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Implicit Eyewitness Memory

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IMPLICIT EYEWITNESS MEMORY

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by

Rolando N. Carol

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To: Dean Kenneth G. Furton
College of Arts and Sciences

This dissertation, written by Rolando N. Carol, and entitled Implicit Eyewitness Memory, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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The dissertation of Rolando N. Carol is approved.

Dean Kenneth G. Furton
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DEDICATION

I dedicate this dissertation to my parents, Mibrian and Orlando Carol. Without their patience, nurturing, and regular support, I would not be this good at delaying gratification.

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ABSTRACT OF THE DISSERTATION

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After a crime has occurred, one of the most pressing objectives for investigators is to identify and interview any eyewitness that can provide information about the crime. Depending on his or her training, the investigative interviewer will use (to varying degrees) mostly yes/no questions, some cued and multiple-choice questions, with few open-ended questions. When the witness cannot generate any more details about the crime, one assumes the eyewitness' memory for the critical event has been exhausted. However, given what we know about memory, is this a safe assumption? In line with the extant literature on human cognition, if one assumes (a) an eyewitness has more *available* memories of the crime than he or she has *accessible* and (b) only explicit probes have been used to elicit information, then one can argue this eyewitness may still be able to provide additional information via implicit memory tests. In accordance with these notions, the present study had two goals: demonstrate that (1) eyewitnesses can reveal memory *implicitly* for a detail-rich event and (2) particularly for brief crimes, eyewitnesses can reveal memory for event details implicitly that were inaccessible when probed for explicitly. Undergraduates (N = 227) participated in a psychological experiment in exchange for research credit. Participants were presented with one of three stimulus videos (brief crime vs. long crime vs. irrelevant video). Then, participants either completed a series of implicit memory tasks or worked on a puzzle for 5 minutes. Lastly, participants were interviewed explicitly about the previous video via free recall and recognition tasks. Findings indicated that participants who viewed the brief crime provided significantly more crime-related details implicitly than those who viewed the long crime. The data also showed participants who viewed the long crime provided marginally more accurate details during free recall than participants who viewed the brief crime. Furthermore, participants who completed the implicit memory tasks provided significantly less accurate information during the explicit interview than participants who were not given implicit memory tasks. This study was the first to investigate implicit memory for eyewitnesses of a crime. To determine its applied value, additional empirical work is required.

TABLE OF CONTENTS

I. INTRODUCTION

After a crime has occurred, one of the most pressing objectives for investigators is to identify and interview any eyewitness that can provide information about the particular crime. Ideally, witnesses should be interviewed immediately after the crime with the aim of generating investigative leads that will result in the eventual apprehension of the culprit(s). Depending on his or her training, the interviewer will use (to varying degrees) the following investigative probes when questioning the eyewitness: mostly yes/no questions (e.g., "Did the culprit get away on foot?"), some cued (e.g., "What was the ethnicity of the culprit?") and multiple-choice questions (e.g., "Was the culprit Black or Hispanic?"), with very few open-ended questions (e.g., "Please tell me everything you can remember about the crime.") (Fisher, Geiselman, Raymond, & Jurkevich, 1987; Schreiber Compo, Hyman Gregory, & Fisher, 2012). Once the eyewitness cannot recall new memories about the crime, the initial interview is concluded. Multiple follow-up interviews may be conducted, potentially eliciting reminiscences (i.e., new crime-related details that were not recalled during the initial interview) from the eyewitness. When the witness cannot generate any more details about the crime, from an investigative standpoint it is assumed that the eyewitness' memory for the critical event has been exhausted. However, given what we know about memory, is this a safe assumption?

Memory researchers have reason to argue that, in fact, an eyewitness' memory for a crime has *not* been exhausted, even after multiple explicit retrieval attempts. Moreover, eyewitnesses should possess untapped memories (i.e., implicitly) of the crime that could still be accessed using the appropriate retrieval cues and methods. Two fundamental distinctions made by cognitive psychologists lend support to this contention:

(1) the distinction between availability and accessibility and (2) the distinction between explicit and implicit memory. Tulving and Pearlstone (1966) distinguished memory availability (i.e., the *presence* of a memory trace in storage) from memory accessibility (i.e., a memory trace that was *retrieved* from storage). Drawing a parallel to an eyewitness scenario, it is important to distinguish between what details of the crime are *available* in an eyewitness' memory and what crime-relevant details are actually *accessible*. Regarding the second fundamental distinction made by cognitive psychologists, Schacter (1987) highlights the dissociation between explicit (i.e., conscious recollection of previous experiences) and implicit memory (i.e., previous experience(s) facilitating performance on a subsequent task without conscious recollection; memory without awareness). While explicit memory is elicited by simply asking witnesses to (consciously) recall or recognize, implicit memory is inferred based on how witnesses perform on a given implicit task. Investigative interviews consist purely of explicit probes, thus leaving eyewitness implicit memory entirely untapped.

Taken together, if one assumes that (a) a given eyewitness has more available memories of the crime than he or she has accessible and (b) only explicit probes have been used to elicit recollections of the crime, then it follows that this eyewitness may still possess untapped memory traces and thus may be able to provide additional information via implicit memory tests. In line with these notions, the present research had two general goals: (1) to demonstrate that eyewitnesses can reveal memory implicitly for a multi-modal, detail-rich event, and (2) to show that eyewitnesses can reveal implicit memory for event details that were inaccessible when probed for explicitly.

Availability versus Accessibility

Ever since Ebbinghaus' (1913) seminal work on human memory, psychologists have understood that memory decays over time; that is, the longer the delay between studying a list of items and being tested for those items, the fewer list items will be recalled at test. As intuitive and true as this finding was, the fate of the unrecalled memory traces was not addressed. Although the assumption was not that unrecalled information was irrevocably forgotten, Tulving and Pearlstone (1966) showed definitively that unrecalled memory traces were not erased from storage. Instead, they were available but effective memory cues were necessary in order to access them. In their experiment participants studied lists of words that belonged to particular conceptual categories (e.g., animals or professions). After the study phase, participants engaged in immediate recall; half of the participants were provided with the categories as retrieval cues while the other half were not. The authors found that participants recalled more words in the cued recall condition than the uncued recall condition, concluding that what is available in memory storage cannot be inferred from what is accessible. In other words, while both groups had an equal number of memories available, the cued recall group outperformed the uncued recall group due to differences in accessibility. More recent work expands upon this notion. For example, Kihlstrom (2004) highlights that while *availability* is a byproduct of memory encoding (e.g., studying the lists of words and categories), *accessibility* is a byproduct of retrieval (e.g., cued vs. uncued recall). Thus, in terms of memory quantity, availability will always exceed accessibility. With regard to the present study, I purport that if eyewitnesses have been interviewed using only explicit cues, then we may assume that these witnesses have memories of the critical event that are still available and accessible if probed for differently. One of the goals of the present research was therefore to access these theoretically available, yet untapped memory traces from eyewitnesses using implicit memory tasks.

Explicit and Implicit Memory

Decades-worth of psychological research on human memory has led to the refined definitions of two distinct ways in which past experiences can be expressed on a subsequent task: explicit memory and implicit memory. Explicit memory refers to the intentional, conscious recollection of past experiences. Typical explicit memory tests include free recall, cued recall, and recognition tasks, wherein individuals are presented with an event or a list of items and, after some delay, are tested for this information by being asked to recall or recognize as many of the critical items or details as possible.

Schacter (1987) first used the term *implicit* memory to describe previous experiences affecting performance on a subsequent task *without* the intentional or conscious recollection of those previous experiences. In a typical implicit memory task, individuals are first presented with a set of stimuli and then asked to complete a task (ostensibly) unrelated to the items presented earlier. A change in task performance (e.g., preferring previously-seen items over previously-unseen items) without explicit recollection of the original stimuli would imply the presence of implicit memory for those stimuli. Stated simply, explicit memory entails conscious recollection, while implicit memory results from the unconscious influence of a previous experience on a subsequent task. Although the term "implicit memory" is now generally accepted when describing this particular phenomenon, this was not always the case; much research on human cognition was necessary in order to arrive at an agreed upon definition and a clear understanding of implicit memory.

In Schacter's (1987) historical review of implicit memory, he explains how philosophers, such as Leibniz and Maine de Biran, discussed the concept of unconscious ideas during the early 1900s: ideas without conscious awareness but influential nonetheless. Henri Bergson, another philosopher of the early 1900s, argued that a person's past survives in two different forms: behaviors and recollections (1913). According to Bergson, the first form of memory, behaviors, was represented in the learning of habits and skills, without explicit references to or sources of these learned behaviors. Recollection, the second form of memory, is represented via the explicit remembering of past events.

Some of the first empirical analyses of implicit memory were conducted by neurologists on their amnesic patients. Neurologists who worked with amnesiacs would describe some of their patients as displaying memory for prior experiences without having explicit recollections of those experiences. For example, Korsakoff (1889) described two patients who always guessed that he was a doctor even though they insisted that each time they met him was the very first time. Eventually, experimental psychologists conducted more systematic observations, comparing implicit memory (or priming) in amnesic subjects and normal subjects. Graf and Schacter (1985) tested for priming of related versus unrelated words in both amnesiacs and subjects with normal memory functioning. The authors found a priming effect for related words in both subject groups, but only when word pairs were studied using elaborative processing. Priming was comparable between amnesic and normal subjects even though amnesiacs had no explicit recollections of the previously-studied word pairs. The study of implicit memory in amnesiacs led to the eventual realization that individuals with normal memory functioning could also display implicit memory in the absence of explicit recollection.

Properties of Implicit Memory

Research in the area of cognitive psychology has shown (1) important experimental dissociations between implicit and explicit memory and thus (2) specific tendencies that implicit memory displays reliably. The following are some of the established experimental dissociations accepted by the psychological community that distinguish implicit from explicit memory.

First, implicit memory functions independently from recognition memory. For example, Tulving, Schacter, and Stark (1982) presented participants with 96 words for five seconds each. After 1 hour, participants were tested with both a graphemic word fragment task (i.e., implicit memory task) and an explicit recognition task. Participants were tested again both implicitly and explicitly 7 days later. Their findings showed a priming effect such that more of the word fragments that were solvable with words presented earlier (i.e., during the study phase) were completed than those that were not solvable with words presented earlier. More importantly, word recognition declined substantially over the 7-day delay while implicit memory performance remained unchanged. Furthermore, the probability that a word fragment was solved successfully was independent of whether the participant accurately or inaccurately identified the word as having been presented during the study phase of the experiment. In other words, regardless of whether participants identify a word as either new (i.e., never seen before) or old (i.e., seen before), they are equally likely to complete the respective word fragment successfully. Tulving et al. observed this independence specifically when the recognition test preceded the implicit test. When word fragments were completed *before* the recognition test, dependence was observed, meaning that a participant successfully completing a word fragment with a target word predicted his or her likelihood of subsequently recognizing that word as old. This dependence is likely due to the additional encoding/study opportunity created by the successful completion of the word fragment with the target word.

Tulving et al.'s (1982) findings also provide evidence that implicit memory is less affected by retention interval; that is, over time, explicit memory decays more rapidly than implicit memory. Jacoby and Dallas (1981) found similar results when they presented participants with a series of words for one second each. Then, participants were given both a perceptual recognition task (e.g., study words presented so briefly that they were difficult to perceive) and an explicit recognition task either immediately, after a 15-minute delay, or after a 24-hour delay. Their results confirmed that priming effects did persist across retention intervals while recognition memory declined over time, providing further evidence that implicit memory seems resistant to decay over time, relative to explicit memory. Hayman and Rickards (1995) argue that dissociations such as these suggest separate memory traces and/or representations, accessible via different memorial cues.

Jacoby and Dallas' (1981) findings further highlight a dissociation that is particularly relevant to the present research: individuals who are presented with difficult (or impossible) to perceive stimuli may still display implicit memory for these stimuli, even without having explicit recollections for said stimuli. Generally speaking, even if people cannot consciously remember having seen something, they can still "remember" it, as can be inferred from their performance on implicit memory tasks. For this reason, the present research presented participants with either a brief (i.e., 15 seconds) or a long (i.e., 30 seconds) version of a mock crime video. Presenting participants with a brief, detail-rich event (compared to a longer version of the same event) is likely to make effortful encoding and thus the formation of consciously-accessible memories, difficult. A brief encoding opportunity should not, however, influence eyewitnesses' ability to reveal memory for the event implicitly. In contrast, lengthy exposure to an event is likely to yield detailed memories that should be easier to access via explicit questioning, thus potentially rendering implicit tasks unnecessary. Put simply, short crimes (i.e., short exposures) -or any situation in which encoding is difficult- should be where implicit eyewitness memory is most important and relevant in terms of its potential to elicit crime-relevant details. If the encoding conditions of an event are impoverished, such as those for a brief and unexpected crime, then this could result in witnesses reporting fewer accurate details and/or less information overall, compared to events that were encoded for a longer period of time. On the other hand, in line with prior research, implicit memory for this same brief event should be intact and accessible, given the appropriate implicit task. Conversely, eyewitnesses with better encoding conditions, such as those for a longer and clearly visible crime, are likely to have detailed explicit memories. In this scenario, probing eyewitnesses implicitly would add little and would thus be less worthy of elicitation. In summary, it was within the context of eyewitnesses viewing a *brief, unexpected crime* (e.g., theft of a wallet) that I predicted the dissociation between implicit and explicit memory to become noticeable and most meaningful.

