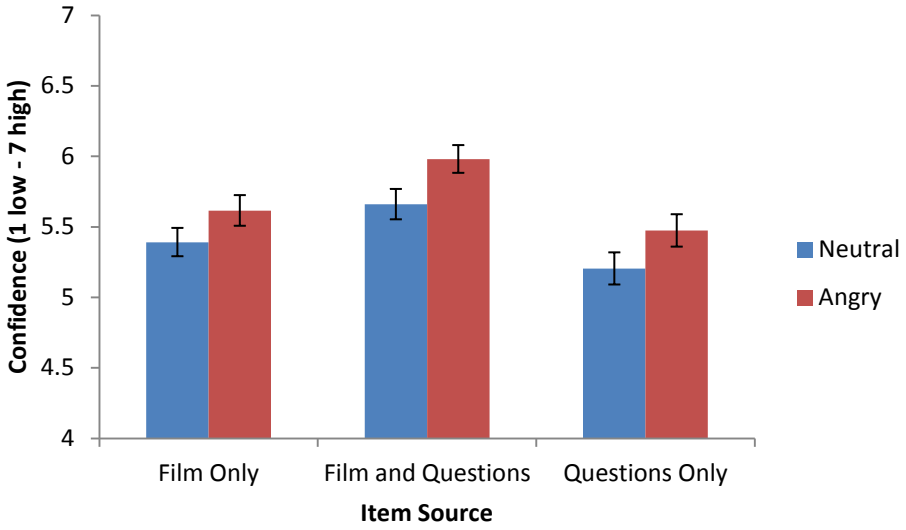


Figure 5: Angry participants' confidence increased as their source accuracy decreased, while neutral participants' confidence increased as their source accuracy increased.

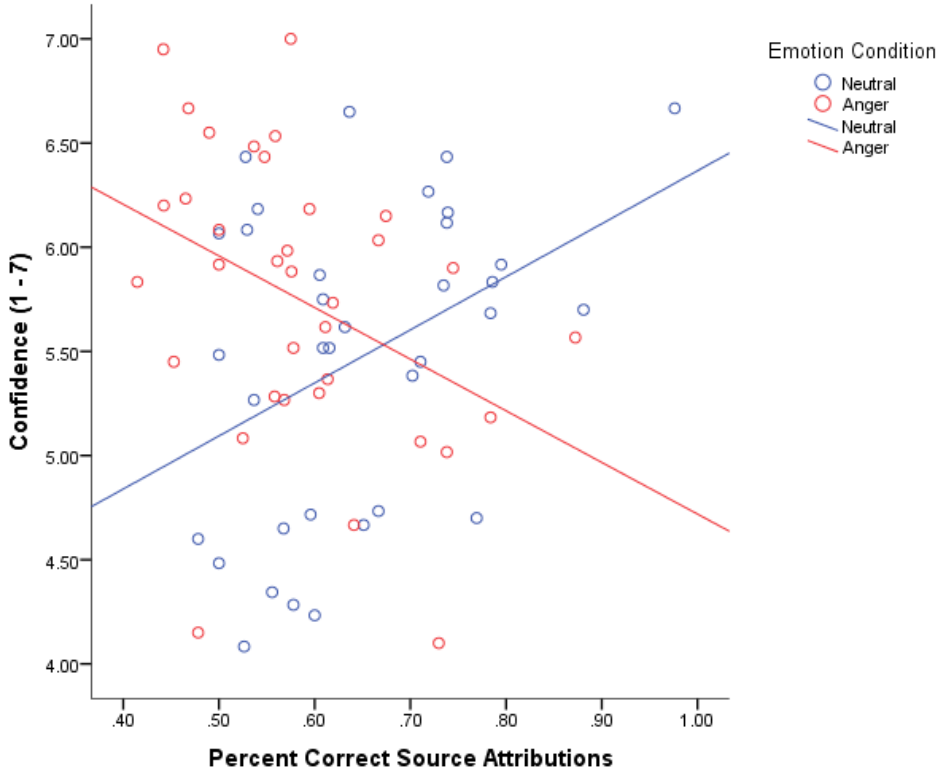


Figure 6: People were generally faster to respond plausible than implausible to inference questions.