Another experimental dissociation between explicit and implicit memory is that levels of processing (i.e., degree of elaboration) have differential effects on either type of memory (for a review, see: Schacter, 1987; Schacter, Chiu, & Ochsner, 1993). Specifically, elaborative processing of study items (e.g., having participants think about the meanings of words by asking them to generate synonyms) generally yields a substantial improvement in (explicit) recall or recognition. Conversely, superficial processing (e.g., asking participants to count the number of round letters in each word) does not yield the same benefit to explicit memory. However, the depth at which study items are processed does not affect performance on implicit memory tasks (Graf, Mandler, & Haden, 1982; Jacoby & Dallas, 1981). Relevant to the present work, research supports the idea that critical details do not need to be encoded deeply for witnesses to yield memory for those items implicitly at a later point in time.

Another dissociation between implicit and explicit memory is the general finding of stochastic independence between performance on implicit memory tasks and performance on recognition or recall memory tasks. Stated simply, successful completion of implicit memory task items can be uncorrelated with successful recognition or recall on explicit memory tasks (for a review, see Schacter, 1987; Experiment 2, Hayman & Rickards, 1995). Statistical independence has also been observed between recognition of previously-studied items and recall of said items (Flexser & Tulving, 1978; Tulving & Thomson, 1973) and between multiple successive implicit memory tests (Hayman & Tulving, 1989). Task sequence, however, can create stochastic *dependence*: successful implicit task completion can predict subsequent explicit recognition (e.g., Hayman & Rickards, 1995; Tulving et al., 1982). Within an investigative interviewing context, then, whether eyewitnesses provide critical details via implicit tasks may not predict whether they will provide those same details explicitly.

Implicit and explicit memory are also dissociable through modality changes between study and test. That is, priming effects appear to be sensitive to changes in modality from study phase to test phase, whereas explicit memory performance remains rather stable across modality changes. Scarborough, Gerard, and Cortese (1979) investigated the effect of modality on implicit memory for lexical decision speed. First, participants were either presented with a written word (e.g., shoe) or with a pictorial representation of a word (e.g., a picture of a shoe) and were asked to pronounce the visually presented stimuli out loud. At test, participants were given a lexical decision task in which they decided if letter sequences were real words or not. The authors measured implicit memory via a decrease in lexical decision latency for words that were presented during the study phase. Scarborough and colleagues found that lexical decision latencies were reduced when modality matched (e.g., participants saw and pronounced the written word "shoe" during the study phase and then identified it as a real word during test) compared to mismatched modality. Although many other studies have found similar decrements in implicit memory as a function of modality shifts (e.g., Hashtroudi et al., 1988; Roediger & Blaxton, 1987), some studies have not. For example, while Roediger and Blaxton (1987) found a reduced priming effect when words were changed from uppercase to lowercase, other studies have failed to replicate this finding (e.g., Clarke & Morton, 1983). With this in mind, modality was held as constant as was feasible across encoding and test phases for the implicitly-tested critical details, given the differential characteristics of the encoding and test phases (i.e., video vs. still images/stimuli); this was done to maximize the chances of detecting eyewitness memory implicitly for the unexpected event.

Yet another rather interesting dissociation between implicit and explicit memory is the effect of working memory load on subsequent task performance. Baques, Saiz, and Bowers (2004) manipulated working memory load (phonological load vs. visuo-spatial load vs. no load) while having participants learn a series of words. On subsequent word stem completion (i.e., implicit memory) and (explicit) cued recall tasks, the authors found that working memory load had no effect on implicit memory performance while it did have a significant detrimental effect on explicit memory performance. Relevant to the present study, these findings suggest that even if eyewitnesses' minds were occupied, that is, working memory was "loaded," they should still be able to display subsequent implicit memory for critical details- even if they cannot recall or recognize those details explicitly.

One last property of implicit memory particularly relevant to the present research, and to implicit eyewitness memory in general, is that our ability to measure/detect memory implicitly should not be affected by test awareness. As defined by Bowers and Schacter (1990), an individual who is "test aware" is conscious of the fact that test items on an implicit task can be completed using items that were encountered during the study phase of the experiment. Bowers and Schacter asked participants to study a list of words, with half of them being studied semantically and the other half being studied structurally (i.e., superficially). Next, participants were tested by performing both a word stem completion task and a cued recall task- the former an implicit memory task and the latter explicit. Participants were also given an awareness questionnaire aimed at distinguishing between those who were aware that some of the words from the study phase were solutions for subsequent word stems and those who were not aware. In contrast to their findings for explicit memory tasks, the authors found that participants performed similarly on the implicit memory task regardless of whether or not they were considered "test aware." These findings suggest that participants should perform similarly on implicit memory tests for an event, irrespective of their being categorized as test aware (or not). This dissociation is especially pertinent to eyewitness scenarios: eyewitnesses who become aware of the true nature of any given implicit memory task should nonetheless perform comparably to those who remain unaware.

Prior studies on human cognition have shown implicit memory for different types of stimuli using different paradigms. The mere exposure effect (Stafford & Grimes, 2012; Zajonc, 1968; Zajonc, 2001) is a phenomenon in which simply being exposed to a stimulus tends to increase one's liking of or preference for that stimulus, independent of stimulus recognition. Prior research has thus tested for implicit memory of novel faces (e.g., Kunst-Wilson & Zajonc, 1980), for example, by asking participants to select quickly faces they prefer, resulting in their tendency to choose faces seen previously. Implicit memory has also been shown for other visual objects such as novel three-dimensional shapes (e.g., Schacter & Cooper, 1993), novel patterns (e.g., Musen & Treisman, 1990), and familiar faces (e.g., Bruce & Valentine, 1985; Young, McWeeny, Hay, & Ellis, 1986). Other studies have shown implicit memory for briefly-seen written words by measuring identification accuracy of masked words (e.g., Feustel, Shiffrin, & Salasoo, 1983) or the completion of word fragments (e.g., Tulving, Schacter, & Stark, 1982). People have also been shown to have implicit memory for aural stimuli, such as spoken words (e.g., Scarborough, Gerard, & Cortese, 1979; Kempley & Morton, 1982; Jackson & Morton, 1984; Schacter & Church, 1992; Stuart & Jones, 1996) or environmental sounds (e.g., Chiu & Schacter, 1995). While undoubtedly important, all previous studies on implicit memory, to my knowledge, have only tested participants for *one* kind of simple stimuli at a time, or stated differently, via one modality. The present research therefore aimed to expand on the implicit memory literature by presenting participants with a multi-modal event (i.e., a mock crime video depicting a wallet theft) that included novel faces, written words, and spoken phrases, and tested participants for their memory of the event using both explicit and implicit memory tasks. Detecting implicit memory for a more ecologically valid stimulus like a simulated crime can help generalize this cognitive phenomenon to real-life scenarios that are particularly relevant to investigative interviewers.

Novel Contributions

This series of studies is the first to investigate implicit eyewitness memory. As mentioned earlier, prior research has shown implicit memory for visual objects (e.g., 3D shapes), visual written stimuli (e.g., written words or numbers), and auditory stimuli (e.g., spoken words or environmental sounds) in various laboratory settings. However, prior research has *not* explored implicit memory for multi-modal stimuli presented simultaneously or in rapid succession as part of one encoding opportunity. Thus, one novel contribution of the present research was to test memory implicitly for multiple faces, visible words, and audible phrases presented as part of a multi-modal stimulus video.

Further, implicit memory has not been explored in relation to investigative interviewing or eyewitness memory in general. The question of whether indirect tests of memory can elicit forensically-relevant information therefore remains unanswered. A second novel contribution of the present series of studies was therefore the assessment of eyewitness memory for a mock crime via implicit memory tests. While eliciting implicit memory in addition to explicit memory for various stimuli across various modalities is a robust finding, it remains unclear whether this pattern will be similarly observed following a single exposure to a multi-modal, detail-rich mock crime video. It may be the case, for instance, that the eliciting of implicit memory is a reliable finding *only* when test/critical items are encoded one at a time, as opposed to when test items co-occur and are thus presented (and encoded) simultaneously. In sum, the present research aimed to contribute to the implicit memory literature by exploring this phenomenon in the context of co-occurring multi-modal stimuli presented as a mock crime and to contribute to the eyewitness memory literature by exploring its benefits in comparison to explicit memory only.

Hypotheses

The present research had four main hypotheses. First, I predicted that participants who witnessed a detail-rich crime would provide significantly more crime-related responses on implicit memory tasks than participants who did not witness the crime. Second, I predicted a dissociation between performance on implicit and explicit memory tasks. Specifically, participants who witnessed the brief crime would provide significantly fewer accurate details via explicit probes than participants who witnessed the long crime. However, participants who witnessed the brief crime and those who witnessed the long crime should *not* differ on (the number of) crime-relevant details provided to implicit memory tasks. Third, I predicted stochastic independence such that the details provided by witnesses implicitly would not predict (i.e., be correlated with) the details provided explicitly, irrespective of encoding duration. Lastly, I predicted that participants' awareness of the implicit memory tasks actually testing for event memory would not predict their likelihood of providing crime-related details on said tasks.

II. STUDY 1: FACIAL PREFERENCE PILOT TESTING

Purpose

The purpose of Study 1 was to choose three actors for the mock crimes videos that would eventually be filmed. Because the faces of the actors would eventually be tested for implicitly, pilot data was necessary to ensure that their faces would not be preferred too often or too infrequently.

Participants

Two hundred and one students (M_{age} = 21, SD_{age} = 3; 70% female; 70% Hispanic, 13% Black, 8% White, non-Hispanic, 3% Asian, 6% "Other") from Florida International University participated in exchange for 1 Sona Systems research credit.

Stimulus materials

In order to first create a pool of photographs that could subsequently be assessed for preference, seventy-two Hispanic male students were recruited via Sona Systems. The study description stated that participants would be photographed in exchange for 1 research credit. They were also informed that they might be contacted at some point in the future to assist with the filming of a mock crime video. Each photograph was a mug-shot-style "head shot" showing each face with a neutral expression, with all participants wearing a white T-shirt and standing in front of a black background. All photographs were digitally cropped at shoulder-level to standardize all future image presentations. After being photographed, each participant was asked to provide his name, telephone number, and email address in case the results of Study 1 revealed him as a suitable perpetrator, victim, or bystander for the mock crime. Photographs were kept anonymous by being assigned a random number; this random number was also attached to the corresponding contact information on a separate data file for when the potential "actors" needed to be contacted.

From this total pool of 72 mug shot photos, 15 were randomly selected, with the only exclusionary criterion being that they not look too similar, since the actors for the mock crime video would be chosen from this smaller pool. Using Qualtrics, an online survey was constructed with each of the 15 photographs being paired with the remaining 14 photographs (e.g., photograph #1 was paired with photograph #2, then photograph #3, etc.) to create a total of 210 unique image pair orders. All possible image pairs were created such that each mug shot was paired with every other mug shot side-by-side, counterbalancing for image location (i.e., all mug shots were the left-most image and the right-most image an equal number of times). This was also the primary reason why all 72 mug shots were not used, as creating all possible image pairings would have become too cumbersome. The mug shot image pairings that *were* created were presented to the 201 participants (as mentioned above) via the online survey constructed using Qualtrics.

Procedure

After reading and electronically signing the study consent form, participants were told they would view a series of face pairs. Specifically, the instructions stated: "For each pair of faces, please choose the face you prefer as quickly as possible, according to your own criteria." Each participant was then presented with a sub-sample of 30 face pairs randomly selected from the total pool of 210 pairs to avoid fatigue effects. Participants viewed and decided on one face pair at a time. After completion of the face preference decisions, participants were asked to provide demographic information (i.e., age, gender, and race/ethnicity), thanked for their participation, and subsequently debriefed.

Results

Table 1 displays participants' preference rates, both as a frequency and a percentage, for each of the 15 mug shots. Participants made a total of 5,882 preference decisions. We can assume that all faces were viewed at equal rates, given the large sample size and that the sub-sample of presented face pairs was selected randomly. Furthermore, assuming a given face was preferred at chance level, it should have been selected in 1 out of every 15 presentations (i.e., 6.67% of the time). Chance performance also serves as our basis for comparison in lieu of a control group, since all participants engaged in the same task. Consequently, I was interested in identifying the faces whose preference rates were *below-chance* to recruit as actors for the mock crime video. Choosing individuals whose faces are preferred below chance helps avoid ceiling (e.g., faces preferred almost always) and floor (e.g., faces preferred almost never) effects. Furthermore, a below-chance base rate leaves room for participant "improvement" in that previous exposure to these faces should increase preference rates of these faces to chance levels or above. The eventual exposure to these faces via the mock crime should theoretically induce participants to prefer them more often than participants who are not exposed to these faces. In other words, participants exposed to the stimulus video should show implicit memory for the critical faces as evidenced by preference rates higher than those of control participants. With this in mind, we contacted all nine individuals whose faces were preferred below chance. We intended to recruit four actors for the mock crime but were only able to recruit three actors successfully.

Table 1

Facial Preferences

Mug Shot	Preferred (count)	(%)
1	490	8.33
2	646	10.98
3	651	11.07
4	470	7.99
5	352	5.98*
6	263	4.47*
7	551	9.37
8	202	3.43*
9	507	8.62
10	288	4.90*
11	248	4.22*
12	330	5.61*
13	331	5.63*
14	290	4.93*
15	263	4.47*

Note: Percentages with a * represent images preferred at below-chance levels.

III. STIMULUS VIDEO

The three actors recruited on the basis of the data from Study 1 were asked to help film a mock crime in exchange for research credits or a $5 gift certificate to Starbucks. The video was filmed at Tamiami Park next to the Modesto Maidique campus of Florida International University. The mock crime included a total of nine critical details for which participants would eventually be tested implicitly: (1) three faces, (2) three written words, and (3) three spoken phrases. The three critical faces were of the three actors: the bystander, the victim, and the perpetrator, with all roles being assigned randomly. The three critical written words were displayed on (1) the cover of the victim's book, (2) a sign hanging from a tree in the background, and (3) the perpetrator's shirt. All three written words were displayed in lower-case letters, Arial font, and printed in black ink. Although font sizes varied across written words (depending on where they were displayed), the camera's zoom was adjusted such that all words were displayed clearly.

The three written words displayed in the video were of medium (i.e., between 10 and 20 occurrences for every 1 million words) to low frequency (i.e., less than 10 occurrences for every 1 million words) in the English language (as determined from the SUBTLEXus database; Brysbaert & New, 2009), ranging from 5 to 8 letters in length. Choosing words of medium to low frequency ensured that participants would be unlikely to complete eventual word stem items with these critical words. A random word generator using the SUBTLEXus database as its source was used to generate words that met these criteria; the words *graduate*, *hiking*, and *dispose* were thus generated and chosen as the three written words displayed during the mock crime. These words would eventually be tested for implicitly using a word stem completion task. According to

Merriam Webster's dictionary (11th edition, 2004), the two-letter stem *gr*- can be solved with 194 different words (*graduate* being one of them). Similarly, the stem *hi*- can be solved with 96 different words and *di*- with 418 different words. Related to the present study, participants who witness the mock crime should solve these three word stems with *graduate*, *hiking*, and *dispose* (or variations of the root words; e.g., graduating, hiker, disposal) more often than participants who do not witness the mock crime.

Each of the three spoken phrases was uttered by one of the 3 actors (one phrase per actor). Each utterance was either one multi-syllabic word or a short, 2 -word phrase, with the utterances being forensically relevant. The bystander uttered the local street name "Waterway" while speaking on the phone, the victim yelled out "My wallet!", and the perpetrator responded to the victim out loud by yelling "I'll shoot!" A wireless microphone was placed on the park bench, hidden by the victim's bag so that the spoken phrases could be heard clearly during the mock crime.

Two versions of the mock crime were filmed and edited with the goal of differing only in duration. The brief version of the mock crime video lasted 15 seconds, with each of the visual critical details (i.e., the actors' faces and the written words) clearly visible for 3-6 seconds each. The long version of the video lasted 30 seconds, with each of the visual critical details being clearly visible for 6-10 seconds each. The speed at which the spoken phrases were uttered was not manipulated nor was the audio sped up or slowed down digitally; spoken phrase speed was thus held constant across mock crime durations so that the spoken phrases in the brief crime would not be said faster, which could have made them stand out or difficult (or impossible) to understand. The video was filmed using a Hi-Definition camera and two microphones: one internal (i.e., attached to the camera) and one wireless. The control group would eventually watch a 30-second clip from the BBC show *Merlin*.

There were two reasons why the brief version of the mock crime was half the duration of the long version. First, 15 seconds is short enough to be considered a "brief" crime while still being long enough to allow for a rich event full of critical details. Although 15 seconds can be considered a long exposure time for some studies, especially those testing implicit memory, none of the critical details were visible for the full duration of the video. Second, presenting participants with a 15-second, detail-rich event (compared to one lasting 30 seconds) should have rendered encoding and thus the explicit recollection, difficult. A brief encoding opportunity should not, however, influence eyewitnesses' implicit memory for the event. The long version of the mock crime should have allowed participants more time to encode the same crime details seen by those who witnessed the brief version, resulting in more explicit memories for the event.

Both mock crime videos depicted an unexpected theft of a man's wallet while he was seated at a bench reading a book. The video also depicted an outdoor scene with trees, benches, and a sign. At the start of the video, the bystander paces while pretending to talk on a cellular phone. As the camera pans across him, he says "Waterway" out loud. The camera continues to pan such that the bystander is no longer visible but the thief can now be seen in the background standing under a tree. The thief proceeds to walk towards the victim, who is seated at a park bench facing the camera while reading a book. The victim's wallet is on top of the bench to his left. The thief continues to sneak up behind the victim until he is within reach of the victim's wallet. Once he grabs the wallet from the bench, the thief proceeds to run off-screen. The victim reacts by standing up and yelling "My wallet!" with the thief yelling "I'll shoot!" in response.

IV. STUDY 2: MOCK CRIME DURATION AND EXPLICIT MEMORY

Purpose

The goal of Study 2 was to establish and confirm that the two different mock crime durations would result in differential performance on explicit memory tasks. If a difference were not found in explicit recollection between the witnesses of the 15-second and 30-second crimes, new mock crimes of varying durations (e.g., 10-second crime vs. 45-second crime) would have been filmed and tested. The potential informativeness of implicit eyewitness memory, forensically-speaking, depends largely on participants' explicit recall of a brief crime being less informative than explicit recall of a longer crime.

Participants

Thirty-five students (M_{age} = 20, SD_{age} = 4; 77% female; 65% Hispanic, 27% Black, 4% Asian, 4% "Other") from Florida International University participated in exchange for 1 Sona Systems research credit.

Procedure

Upon arrival, participants were seated at a computer desk and asked to read over and sign the consent form. Next, the experimenter collected the consent form and then placed a set of headphones around the participant's ears, making sure that the headphones fit comfortably and that the audio was also at a comfortable level. Prior to their arrival, participants were randomly assigned to watch either the brief mock crime or the long mock crime. The experimenter proceeded to prepare the correct version of the mock crime that corresponded to the participant's experimental condition. Next, the experimenter stated the following instructions out loud: "You will now watch a video. Please, pay attention to the entire video, as it will last no longer than 1 minute." The experimenter then played the video at full screen. Once the video had ended, the experimenter removed the participant's headphones, turned the computer monitor off, and escorted the participant to a different desk, allowing him or her to have plenty of desk space to fill out the response packet (see Appendix A).

Participants were asked to read the instructions on the first page of the response packet quietly while the experimenter read them aloud. First, participants were asked to write down everything they could remember about the video they just witnessed. When they appeared to finish writing, the experimenter probed them with two more open-ended prompts (e.g., "Before you turn it in, please write down anything else you can remember about the video."). The next three items in the packet asked participants to write down everything they could remember about the bystander, the victim, and the perpetrator. Then, participants were asked to write down anything that was *said* (i.e., verbally/audibly) and any words that were *seen* during the video. After responding to these items, participants were escorted back to the computer desk in order to view a sequential lineup. The experimenter turned the computer screen back on and read the following instructions aloud: "You are about to view a series of faces, one at a time. For each face, please indicate whether or not the pictured individual was in the video you watched earlier." Using Microsoft PowerPoint, participants viewed one of 15 mug shots at a time, with three of those mug shots being of the actors in the mock crime video. The first five faces of this sequential lineup served as practice items and distractors, so there were no familiar faces at the beginning of the lineup. For each image, participants responded by circling "*Was in the video*" or "*Was NOT in the video*" in the response packet. The response sheet for the sequential lineup had 24 items so that participants would not know how many mug shots to expect. Upon completion of the sequential lineup task, participants provided their demographic information and were then debriefed.

Segmenting and Scoring

For all open-ended and cued questions on the response packet, participants' written responses were broken down into segments. A "segment" was operationally defined as the smallest unit of information that could be scored for accuracy (i.e., objectively). After all responses were segmented, a trained rater scored each unit for accuracy. Segments that were opinions or unverifiable (e.g., "the guy who stole the wallet looked mean") were scored as subjective.

Results

The purpose of Study 2 was to examine if participants who witnessed the long (i.e., 30-second) mock crime would remember the event more accurately than participants who witnessed the brief version (i.e., 15-second). Specifically, participants who viewed the 30-second mock crime were expected to recall significantly more accurate details than participants who viewed the 15-second mock crime. Thus, the primary dependent variable was the number of accurate details recalled for all open-ended and cued probes combined.

To test for an effect of mock crime duration on the number of accurate details recalled, we conducted an independent-samples t test. There was a main effect of crime duration on memory accuracy such that participants viewing the long crime remembered significantly more accurate details (*M* = 38.89, *SD* = 8.78) than those viewing the brief crime (*M* = 28.64, *SD* = 6.74), $t(33) = -3.85$, $p < .001$. There was no difference in the number of inaccurate details recalled between viewing conditions, $p = .64$.

To test the effect of mock crime duration on participants' ability to identify the faces of the individuals from the mock crime in the sequential lineup, three separate Pearson Chi-Square analyses were conducted (i.e., one for each mock crime role). Crime duration did not affect participants' ability to correctly identify the bystander: 18% of participants who viewed the brief crime identified the bystander correctly compared to 28% of those who viewed the long crime, $p = .48$. Crime duration also did not affect participants' ability to recognize the victim correctly: 47% of participants in the brief crime condition recognized the victim correctly, compared to 44% of those in the long crime condition, $p = .88$. Crime duration did, however, have a marginal effect on participants' ability to recognize the perpetrator correctly from the sequential lineup, $\chi^2(1) = 3.47$, $p = .10$. All participants in the long crime condition recognized the perpetrator correctly, compared to 82% of participants in the brief crime condition.

Taken together, findings from Study 2 supported the prediction that exposure to a 30-second mock crime allowed participants to recall significantly more accurate information than exposure to a 15-second version of the same crime. Thus, the two stimulus video versions, differing only in duration, were suitable for testing the one of the central predictions of the present study, namely, that participants who witness the brief crime and those who witnessed the long crime should differ on crime-relevant details provided via explicit probes. Arguably, if explicit free-recall accuracy is comparable across mock crime durations, then testing eyewitness memory implicitly may be unnecessary or uninformative.

V. STUDY 3: WHITE NOISE PILOT TESTING

Purpose

The purpose of Study 3 was to determine a level for the white noise mask that could eventually be used during the implicit memory task for spoken phrases (i.e., Study 4). Previous studies (e.g., Schacter & Church, 1992; Stuart & Jones, 1996) have examined implicit memory for spoken phrases by first exposing participants to the aural stimuli and then testing their ability to correctly identify what is being said masked under white noise (i.e., static). Spoken phrases heard previously should be easier to identify under white noise than previously-unheard phrases. Drawing a parallel to the present study, the goal was to find a level of white noise (in decibels) that would render participants' ability to identify various spoken phrases correctly under white noise at or below chance levels, suggesting that participants are guessing at best.

Participants

Fifty-one students ($M_{age} = 21$, $SD_{age} = 3$; 76% female; 77% Hispanic, 16% Black, 4% White, 2% Asian) from Florida International University participated in exchange for 1 Sona Systems research credit.

Stimulus Materials and Design

A total of 16 spoken phrases were recorded using the same Hi-Definition video camera and wireless microphone used to record the mock crime. The audio for three of the spoken phrases- specifically, the three phrases from the mock crime- was extracted from the mock crime video itself. An additional 13 spoken phrases serving as experimental comparisons were recorded at Tamiami Park immediately after filming the mock crime; this was done to keep audio quality constant across all 16 spoken phrases (i.e., recorded outdoors using a video camera and wireless microphone). Using a random word generator, the to-be-recorded words were chosen according to the following 2 criteria: (1) half of the words would have 1 syllable while the other half would be multi-syllabic words, (2) half of the words would be "crime-relevant" with the other half being "crime-irrelevant." Table 2 displays the list of 16 spoken phrases recorded by the actors, sorted by crime relevance and syllable count. To ensure that participants would hear each actor's voice an equal number of times, each of the spoken phrases was randomly assigned to each of the three actors. This random assignment of spoken phrase resulted in "the bystander" recording 6 of the spoken phrases, "the victim" recording 5 of the phrases, and "the perpetrator" recording the remaining 5 phrases.