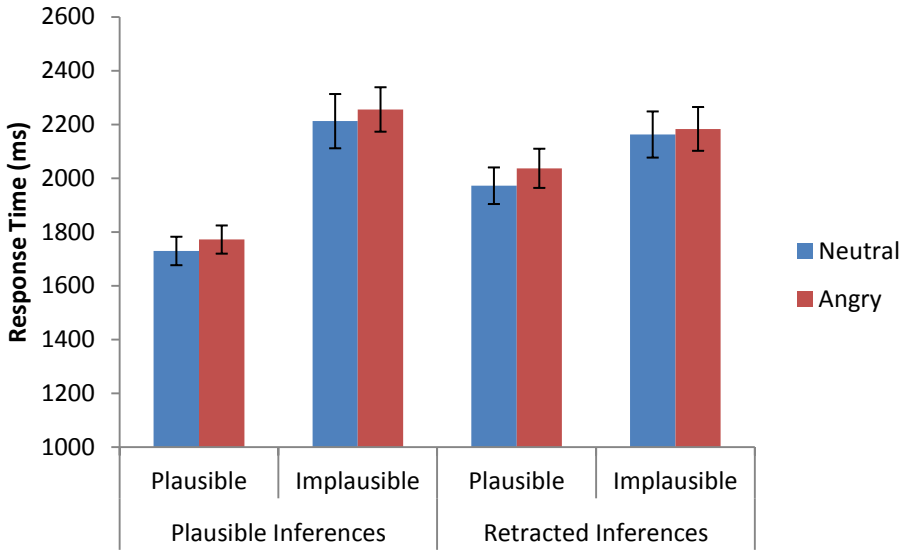


Figure 7: Angry participants responded slower to retracted facts than neutral participants. This effect was most pronounced when responding that the fact was implausible.

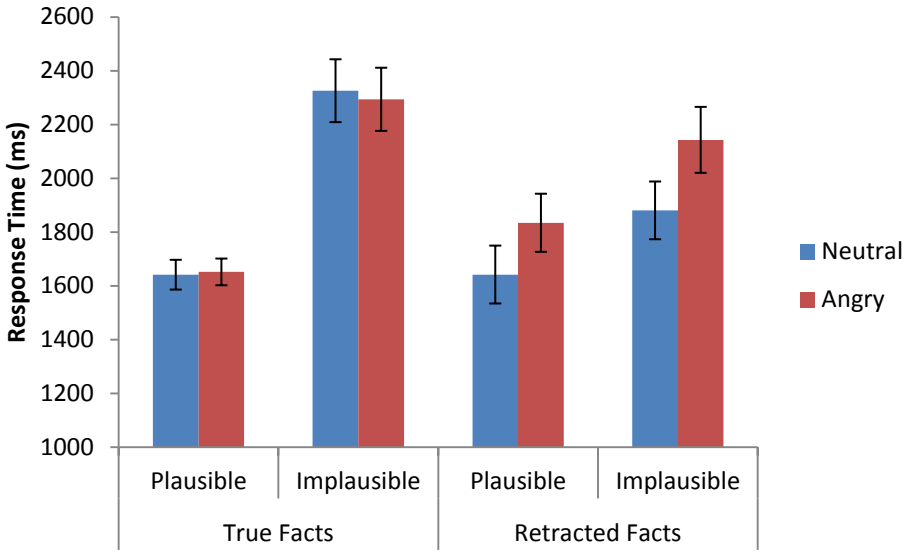


Figure 8: Angry participants were slower to respond to retracted facts than were neutral participants. No such difference exists for true facts.