Using Final Cut Pro®, a video and sound editing program, the audio tracks for the 16 spoken phrases were extracted and then distorted with varying decibel levels of white noise. The specific levels of white noise distortion applied to each spoken phrase were randomized, resulting in three control phrases (i.e., no distortion), three phrases with 0 decibels (0 Dbs) of distortion, three phrases with 2 Dbs of distortion, three phrases with 4 Dbs of distortion, two phrases with 6 Dbs of distortion, one phrase with 8 Dbs of distortion, and one phrase with 10 Dbs of distortion.

Procedure

Participants were first seated at a computer desk and asked to read over and sign a consent form. After consenting to take part in the study, an experimenter placed a set of headphones over the participant's ears, ensuring that the audio was working properly by setting the computer volume to the appropriate level. Next, participants were informed that they would be listening to a series of spoken phrases masked in white noise. The distorted spoken phrases would be heard through the headphones, one clip at a time. For each clip, they were asked to write down on the response sheet the first word or phrase they thought they heard under the white noise. If they were uncertain about what they heard, they were encouraged to write down their best guess, and if they had no idea they were to simply draw a line indicating a blank response. After the experimenter confirmed that participants understood the instructions, the distorted spoken phrases were presented one clip at a time in random order using SuperLab® 4.0. For each distorted clip, participants listened, wrote down their response, and then pressed the space bar on the computer keyboard to proceed to the next random clip. After listening and responding to all clips, participants completed a demographics questionnaire and were debriefed.

Results

Accuracy as a percentage (i.e., the percentage of participants identifying each distorted phrase correctly) was calculated for all 16 audio clips. The aim of Study 3 was to find a level of white noise distortion that would produce below-chance identification performance. Sixty-six percent of participants correctly identified the control (i.e., no distortion) phrases. Forty-four percent of participants were able to identify the spoken phrases distorted by 4Dbs of white noise. Surprisingly, 65% and76% of participants were able to identify the phrases with 8 Dbs and 10 Dbs of distortion, respectively. This could have been due to the specific phrases themselves. For example, “keyboard” was heard with 10 Dbs of distortion, but because it is a common, multi-syllabic word participants may have had a particularly easy time identifying the phrase. Thus, in order to standardize the stimuli, all spoken phrases (to be used in Study 4) were distorted/masked with 4 Dbs of white noise.

Table 2
All Spoken Phrases by Crime Relevance and Syllable Count

	Crime-relevant	Crime-irrelevant
1-syllable Words	Cop Punch Jail Kill	Shoe Corn Flame Draw
Multi-syllable Words	Waterway My wallet I'll shoot Bookbag	Keyboard Fastball Loudspeaker Exhibit

VI. STUDY 4: IMPLICIT EYEWITNESS MEMORY

Purpose and Design

Recall that the overarching objective of the present research was to investigate the effect of exposure time on witnesses' ability to reveal memory for the event implicitly and explicitly. To this end, participants were exposed to either a brief, 15-second mock crime, a longer, 30-second version of the crime, or an irrelevant 30-second clip from a television show. Furthermore, participants were either tested for their memory of the crime implicitly *and* explicitly, or they were tested explicitly only, after a 5-minute delay. The present study was a 2(event length: brief crime vs. long crime) X 2(memory task: implicit & explicit memory tasks vs. only explicit tasks) between-participants design, with a hanging control group. Participants assigned to the control group witnessed an irrelevant, 30-second clip from a British television show and completed all filler/implicit memory tasks, but were never interviewed explicitly about the video they watched. Event length and the presence (or absence) of implicit memory tasks were both manipulated between participants. Whether or not participants were tested implicitly for the event was manipulated to assess the potential effect of engaging in implicit memory tasks on subsequent explicit memory performance.

Three distinct implicit memory tasks were used, specific to the particular details being assessed. Using data gathered from Study 1, memory for faces was measured implicitly via participants' preference decisions; that is, participants were presented with a series of face pairs. Three of the face pairs contained the faces of the bystander, the victim, and the perpetrator from the mock crime. For each pair, participants were asked to choose which face they preferred. The logic behind having participants select the faces they preferred is based on the mere exposure effect (Stafford & Grimes, 2012; Zajonc, 1968; Zajonc, 2001); participants who witnessed the mock crime were expected to prefer the faces seen during the crime more often than participants who did not witness the mock crime. Memory for written words was measured implicitly via completed word stems; that is, participants were presented with a series of two-letter word stems (e.g., "us______"). Three of the word stems were soluble using written words visible during the crime. Memory for spoken phrases was measured implicitly using data gathered from Study 3, specifically, the accuracy with which participants identified the spoken phrases distorted by white noise. Three of the spoken phrases were heard during the crime video. Memory for the crime was assessed *explicitly* using open ended probes (e.g., "Please, tell me everything you can remember about the crime you witnessed earlier") and a series of recognition tasks, designed similarly to the implicit memory tasks.

Participants

Two hundred twenty-seven undergraduate students (71.4% female; M_{age} = 21, SD_{age} = 5; 66% Hispanic, 15% Black, 11% White, non-Hispanic, 4% Asian, 4% "Other") from Florida International University participated in exchange for 1 Sona Systems research credit. Students who participated in Studies 1 through 3 were excluded from participating in Study 4.

Materials

Stimulus videos. Both versions of the mock crime video (discussed in detail in Chapter III) portrayed the theft of a young man's wallet while seated at a park bench reading a book. Participants in any of the experimental conditions viewed either the brief version or the long version of the crime. Participants randomized to the control condition watched a 30-second clip from the BBC show, *Merlin*.

Number preference filler task. On a computer screen, participants were presented with 60 different pairs of 3-digit numbers (e.g., 368 or 923). For each pair, participants were asked to choose which 3-digit number they preferred as quickly as possible; specifically, the experimenter instructed participants to press the "Q" key when they preferred the number on the left and the "P" key when they preferred the number on the right. This task was always the first (and the only genuine) filler task administered after viewing the stimulus video.

The reasons for administering the number preference filler task were three-fold. First, administering this task to all participants after the stimulus video created a buffer (i.e., delay) between encoding the crime and the subsequent implicit memory tasks, thus allowing memory for the crime to decay somewhat. Second, the filler task should have occupied participants' working memory, making it difficult for them to think about and rehearse any details from the video for a short while. Third, formatting this filler task similarly to the immediately-following implicit memory task for faces (see below) should have reduced participants' suspicion regarding the subsequent implicit memory tasks, which were also presented as filler tasks.

Implicit memory task for faces. Participants were presented with 13 different pairs of faces (similar to the procedure of Study 1) in random order using SuperLab® 4.0. The first five trials served as a buffer, meaning that the three critical faces never appeared during these trials. The remaining eight face pair trials were presented in random order as well, and included three critical trials where one of the faces belonged to the bystander, the victim, and the perpetrator from the mock crime. All faces included in the remaining eight trials were randomly chosen from the image pools created and used during Study 1. Full randomization further allowed for each actor's face to have an equal chance of being presented on either side (left or right) of the computer screen and an equal chance of being paired with one of 12 other faces. Thus random presentation of face pairs, their orders, and the faces with which they were paired should have avoided potential confounds, allowing the assessment of actual preference rates for each critical face. For each face pair, participants were asked to choose which of the two faces they *preferred* (for example, see Kunst-Wilson & Zajonc, 1980). Specifically, participants were instructed that they would be presented with a series of face pairs, one at a time. For each pair, they were to choose quickly which face they preferred, pressing the "Q" key for the face on the left and the "P" key for the face on the right. Participants were not told how many trials to expect.

Implicit memory task for written words. Described as a "word-stem filler task," participants were presented with 16 unique 2-letter word stems (e.g., hi_____), with each word stem being soluble with meaningful words in the English language. Participants were instructed to complete each word stem with the first word that came to mind (e.g., hi______ could be completed with hiking, hills, or hinder). Also, each solution had to be longer than three letters. Using *The Merriam-Webster dictionary*, it was verified that all word stems were soluble, with the fewest solutions being 14 words (*us*-) and the most solutions being 490 words (*de*-). Regarding the critical written words (i.e., *hiking*, *graduate*, and *dispose*), the two-letter stem *gr*- could be solved with 194 different words, the stem *hi*- could be solved with 96 different words and *di*- with 418 different words.

The word-stem task was administered on a white sheet of paper (as part of a response packet) with the word stems being printed in lower-case letters using Arial font and in black ink (see Appendix B). Three of the 16 word stems were soluble using the three critical written words visible during the mock crime, thus allowing the test of participants' memory for these written words implicitly. Two versions of the word-stem task were constructed to vary presentation order. Furthermore, the first five word stems for each version of the task served as a buffer, that is, they never included any of the three critical word stems.

Implicit memory task for spoken phrases. Using a set of headphones, participants listened to 16 unique spoken phrases distorted by 4 Dbs of white noise (for a detailed description, see Chapter V). For each spoken phrase, participants were instructed to write down the first discernible word or phrase they thought they heard under the white noise. If uncertain, participants were to write down their best guess. If participants had no idea, they were asked to draw a line indicating a blank response. All 16 aural items were presented in random order. For each trial, participants were instructed to press the space bar on the keyboard to listen and then write down their response in the appropriate answer blank (see Appendix C). The volume at which participants listened to the distorted phrases was kept constant throughout the study. Three of the 16 distorted phrases were the critical spoken phrases from the mock crimes (i.e., "Waterway," "My wallet," and "I'll shoot"). For the remaining 13 utterances, each of the actors from the mock crime recorded one-third of the utterances (chosen at random); this resulted in each actor's voice being heard by all participants one-third of the time.

Awareness questionnaire. The purpose of this questionnaire was to assess post-hoc whether or not participants were aware that the various "filler tasks" were actually testing their memory for the mock crime implicitly. The awareness questionnaire (see Appendix D) consisted of four questions similar to those of Bowers et al.'s (1990). The first two questions were open-ended: (1) "What did you think was the purpose of the various filler tasks that you completed earlier?" and (2) "What was your general strategy in completing the previous filler tasks?". The last two questions were more directed: (3) "Did you notice any relation between the items on the filler tasks and the video you watched earlier?" and (4) "While working on the filler tasks did you notice whether you completed some of the items with details from the video you watched earlier?". For each of the four questions where a participant indicated that his or her memory for the stimulus video was actually being tested, a point was added to his or her awareness score. Thus, participants' level of test awareness ranged between 0 (*completely unaware*) to 4 (*completely aware*).

Explicit memory task (The eyewitness interview). Participants were told that the purpose of the witness interview was to assess what they remembered about the crime they witnessed earlier. The interview consisted of two types of explicit tasks: open-ended probes (i.e., uncued recall) and recognition tasks (i.e., cued recall). An initial open-ended probe ("Please, tell me everything you can remember about the crime you witnessed earlier.") was followed by two additional open-ended probes ("What else do you remember about the crime you witnessed earlier?"). The recognition memory tasks were designed such that they mirrored the implicit memory tasks, but instead probed for crime-relevant details explicitly. Specifically, participants were presented with a sequential lineup that included the faces presented earlier during the implicit memory task for faces. Instructions indicated that they would be presented with a series of mug shots, one at a time. For each mug shot, participants indicated whether or not they recognized that face from the mock crime by pressing "Y" on the keyboard (i.e., indicating "Yes, he was present during the crime") or pressing "N" (i.e., indicating "No, he was NOT present during the crime). Participants viewed 16 faces in random order without knowing how many faces to expect. Three out of the 16 faces were those of the bystander, the victim, and the perpetrator.

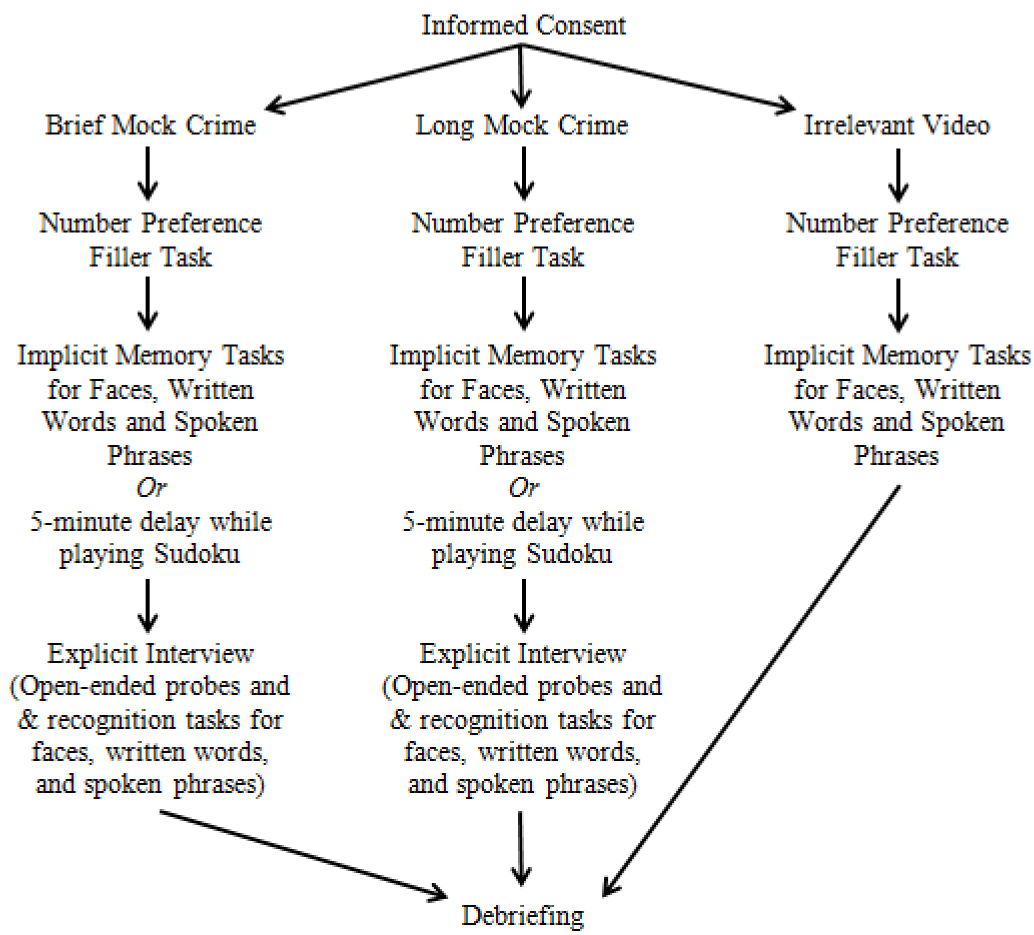
The recognition task for the critical written words asked participants to complete the same 16 word stems presented earlier, with the explicit instruction to use words visible during the mock crime. Similarly, the recognition task for the critical spoken phrases had participants listen to each of the 16 distorted phrases, only this time they were asked to specifically identify words or phrases that were said during the mock crime. All recognition task items were presented in random order (see Appendix E for the full explicit interview response packet).

Procedure

Upon arrival, participants were seated at a computer desk and asked to provide informed consent. Next, to match the level of anticipation and attention in real-world eyewitnesses, participants were not told that the video they were about to watch depicted a crime; instead, they were told that the researchers were interested in their assessment of the video's quality, as it may be used in a future experiment. While wearing a set of headphones, participants then watched the brief crime, the long crime, or the irrelevant video. After watching the stimulus video, participants removed the headphones and were then made aware that they had just witnessed a crime. Because they were now eyewitnesses to a crime, they would be interviewed about the crime to see what they remembered. Before the interview, however, participants were asked to complete a series of "filler tasks" while they waited for the investigator. They were informed that the following filler tasks (before the investigative interview) served to introduce a delay between encoding and retrieval, similar to real-world delays between the occurrence of a crime and the subsequent witness interview. Three of the four "filler tasks" were actually the implicit memory tasks designed to assess participants' memory for the mock crime indirectly. All participants completed the number preference filler task. Then, depending on a participant's experimental condition, he/she also completed the implicit memory tasks for faces, written words, and spoken phrases (in that order) or he/she simply worked on a Sudoku puzzle for 5 minutes before proceeding with the experiment. Completing the implicit memory tasks took participants approximately 5 minutes, so a 5-minute delay was implemented for those participants who would not complete any implicit memory tasks to standardize the retention interval between encoding and retrieval. Next, the experimenter administered the awareness questionnaire to participants who completed the implicit memory tasks to assess the extent to which they became aware that the supposed "filler tasks" were actually testing for memory of the stimulus video. Once the awareness questionnaire was completed, the current experimenter (i.e., the research assistant) was replaced by a new experimenter, who played the "investigator" role. The investigator explained that the purpose of this interview was to assess participants' memory for the crime they witnessed earlier. The explicit interview consisted of three open-ended probes followed by three recognition memory tasks designed analogous to the three implicit memory tasks. Finally, after the explicit witness interview, participants completed a demographics questionnaire and were then debriefed as to the true purpose of the study. See Figure 1 for a flowchart of Study 4's general procedure.

Figure 1

General Study 4 Procedure



VII. RESULTS

Primary Analyses

The primary dependent variables for the following analyses were the *number* (i.e., frequency/count) of accurate details provided for each memory task, across all implicit and explicit tasks (open-ended questions, and recognition tasks).

The present study had four main hypotheses. First, I predicted that participants who witnessed a mock crime would provide significantly more crime-related responses on implicit memory tasks than participants who watched an irrelevant video, demonstrating the presence of implicit eyewitness memory. This prediction was tested via an independent-samples *t* test comparing the mean number of crime-related details provided to implicit memory tasks between those participants who watched the mock crime video(s) and those who watched the irrelevant video. There was a significant effect of video type such that participants who watched either version of the mock crime provided significantly more crime-related details ($M = 2.43$, $SD = 1.07$) on the implicit memory tasks than participants who watched the irrelevant video ($M = 1.40$, $SD = 1.02$), $t(156) = 5.79$, $p < .001$.

An exploratory one-way Analysis of Variance (ANOVA) compared participants' mean preference rates of the critical faces among the brief crime, long crime, and irrelevant video conditions. The omnibus test was not significant ($p = .20$) but participants who watched the brief crime ($M = 1.34$, $SD = .79$) preferred the critical faces marginally more often than participants presented with the irrelevant video ($M = 1.06$, $SD = .86$), $p = .08$. A second one-way ANOVA compared mean critical word stem task completion among the three video conditions. The omnibus test was significant, $F(2,160)$

= 3.95, $p = .02$. Post-hoc tests revealed that participants who watched the long crime completed the critical word stems ($M = .28$, $SD = .53$) significantly more often than those who watched the irrelevant video ($M = .11$, $SD = .32$), $p = .03$. A third one-way ANOVA compared participants' implicit identification of the critical spoken phrases among the three video conditions. There was a significant effect of video condition on participants' mean identification rates of the three critical phrases, $F(2,158) = 74.03$, $p < .001$. Post-hoc analyses indicated that participants who witnessed the brief crime identified significantly more of the distorted critical spoken phrases ($M = 1.40$, $SD = .57$) than those who watched the irrelevant video ($M = .22$, $SD = .42$), $p < .001$. Further, participants who witnessed the long crime identified significantly more critical phrases than those who watched the irrelevant video, $p < .001$. Taken together, these data supported my prediction that witnessing the mock crime increased participants' likelihood of completing implicit memory items with details seen in the video, compared to participants who witnessed an irrelevant event.

My second prediction was a dissociation between the details provided implicitly and explicitly. Specifically, I expected participants who witnessed the brief crime and those who witnessed the long crime would *not* differ on the number of crime-related details provided *implicitly*. However, I expected participants who witnessed the brief crime to provide significantly fewer accurate details via *explicit* probes than participants who witnessed the long crime. To begin testing this hypothesis, a one-way ANOVA compared the number of crime-related details provided *implicitly* across stimulus video conditions (brief vs. long vs. irrelevant). Data revealed a significant effect of video condition on the number of details provided implicitly, $F(2,155) = 27.77$, $p < .001$. Post-hoc tests indicated that participants in the brief crime condition provided significantly more crime-related details implicitly ($M = 2.85$, $SD = .91$) than those in the irrelevant video condition ($M = 1.40$, $SD = 1.02$), $p < .001$. Furthermore, participants in the long crime condition provided significantly more crime-related details implicitly ($M = 2.02$, $SD = 1.07$) than those in the irrelevant video condition, $p = .002$. Interestingly, and contrary to predictions, participants who viewed the brief crime also provided significantly more crime-related details implicitly than those who viewed the long crime, $p < .001$. See Figure 2 for a graphical representation of this finding.

To address the second portion of this prediction, namely, that participants who witnessed the brief crime would provide significantly fewer accurate details via explicit probes than participants who witnessed the long crime, a series of independent-samples *t* tests compared the brief crime and the long crime conditions on various dependent measures from the explicit memory tasks. When assessing the average number of accurate crime-related details provided during the explicit *recognition* tasks (i.e., the sequential lineup, the explicit word-stem task, and the explicit distorted phrase recognition task), there was no difference between the long crime witnesses and brief crime witnesses. Participants who viewed the brief crime responded correctly to the recognition tasks just as often ($M = 2.96$, $SD = 1.21$) as those who viewed the long crime ($M = 3.08$, $SD = 1.57$), $p = .68$. There was, however, a marginally significant effect of mock crime duration on the average number of accurate details provided during the open-ended/free-recall portion of the explicit interview, $t(108) = -1.64$, $p = .10$. Specifically, participants who viewed the long mock crime provided more accurate information during free-recall ($M = 16.19$, $SD = 6.80$) than those who viewed the brief mock crime ($M =$

14.11, *SD* = 6.47). There was no effect of mock crime duration on the number of accurate details provided during the entire explicit witness interview; participants in the brief crime condition provided just as much accurate information during the explicit interview (*M* = 17.07, *SD* = 6.93) as participants in the long crime condition (*M* = 19.25, *SD* = 7.39), $p = .12$.

My third hypothesis was that stochastic independence would be observed between critical details provided implicitly and explicitly. Stated differently, stochastic independence would be represented by the lack of a statistical relationship between participants providing information implicitly and their providing information explicitly. Prior studies have assessed stochastic independence in a number of ways, such as via logistic regressions (e.g., Flexser & Tulving, 1978) or via correlations and conditional probabilities (e.g., Hayman & Rickards, 1995; Tulving et al., 1982). Thus, initially a Pearson's bivariate correlation was conducted between the average number of crime-related details provided to all three implicit memory tasks and the average number of crime-related details provided to all three explicit recognition tasks. This correlation was significant, meaning that the more crime-related details provided implicitly, the more likely participants were to provide crime-related details via explicit recognition, $r = .43$, $p < .001$.

For the three critical faces a logistic regression tested if preference rates on the implicit task directly predicted recognition rates on the explicit sequential lineup. The binary response of preference (i.e., preferred or not) for each face was used to predict the binary response of recognition (i.e., recognized from the video or not). The model was a good fit ($\chi^2(1) = 219.47$, $p < .001$), indicating that preferring a face did predict subsequent recognition of that face, $\beta = .61$, $SE = .26$, $z = 2.32$, $p = .02$. A second logistic regression was conducted for the three critical written words to assess if successful implicit word stem completion predicted successful explicit word stem completion. The binary response of success (i.e., completion of stem with critical word or not) was used to predict successful explicit word stem completion. Performance on the implicit word stem task was not a significant predictor of performance on the explicit word stem task, $p = .49$. A final logistic regression was conducted for the three critical spoken phrases to test if successful phrase identification under white noise predicted subsequent recognition. The model was a good fit ($\chi^2(1) = 198.81$, $p < .001$): the binary response of successful identification (i.e., identified the correct phrase or not) predicted successful phrase recognition, $\beta = 2.59$, $SE = .44$, $z = 5.86$, $p < .001$. In sum, it appears that when assessing details provided implicitly and those details being subsequently provided explicitly, there was support for stochastic *dependence* for the critical faces and critical spoken phrases, and stochastic *independence* for the critical written words.

The last main prediction was that participants' awareness that the alleged filler tasks were actually assessing for memory for the mock crime would not predict their likelihood of providing crime-related details to implicit memory tasks. To test this hypothesis, a linear regression was conducted with test awareness as the predictor variable and the total number (out of 9) of crime-related details provided to all implicit memory tasks as the criterion/dependent variable. Contrary to my prediction, test awareness significantly predicted the number of crime-related details to implicit memory tasks; the more test awareness a participant exhibited, the more crime-related details he or she previously provided to implicit items, $r = .32$, $r^2 = .10$, $\beta = .32$, $SE = .10$, $t(103) = 3.38$, $p = .001$.

To explore this unexpected relationship between test awareness and implicit memory performance further, an independent-samples *t* test was conducted to compare test awareness between participants in the brief crime and long crime conditions. It may have been possible, for example, that participants who viewed the long crime were more test aware than participants who viewed the brief crime, resulting in their consciously providing crime-related details to implicit items. Data indicated, however, that participants in the brief crime condition reported significantly more test awareness ($M = 2.06$, $SD = .83$) than participants in the long crime condition ($M = 1.43$, $SD = .99$), $t(105) = 3.52$, $p = .001$.