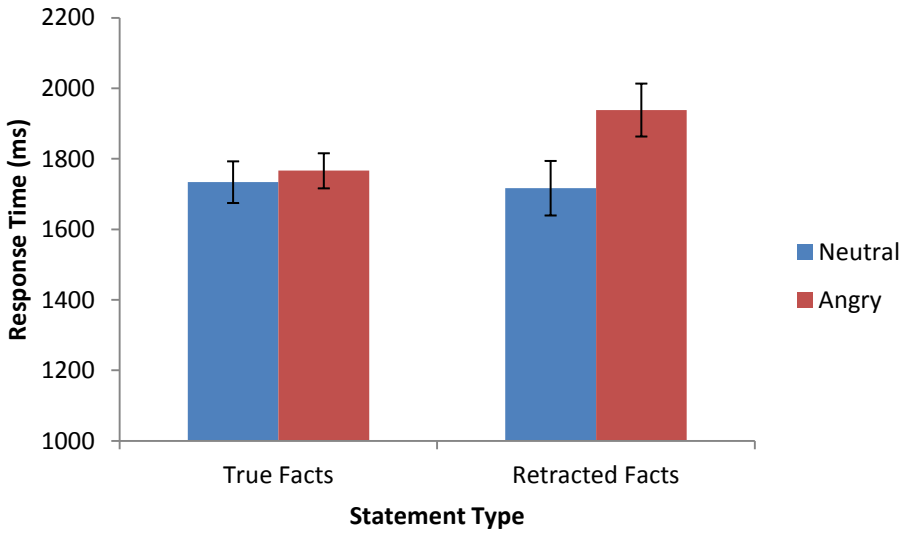
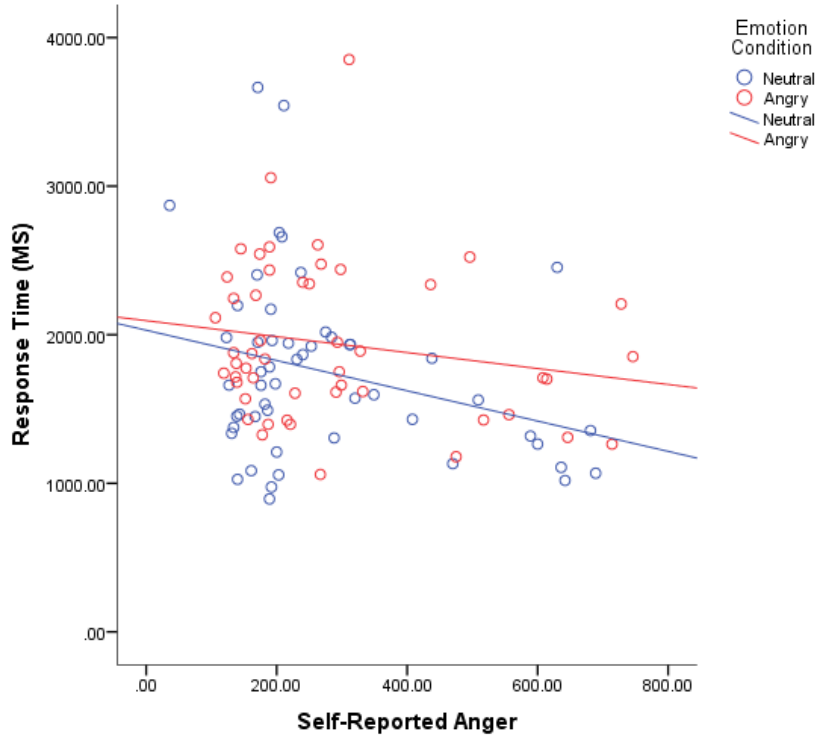


Figure 9: For retracted facts (A), higher levels of self-reported anger were related to faster responding, but participants in the angry condition responded slower than neutral participants. For true facts (B), no such relationship existed.