Recall that the awareness questionnaire was comprised of 4 items assessing participants' insight into the true purpose of the implicit memory tasks. The first two items were open-ended probes while the last two items were directed probes, assessing participants' awareness by drawing their attention to relationships between their responses to the "filler tasks" and the mock crime video. Given this format of two open-ended probes followed by two directed probes, it may have been possible for participants to become progressively aware, that is, expressing a lack of awareness on the first two items but subsequently reporting awareness once their attention had been drawn to having provided video-related details to "filler task" items. To address the possibility of progressive awareness, a one-way ANOVA compared awareness on the first two items (together) amongst the brief video, long video, and irrelevant video conditions. When assessed in this fashion, test awareness (as elicited via the open-ended probes only) did not differ as a function of video condition, $p = .16$. A second one-way ANOVA compared awareness on the last two items across the three video conditions. There was an effect of video condition on test awareness, $F(2,162) = 104.70$, $p < .001$. Post-hoc tests revealed that participants who viewed the brief crime ($M = 1.75$, $SD = .58$) were significantly more aware on the two directed questionnaire items than participants who viewed the long crime ($M = 1.40$, $SD = .79$), $p = .002$. Further, participants who viewed the long video were significantly more aware than participants who viewed the irrelevant video ($M = .15$, $SD = .41$), $p < .001$.

Secondary Analyses

Effect of implicit memory tasks on explicit memory performance. In the present study whether or not participants completed implicit memory tasks before being interviewed explicitly about the mock crime was manipulated: some participants completed the implicit memory tasks for faces, written words, and spoken phrases while others worked on a Sudoku puzzle instead. Whether or not participants completed implicit memory tasks was manipulated to assess their effect on participants' performance during the explicit phase of the witness interview. To this end, a 2(crime duration: brief vs. long) X 2(implicit memory tasks: present vs. absent) between-factors ANOVA was conducted. The dependent variable for this analysis was the number of accurate details freely-recalled. The two-way ANOVA revealed a significant main effect of crime duration, $F(1,167) = 5.02$, $p = .03$, $\eta_p^2 = .03$. Participants who witnessed the long crime freely recalled significantly more accurate information ($M = 17.97$, $SE = .82$) than those who witnessed the brief crime ($M = 15.43$, $SE = .79$). The ANOVA also revealed a main effect of prior implicit memory testing, $F(1,167) = 7.49$, $p = .01$, $\eta_p^2 = .04$.

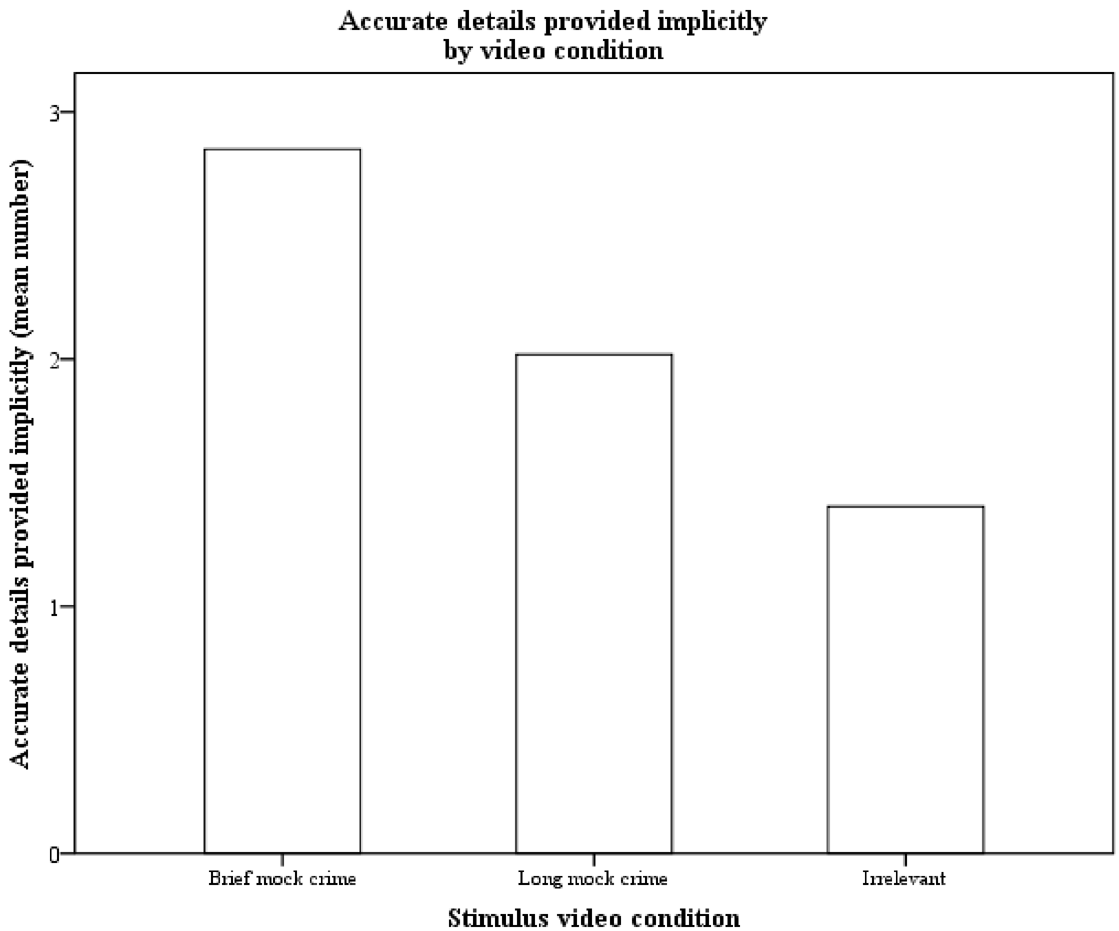
Participants who completed the implicit memory tasks before being interviewed about the mock crime freely-recalled significantly *less* accurate information (M = 15.15, SE =.68) than participants who played Sudoku during the 5-minute delay between witnessing the crime and being interviewed about it (M = 18.25, SE = .91). There was no significant interaction between crime duration and prior implicit testing, p = .68. See Figure 3 for a graphical representation of these data.

The second analysis conducted examined the effect of completing implicit memory tasks on participants' explicit interview performance. Another 2(crime duration: brief vs. long) X 2(implicit memory tasks: present vs. absent) between-factors ANOVA was conducted. The outcome measure was the number of accurate details reported throughout the entire explicit interview. Findings indicated a main effect of crime duration on explicit interview performance such that participants who witnessed the long crime provided significantly more accurate information (M = 21.12, SE = .88) than participants who witnessed the brief crime (M = 18.39, SE = .83), $F(1,165) = 5.09$, p = .03, $\eta_p^2 = .03$. There was also a main effect of prior implicit memory tasks, suggesting that participants with prior implicit testing provided significantly less accurate information explicitly (M = 18.16, SE = .72) than those who were not tested implicitly (M = 21.36, SE = .97), $F(1,165) = 7.00$, p = .01, $\eta_p^2 = .04$. Crime duration and implicit memory task completion did not interact, p = .65.

Crime-related details provided implicitly by modality. The implicit memory tasks assessed participants' memory indirectly for faces, written words, and spoken phrases. Each of the three implicit memory tasks tested for three different details depending on the modality, so the tasks assessed participants' likelihood of (1) preferring the faces of the three actors, (2) completing three word-stems with the written words visible during the crime, and (3) identifying the three spoken phrases from the crime while masked under white noise. To examine whether mock crime duration affected participants' likelihood of preferring the three critical faces, an independent-samples *t* test was conducted. The analysis revealed no difference in facial preference rates between the brief crime participants and the long crime participants, $p = .28$. To assess the effect of mock crime duration on the number of word stems completed implicitly with the words visible during the stimulus video, another independent-samples *t* test was conducted. This test revealed a significant difference such that participants who viewed the brief crime completed word stems with the three written words from the video significantly less often ($M = .09$, $SD = .29$) than those who viewed the long crime ($M = .28$, $SD = .53$), $t(108) = -2.42$, $p = .02$. A third independent-samples *t* test assessing the effect of mock crime duration on the number of spoken phrases identified implicitly was also significant, $t(105) = 7.56$, $p < .001$. This effect, however, was in the opposite direction: participants who viewed the brief crime identified the distorted spoken phrases (on the implicit task) significantly *more* often ($M = 1.40$, $SD = .57$) than those who viewed the long crime ($M = .59$, $SD = .53$). It appears, then, that those who witnessed the brief crime revealed memory implicitly for spoken phrases *more* often, for written words *less* often, and for faces *just as* often, when compared to participants who witnessed the long crime (see Table 3). Table 4 displays the proportion of participants who did *not* report the crime-related details via recognition but *did* provide them implicitly, broken down by crime duration and item type.

Crime-related details provided via recognition tasks by modality. The same three faces, written words, and spoken phrases that were tested for using implicit memory tasks were also tested for using (explicit) recognition tasks. To assess the effect of mock crime duration on participants' facial recognition during the sequential lineup (i.e., the mean number of faces recognized correctly from the mock crime), an independent-samples *t* test was conducted. This analysis revealed no difference in facial recognition rates between the brief crime participants and the long crime participants, $p = .18$. A second independent-samples *t* test was conducted to see if mock crime duration affected participants' ability to complete word stems with the written words visible during crime when asked to do so explicitly. Data revealed a significant difference such that participants who viewed the long crime were able to complete the word stems with the visible critical words more often ($M = .93$, $SD = 1.04$) than those who witnessed the brief crime ($M = .33$, $SD = .67$), $t(109) = -3.63$, $p < .001$. Finally, an independent-samples *t* test was conducted to assess the effect of mock crime duration on participants' ability to recognize the phrases uttered during the crime while masked under white noise. Participants who witnessed the brief crime were significantly better at recognizing the distorted phrases ($M = 1.49$, $SD = .57$) than those who witnessed the long crime ($M = .75$, $SD = .59$), $t(108) = 6.68$, $p < .001$.

Figure 2



Accurate details provided implicitly
by video condition
Accurate details provided implicitly (mean number)
0
1
2
3
Brief mock crime
Long mock crime
Irrelevant
Stimulus video condition

Figure 3

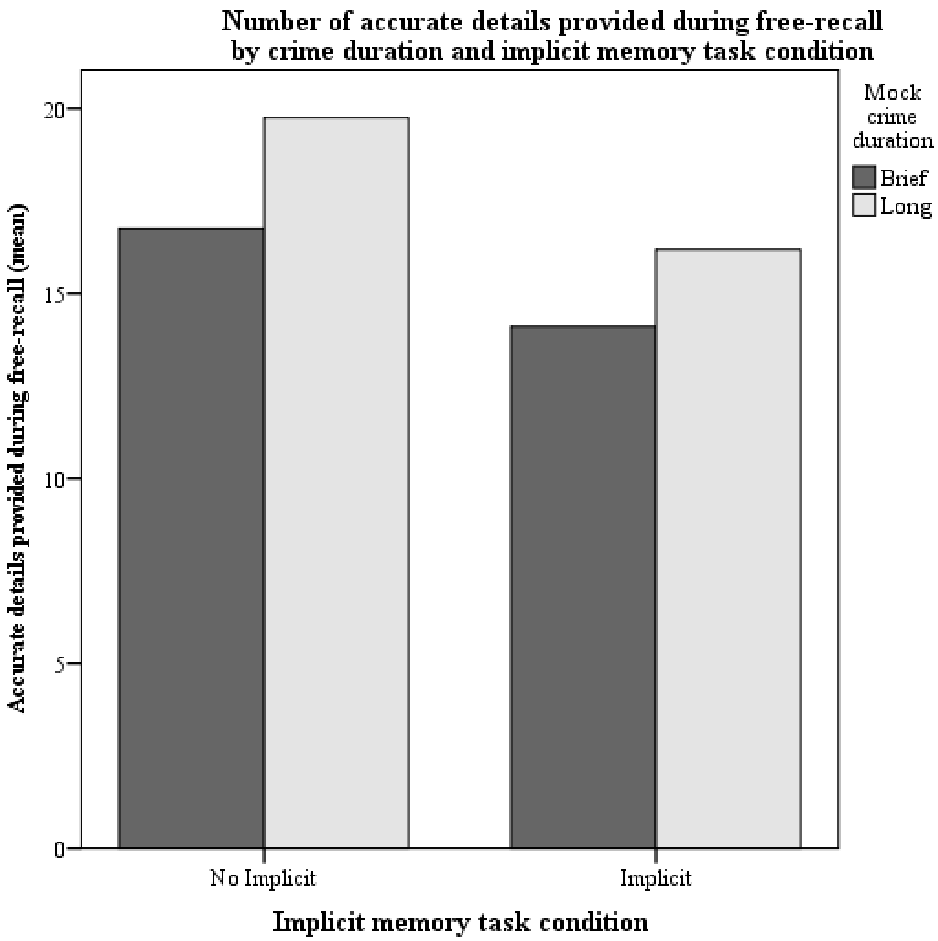

Number of accurate details provided during free-recall
by crime duration and implicit memory task condition
Accurate details provided during free-recall (mean)
0
5
10
15
20
No Implicit
Implicit
Implicit memory task condition
Mock crime duration
Brief
Long

Table 3

Crime-related details tested for implicitly and via recognition tasks (with and without prior implicit testing)

	Via Implicit Tasks			Via Recognition (prior implicit)			Via Recognition (no prior implicit)		
Crime-related details	Mock crime	*M*	*SD*	Mock crime	*M*	*SD*	Mock crime	*M*	*SD*
Faces	Brief	1.34	.79	Brief	1.14	.86	Brief	.97	.15
(out of 3)	Long	1.17	.86	Long	1.38	.97	Long	1.00	.16
Written words	Brief	$.09_a$	.29	Brief	$.33_d$	.67	Brief	$.76_f$	.79
(out of 3)	Long	$.28_a$	.53	Long	$.93_d$	1.04	Long	1.11_f	.88
Spoken phrases	Brief	1.40_b	.57	Brief	1.49_e	.57	Brief	1.27_g	.52
(out of 3)	Long	$.59_b$	.53	Long	$.75_e$	.59	Long	$.75_g$	.59
Total (out of 9)	Brief	2.85_c	.91	Brief	2.96	1.21	Brief	1.08	.79
	Long	2.02_c	1.07	Long	3.08	1.57	Long	1.25	.90

Note: Means sharing subscripts are significantly different at $p < .02$

Table 4

Proportion of participants who did not provide critical details via recognition but did via implicit tasks by crime duration and item type

Item type	Crime	n	*M*	*SD*
Faces				
Bystander	Brief	43	.28	.45
	Long	33	.24	.44
Victim	Brief	43	.51	.51
	Long	35	.26	.44
Thief	Brief	18	.39	.50
	Long	18	.22	.43
Spoken Phrases				
Waterway	Brief	51	.04	.20
	Long	48	.02	.14
My wallet	Brief	2	.00	.00
	Long	18	.06	.24
I'll shoot	Brief	30	.03	.18
	Long	53	.02	.14
Written Words				
Graduate	Brief	56	.00	.00
	Long	40	.00	.00
Dispose	Brief	49	.00	.00
	Long	39	.03	.16
Hiking	Brief	47	.02	.15
	Long	30	.03	.18

VIII. DISCUSSION

The present set of studies had several goals. One goal was to expand upon the extant implicit memory literature by testing implicit memory for a detail-rich event, that is, a mock-crime. No study to date has examined the conditions under which implicit memory for a multi-modal event could be demonstrated. Moreover, if assessing eyewitness memory implicitly could potentially elicit additional crime-relevant details beyond what has been elicited via explicit means, this could prove helpful when generating leads in real-world investigations. Furthermore, beginning to understand under which conditions generating implicit memory could be particularly useful was another objective of the present set of studies. Specifically, it was examined if the length of a crime differentially affected implicit and explicit memory performance. The present set of studies thus compared a brief crime exposure with a long crime exposure in their respective effects on both implicit and explicit memory measures. To my knowledge, the present work is also the first to compare different encoding durations of a single, multi-modal event. Finally, the present research also investigated the effect of engaging in implicit memory tasks on subsequent explicit memory performance. Four central predictions were made in line with previous research findings: (1) Participants who witnessed a crime would be more likely to provide crime-related information on implicit memory tasks than participants who did not witness a crime, (2) there would be an experimental dissociation such that encoding duration would affect explicit memory performance but would *not* affect implicit memory performance, (3) stochastic independence between details reported implicitly and explicitly, and (4) participants' awareness of the alleged filler (and actual implicit) tasks actually assessing for memory of the crime would not predict their likelihood of providing crime-related details to the implicit tasks.

In line with my first hypothesis, participants who witnessed a crime were indeed more likely to provide crime-relevant details when tested implicitly than participants who watched a crime-irrelevant video, demonstrating that implicit eyewitness memory can be elicited. These data lend support to the novel idea that memory for a crime can reveal itself even when eyewitnesses are tested implicitly, not requiring that witnesses necessarily be aware that their memory for the critical event is being tested or be warned that a crime is about to be witnessed prior to the event. This finding is in line with those of prior studies on implicit memory (e.g., Tulving, Schacter, & Stark, 1982; Jacoby & Dallas, 1981), showing that previous experiences- in this case, an episodic memory experience- can affect performance on a subsequent task without the intentional retrieval of said experiences. This finding also expands the implicit memory literature by revealing that memory can be assessed implicitly for a multi-modal event where stimuli co-occur. Prior research has shown implicit memory for difficult to perceive stimuli (e.g., Jacoby & Dallas, 1981) or when working memory is taxed (e.g., Baques et al., 2004), but this is the first study to show implicit memory for faces, written words, and spoken phrases presented simultaneously or in rapid succession. Taken together, the present research further supports the robustness of implicit memory across various modalities and experimental circumstances. If applied to an investigative setting, this finding suggests that if someone unexpectedly witnessed a crime, memory for this crime could be assessed, at least in part, without explicit memory probes.

Findings further revealed an unexpected yet interesting pattern regarding the specific conditions under which eliciting implicit memory may be of particular help: collapsed across all modalities, participants who witnessed the brief crime provided significantly *more* crime-relevant details via implicit testing than those who witnessed a longer version of the same crime. This pattern differs starkly from what is typically found in implicit memory research, namely that implicit memory seems unaffected by encoding conditions. The extant memory literature would lead one to predict, as I did, that the quality of the encoding conditions (e.g., Schacter, 1987; Schacter et al., 1993) would not affect participants' likelihood of providing details when tested implicitly. The present data seem to suggest, however, that briefer encoding intervals may render indirect memory tests more useful than longer intervals. Incidentally, this pattern may shed some light on one of this work's central questions: when encoding conditions are impoverished, can testing an eyewitness implicitly be particularly informative? While this series of studies is the first to investigate implicit eyewitness memory, these data, preliminary and tentative, nevertheless support the notion that indirect tests of memory *can* elicit crime-relevant information and that they can do so particularly from witnesses who had a brief encoding opportunity.

The peculiar finding that witnesses of the brief crime provided significantly more details implicitly than witnesses of the long crime appears to have been driven largely by the critical spoken phrases identified under white noise. Specifically, participants who viewed the brief crime were more likely to identify implicitly the critical spoken phrases than those who viewed the long crime. Participants in the brief crime condition also tended to prefer the critical faces more often than those in the long crime condition, though this was just a trend. In combination, these findings suggest that those with the shorter encoding conditions were likely to remember implicitly the critical auditory information and somewhat more likely to prefer previously seen faces. When interpreting these findings it is important to consider that both versions of the mock crime were equivalent in terms of information *quantity*, that is, witnesses of the brief crime were exposed to the same number of visual details but in half as much time as witnesses of the long crime. While one can argue that participants' visual attention/visuospatial sketchpads were differentially taxed, participants' phonological loop/auditory systems experienced the same quantity and quality of auditory information (for a review of working memory, see Baddeley, 2003; Nagel, Ohannessian, & Cummins, 2007). Whereas equivalent exposure times to auditory information could have explained the lack of a difference in implicit output between the brief and long crime conditions, it does not explain why implicit identification of auditory information was *better* for witnesses of the brief crime. It may, however, provide evidence for the notion of independent implicit and explicit memory systems, or that implicit and explicit tests access different and separate memory representations (Schacter, 1987; Schacter et al., 1993). Specifically, the details of the mock crime could have been encoded and represented in memory differently and in multiple ways. Because the auditory details represented a proportionately larger piece of the event as a whole for participants in the brief crime condition, once encoded, this memorial information could have thus "stood out" or been differentially accessible compared to participants who witnessed the long crime.

Regarding the implicit word stem task, participants who viewed the long crime were more likely to provide the critical written words than those who viewed the brief crime; those who witnessed the long crime were given a longer encoding opportunity and thus should have been better able to remember details from the event, even the written words visible throughout the video. Arguably, a witness' attention is likely to be directed toward the individuals involved in a crime, more so than words written on a shirt of a sign. It is therefore unsurprising that those with better encoding conditions were more likely to provide crime-related details that were difficult to notice, relative to those with a briefer exposure to the critical event.

Regarding recognition performance for those same crime-relevant details, accuracy did not differ between witnesses of the brief crime and the long crime. Specifically, whereas participants who witnessed the brief crime provided more details implicitly than witnesses of the long crime, recognition of those crime details no longer differed between exposure durations. It appears then that while witnesses of the long crime were relatively uninformative when tested implicitly, they were able to provide just as many details as witnesses of the brief crime when asked explicitly to recognize information from the crime. In one sense, this pattern is contrary to my prediction in that explicit recognition performance should have been higher among participants who witnessed the long crime when compared to the brief-crime participants. The longer the exposure, the better the encoding conditions, and thus the better explicit memory performance should have been for those who witnessed the long crime. However, this pattern does parallel the general finding (and expectation) that witnesses with a relatively good view of the crime should be able to provide more information when probed explicitly than when filling out a series of implicit memory tasks. In other words, witnesses of the long crime were more informative when asked to remember the crime *explicitly* than when tested implicitly. Recognition performance may not have differed between exposure durations because of the nature of the measure itself: one's ability to access memory is highly contingent upon the cues themselves (Tulving & Pearlstone, 1966; Tulving & Thomson, 1973). It is possible, then, that the recognition tasks served as sufficient memorial cues allowing participants to recognize previously-seen details, irrespective of encoding duration.

Importantly, the expected difference between explicit memory performance for brief versus long encoding durations was observed for accurate free recall (e.g., "Please tell me everything you remember about…") and for overall accuracy throughout the entire explicit interview, collapsed across free recall and recognition data. That is, participants who witnessed the long crime provided more accurate information than those who witnessed the brief crime. This pattern is typical of investigative interviewing and memory research in general; the better the witness' view of the crime, the more he or she is able to attend to and encode, and thus the more accurate information he or she is likely to provide upon being interviewed. Importantly, this difference was observed in the present work only when participants were allowed to define their own output criterion, via a free narrative. When probed for specific crime-relevant details, the advantage of a longer encoding opportunity disappeared.

The prediction of stochastic independence, that is to say implicit memory performance not predicting explicit performance, was not supported with one caveat: stochastic *independence* was observed for the critical written words, meaning participants providing these details implicitly did not predict participants providing them explicitly. Stochastic *dependence* was observed between implicit and explicit tasks for the critical faces and spoken phrases. As a whole, the more crime-related details witnesses provided implicitly, the more likely they were to provide crime-related details explicitly. This finding is contrary to some of the extant implicit memory literature where revealing memory for an item implicitly has no bearing on whether or not one will consciously remember that same item. However, stochastic independence may be more likely when explicit memory tasks *precede* implicit tasks. For instance, Hayman and Rickards (1995) observed independence when participants were tested explicitly first and implicitly second, while they observed dependence when the implicit tests came before the explicit tests. Statistical dependence between implicit and explicit memory performance likely resulted from successful implicit item completion: upon providing crime-relevant information while completing the implicit tasks, participants, incidentally, could have recognized said information from the video, serving as a rehearsal opportunity for subsequent explicit recall. In other words, successful completion of implicit items could lead directly to successful performance on explicit recognition items.

Another related explanation for the lack of stochastic independence may be due to the nature of the stimulus even itself. Participants watched videos of either 15 or 30 seconds in length, with specific critical details being visible between 3 and 10 seconds. While a 15-second crime can be considered brief, it may have still been a long enough encoding opportunity to allow for sufficient attention to critical details, especially considering the multi-modality of the details themselves. This in turn could have affected performance on both implicit and explicit memory tasks in that participants may have recognized video details while completing the implicit tasks. In contrast, previous studies (e.g., Jacoby & Dallas, 1981; Feustel, Shiffrin, & Salasoo, 1983) have presented to-be-tested stimuli at difficult-to-perceive durations (e.g.,1 second per item or 50 milliseconds per item). Therefore, stochastic independence may be easier to establish when explicit recollection is rendered difficult. When an experimental design intends to leave participants unaware of the stimuli presented, participants may be more likely to reveal memory for these items implicitly without corresponding explicit recollection.

My last prediction, namely that participants' awareness of the alleged filler tasks being bona fide memory tests, was not supported. Not only did test awareness predict implicit memory performance, but participants who witnessed the brief crime were *more* aware than those who witnessed the long crime. However, exploring this strange pattern further revealed participants- particularly those who witnessed the brief crime- became progressively test aware while completing the questionnaire. While they did not differ on test awareness reported for the first two open-ended probes, participants who witnessed the brief crime reported being more aware on the last two directed probes than those who witnessed the long crime. If participants were aware that the facial preference task, word-stem task, and white noise task were assessing their memory for the crime, then participants may have been recalling information consciously despite the task instructions, which could have resulted in awareness and implicit task performance being correlated. However, this does not explain why being exposed to the brief crime resulted in *more* test awareness than being exposed to the long crime.