A:



B:

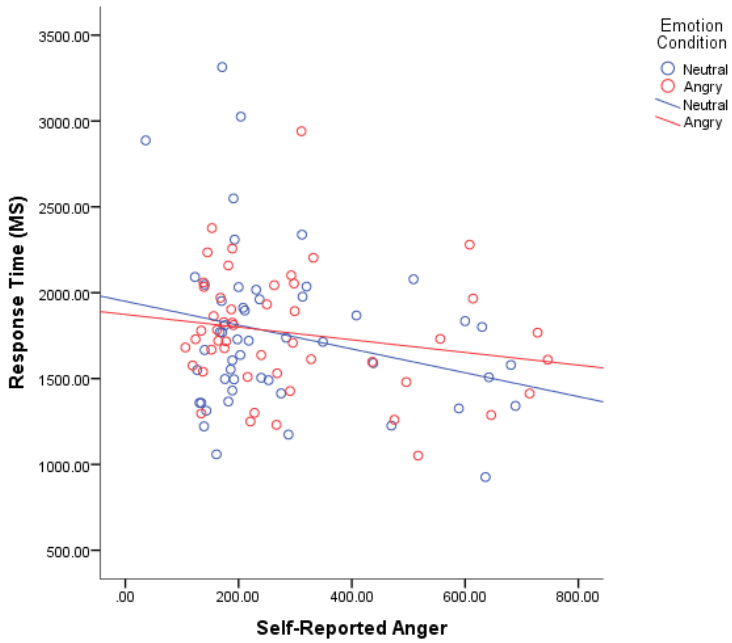
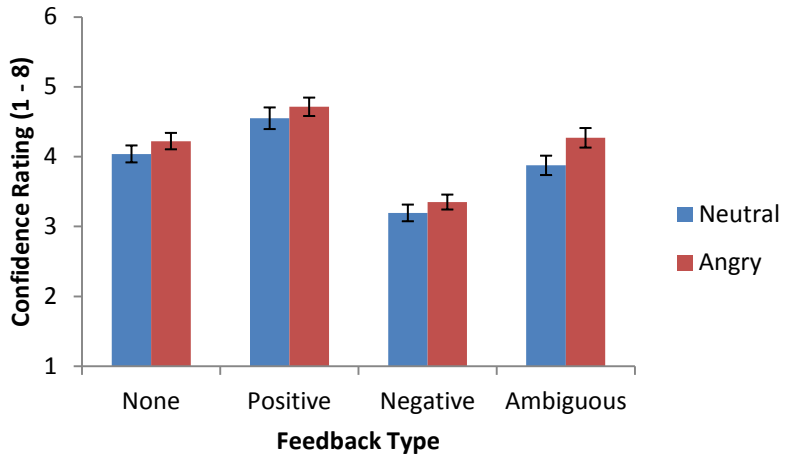
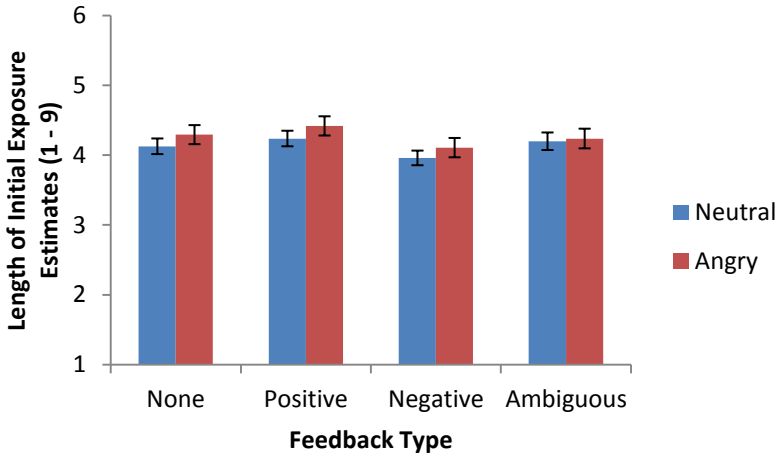