Another possibility could be that completion of implicit memory items may have led to participants' increased test awareness, particularly for witnesses of the brief crime. As mentioned earlier, witnesses of the brief crime provided significantly more details implicitly than witnesses of the long crime. Consequently, it is quite possible that after unintentionally preferring the previously-seen faces or unintentionally completing word stems with previously-seen words, participants in the brief crime condition recognized these items as crime-related details. In other words, witnesses of the brief crime may have become particularly test aware *because of* their decisions on the implicit memory tasks. Hence, superior performance on implicit memory tasks could have led participants to report noticing a relationship between the mock crime and their subsequent responses.

Finally, another unexpected finding is worth noting. Namely, participants instructed to engage in a numbers puzzle (i.e., Sudoku) throughout the retention interval freely recalled significantly more accurate information than participants who completed implicit memory tasks. There are two potential explanations for the no-implicit-tasks participants outperforming those who did complete implicit tasks on free recall accuracy. One, assuming participants genuinely engaged in the Sudoku puzzle for the entire duration of the retention interval, this may suggest the type of task (or the particular demands of the task) may interfere with consolidation and storage of the information and thus subsequent free recall. Specifically, it is possible that engaging in implicit memory tasks that required participants to process facial information, textual information, and auditory word information may have interfered with participants' ability to consolidate that information comprehensively to be available for subsequent explicit recall. Sudoku puzzles require logical decision-making in order to fill a 9X9 grid with numbers while avoiding redundancies. Completing a Sudoku puzzle does *not* require facial processing, word generation/recognition, or auditory phrase recognition.

Second, whether participants actually worked on the Sudoku puzzle was not enforced, in contrast to those engaging in the implicit memory task. It is possible that participants were not engaged fully in completing the Sudoku puzzle but rather appeared to be thinking about possible puzzle solutions without ever writing (or thinking about) a single number. Thus, it could be that despite the experimenter's instructions to work on the puzzle for 5 minutes, participants simply *pretended* to work on the puzzle. This could have resulted in participants spending their cognitive resources on rehearsing information from the crime they just witnessed. Further, pretending to work on the puzzle could have interfered with participants' memory consolidation processes less than completing the implicit memory tasks. Because progress for participants given implicit memory tasks required that they complete said tasks, and because progress for other participants did *not* hinge upon their completion of the Sudoku puzzle, it is possible that participants' working memory systems and consolidation processes were differentially taxed, depending on task demands. These explanations (separate or in combination) could have produced participants' inferior free recall accuracy when asked to complete a series of implicit memory tasks throughout the retention interval.

Limitations and Future Directions

The present set of studies had several limitations. One, only two crime durations were compared and as there was no prior research on implicit eyewitness memory to consult with, the difference in exposure length between the two crimes was arguably chosen arbitrarily and may have therefore been ineffective at maximizing important differences and dissociations between implicit and explicit memory. Specifically, the difference between a 15- and a 30-second crime exposure may have not been large enough to elicit a measureable difference in participants' recognition performance. As most studies on implicit memory expose participants to stimuli for much briefer periods (e.g., 1 second), future studies investigating implicit eyewitness memory should reduce exposure durations systematically to maximize the differences in recognition accuracy between brief crimes and long crimes, in addition to maximizing the differences between implicit and explicit memory performance. Including shorter exposures would also allow one to mimic actual crimes of a similar brief nature.

A second limitation may have been the way in which word stems were used as an implicit memory test. To increase the applied relevance and value of the information gained from the word-stem completion task, participants were given a series of two-letter word stems with an undetermined number of letter blanks (e.g., "hi_____" for hiking). As it is unlikely that real-world investigators will know which words may have been visible to a given eyewitness, generating two-letter word stems of undetermined length seemed feasible and practical. In contrast, prior studies on implicit memory for written words typically present participants with three-letter word stems with a finite number of letter blanks ("hi _ _ _ _" for hiking; e.g., Baques, Saiz, & Bowers, 2004). Participants' likelihood of completing three-letter words stems with the target words are increased drastically, as the number of possible solutions are heavily controlled. It is very possible then that participants in the present studies did not exhibit the typically-present pattern of responding for the word-stem completion task because there were simply too many possible solutions to the critical word stems. Future research interested in testing implicit eyewitness memory for written words should provide word stems with fewer solutions to increase participants' likelihood of solving the stems with words visible during the crime.

A third limitation of the present research was the way in which test awareness was measured in relation to the mock crime. The awareness questionnaire used in the present study was modeled after Bowers and Schacter (1990), where participants were asked the same four questions in relation to semantically-related word pairs. The awareness questionnaire was thus not modified for the specific stimuli used in the present study, namely detail-rich, multi-modal videos depicting a theft. Future studies should modify the questionnaire items to reduce the chances of participants being made aware of the true purpose of the implicit memory tasks via answering awareness questions, especially by the directed questionnaire items (e.g., "While working on the filler tasks did you notice whether you completed some of the items with details from the video you watched earlier?"). In addition, mock crimes briefer than 15 seconds can serve to further reduce test awareness, reducing participants' likelihood of explicitly recalling crime-related details during implicit memory tasks, and thus making it less likely that awareness predicts implicit memory performance.

A fourth limitation of the present study was the brevity of the retention intervals between encoding, implicit testing, and explicit retrieval. Specifically, the delay between viewing the crime and implicit testing was approximately one minute, while the delay between encoding and explicit testing was approximately five minutes. While differences were observed in the present research among the experimental conditions using these short retention intervals, longer delays (e.g., one day or one week) may (a) further magnify differences in recall accuracy for implicit and explicit tests and (b) may better mimic real-world retention intervals, allowing researchers to continue assessing the applied viability of implicit eyewitness memory testing. Thus, future studies systematically manipulating the delays between stimulus presentation, implicit testing, and explicit recognition and/or recall may help highlight the dissociations between the two memory systems, potentially increasing the likelihood that witnesses fail to recognize critical information but nonetheless provide it implicitly.

A final limitation of the present work stems from the nature of implicit memory itself. Namely, an individual exhibiting implicit memory for a stimulus is *inferred* from his or her performance on a particular task. In a laboratory setting, meticulous construction of implicit tasks and measurement of implicit memory allows one to test this phenomenon directly. However, actual criminal investigations do not have the luxury of knowing ground truth, so identifying the "signal" of implicit memory amongst the "noise" of random or idiosyncratic witness responding is key to establishing the potential applied value of implicit memory testing. As such, one must be cautious with conclusions drawn from a given eyewitness' performance on an indirect memory test. Furthermore, the extent to which implicit memory is reliable or corruptible, especially in comparison to information elicited explicitly, remains unanswered. Given these preliminary data, details provided implicitly may be used for investigative lead generation at best. Future studies should explore the potential for implicit memory details to corroborate co-witness reports, in addition to narrowing the potential for reliable generation of investigative leads.

Implications and Conclusions

To summarize, the present work lends credence to the notion that under impoverished encoding conditions, witnesses may reveal memory for an unexpected event via indirect testing. Under brief encoding conditions in particular, witnesses were able to provide more crime-relevant information than those with longer encoding conditions, supporting the conceptualization of implicit memory as a partially independent memory system from explicit memory. Moreover, with regard to novel faces, witnesses of the brief crime were especially likely to prefer previously-seen faces while subsequently failing to recognize those same faces from the crime. Beyond replicating the mere exposure effect (Zajonc, 1968), this pattern further indicates potential for investigators' ability to gather crime-relevant information from witnesses who had a relatively poor encoding opportunity via indirect tests, such as facial preference tasks.

Explicit memory data supported general trends in witness memory research: witnesses reported more accurate information freely after long compared to brief crime exposures. The present data also highlighted some unexpected and interesting new avenues for research when investigating eyewitness memory both implicitly and explicitly. For instance, whereas implicit memory testing may generate new investigative leads, it may also have a detrimental effect on subsequent explicit retrieval attempts. Also, although implicit memory tasks were most useful for witnesses of a brief crime, engaging in these tasks themselves may still prove counter-productive. At this early stage of empirical research on this topic, it remains unclear if the potential benefits (i.e., information gains) outweigh the potential risks (i.e., information losses) of assessing memory implicitly without further study.

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APPENDICES

Appendix A

Video Questionnaire

1. Please, write down everything you can remember about the video.

2. Please, write down everything you can remember about the **bystander**.

3. Please, write down everything you can remember about the **victim**.

4. Please, write down everything you can remember about the **thief**.

5. Please, write down everything you can remember about what was said (i.e., verbally) during the video.

6. Please, write down everything you can remember about any words visible during the video.

Sequential Facial Recognition

1. Was in the video / Was NOT in the video
2. Was in the video / Was NOT in the video
3. Was in the video / Was NOT in the video
4. Was in the video / Was NOT in the video
5. Was in the video / Was NOT in the video
6. Was in the video / Was NOT in the video
7. Was in the video / Was NOT in the video
8. Was in the video / Was NOT in the video
9. Was in the video / Was NOT in the video
10. Was in the video / Was NOT in the video
11. Was in the video / Was NOT in the video
12. Was in the video / Was NOT in the video
13. Was in the video / Was NOT in the video
14. Was in the video / Was NOT in the video
15. Was in the video / Was NOT in the video
16. Was in the video / Was NOT in the video
17. Was in the video / Was NOT in the video
18. Was in the video / Was NOT in the video
19. Was in the video / Was NOT in the video
20. Was in the video / Was NOT in the video
21. Was in the video / Was NOT in the video
22. Was in the video / Was NOT in the video
23. Was in the video / Was NOT in the video
24. Was in the video / Was NOT in the video

Appendix B

Word-stem Filler Task

Please, complete each word stem with the first English word that comes to mind. Write clearly and legibly. Each word must be longer than 3 letters.

- us________
- po________
- ru________
- ex________
- ti________
- pe________
- di________
- se________
- ca________
- hi________
- gr________
- de________
- th________
- sm________
- ou________

Appendix C

White Noise Filler Task

Instructions: Please, write down the first word/phrase you hear under the white noise. If you are uncertain, write down your best guess. If you have absolutely no idea, draw a straight line indicating a blank response. Refer to your computer screen for further instructions.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

7. ______________________________

8. ______________________________

9. ______________________________

10. ______________________________

11. ______________________________

12. ______________________________

13. ______________________________

14. ______________________________

15. ______________________________

16. ______________________________-

Appendix D

Questionnaire

1. What did you think was the purpose of the various filler tasks that you completed earlier?

____

____

____

2. What was your general strategy in completing the previous filler tasks?

____

____

____

3. Did you notice any relation between the items on the filler tasks and the video you watched earlier?

____

____

____

4. While working on the filler tasks did you notice whether you completed some of the items with details from the video you watched earlier?

____

____

____

Appendix E

Explicit Interview

Please, write down everything you can remember about the crime you witnessed earlier.

<u>Recognition Tasks</u>

- **Word-stem Task**

*Please, complete the following word stems with English words that were **visible during the crime**.*

- us________
- po________
- ru________
- ex________
- ti________
- pe________
- di________
- se________
- ca________
- hi________
- gr________
- de________
- th________
- sm________
- ou________

Sequential Facial Recognition

1. Was in the video / Was NOT in the video
2. Was in the video / Was NOT in the video
3. Was in the video / Was NOT in the video
4. Was in the video / Was NOT in the video
5. Was in the video / Was NOT in the video
6. Was in the video / Was NOT in the video
7. Was in the video / Was NOT in the video
8. Was in the video / Was NOT in the video
9. Was in the video / Was NOT in the video
10. Was in the video / Was NOT in the video
11. Was in the video / Was NOT in the video
12. Was in the video / Was NOT in the video
13. Was in the video / Was NOT in the video
14. Was in the video / Was NOT in the video
15. Was in the video / Was NOT in the video
16. Was in the video / Was NOT in the video
17. Was in the video / Was NOT in the video
18. Was in the video / Was NOT in the video
19. Was in the video / Was NOT in the video
20. Was in the video / Was NOT in the video
21. Was in the video / Was NOT in the video
22. Was in the video / Was NOT in the video
23. Was in the video / Was NOT in the video
24. Was in the video / Was NOT in the video

<u>White Noise Recognition</u>

Instructions: Please, write down the first word/phrase you hear under the white noise that you **also heard during the crime**. If you are **uncertain**, write down **your best guess**. If you have **no idea**, please **draw a line** indicating a blank response.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________
13. ______________________________
14. ______________________________
15. ______________________________
16. ______________________________

Demographics Sheet

Age: ______

Gender: Male / Female (Circle one)

Ethnicity: (Circle the one you feel is most accurate)

White, non-Hispanic

Black, non-Hispanic

Hispanic

Native American

Asian

Pacific Islander

Other

Major:

Psychology (circle if appropriate)

Other _________________

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