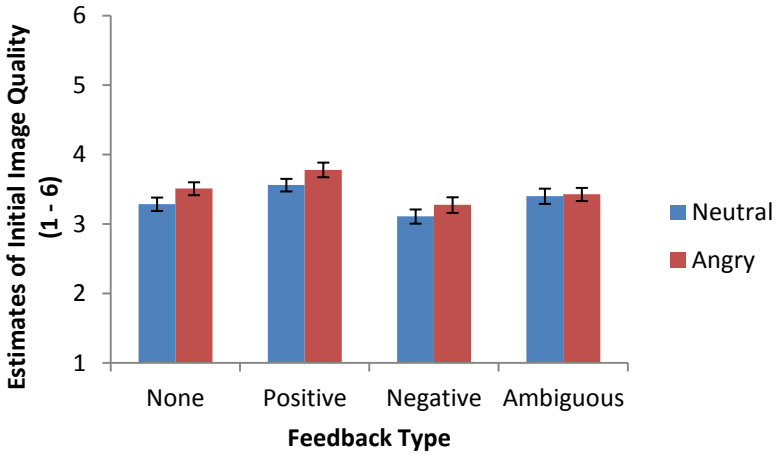
Figure 10: The effects of emotion on a person's confidence (A), exposure length (B), and image quality (C) judgments based upon the type of feedback the person received.



A:



B:



C:

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Appendix A

- The three movie clips you are about to watch are from a movie about a resort called Divorce City.
- In this movie, anyone who is getting a divorce goes to Divorce City to be pampered while they go through the court proceedings.
- Divorce City is split so that people are unlikely to see their spouses while they are there.
- While staying at Divorce City, residents are given the chance to meet other people who are getting divorced.
- This gives the divorcees the opportunity to meet someone new and move on with their lives.
- Daniel and Julia are both going through divorces and staying at the Divorce City resort.
- Daniel's divorce has been very difficult and he has taken to calling his wife's lawyer "The Prosecutor" because of how he feels she is beating him.
- Julia's divorce, in contrast, has been very easy and she is on a first name basis with her lawyer.
- By chance, Daniel and Julia met at a comedy show and have started to see each other.
- The first two clips that you will be seeing are from their first date.
- The final clip is from another date at a fancy restaurant in Divorce City.

Appendix B

- On Saturday, January 23rd, multiple national news networks ran a story about a scandal involving Senator John Wolfe of Utah.
- A reporter following the Wolfe campaign saw the senator hold the door for a young woman wearing a short skirt at a hotel. The reporter followed him inside and learned that the senator paid for a room in cash.
- The reporter waited outside the hotel and saw the woman leave the senator's room two hours later. She got into a cab that went to a poor section of the city.
- Senator Wolfe had been basing his campaign on strong family values, saying that he has been happily married to his wife for 10 years.
- Since the initial story about the scandal, the Wolfe campaign has refused all interview requests. However, a campaign insider leaked that Sandra Wolfe, the senator's wife, came to campaign headquarters in a furious rage after the story broke.
- An accountant from the Wolfe campaign told a reporter that $10, 000 was missing from the campaign fund. According to the source, the money vanished with no explanation for its loss.
- The Wolfe campaign fired a member of the senator's staff. The campaign announced that the staffer was negligent in his duties, but the ex-staffer claims it was because he spoke to a reporter.
- Reporters from a local paper published the Senator's resume, which showed that he had worked for the law firm of Bez, Foy, & Congo. The firm recently had a high profile case defending a prostitute who was accused of murder.
- Three days after the scandal, the Wolfe campaign changed the television ads they were using. The new ads show how the senator cares for his constituents rather than showing him as a family man.
- A woman named Starr was identified as the woman who had been seen at the hotel when the senator was there. When interviewed, she said that she would be voting for Senator Wolfe in the November election because he supports tax breaks and social programs for poor people.
- Sandra Wolfe was seen at the theater in a new fur coat, with an expensive new handbag, and a new dress. Fashion reporters estimate that it cost thousands of dollars.
- As a result of fact-checking, a discrepancy in the initial story was discovered. The reporter lied about seeing Starr leave the Senator's room and has since retracted his story. The reporter saw Starr leave the hotel, but did not see Starr ever enter or leave the Senator's room. Therefore, there is no evidence that the Senator and Starr were in the same room.
- Sandra Wolfe was recently seen driving a new car. When asked, Sandra told a reporter that the car was a present from the Senator and that she refused to say any more.
- After two weeks of silence, Senator Wolfe agreed to give an interview. During the interview he requested an official audit of his funds. After the audit, it was revealed that no money was missing from the campaign.
- Sandra Wolfe gave an interview of her own where she announced that she and the Senator have separated and that she does not know how long they will remain so.