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Age Differences in False Memory

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Abstract

After witnessing an event, a witness may be exposed to additional details about the event. These details can be inaccurate and delivered by numerous sources including other witnesses, law enforcement, and news reports. The purpose of this study was to examine how such post-event details can influence eyewitness memory reports, specifically when the post-event details are delivered by individuals from a social in-group or social out-group. Participants were young and older adults who were paired with a fictional partner. The fictional partner was manipulated to appear a member of the same racial group or a different racial group. Participant and partner pairs completed a social memory task in which the partner introduced false details to the participants. The results of the study were consistent with past research that has been done, indicating that older adults typically have a worse memory compared to young adults. It was further demonstrated that older adults are more susceptible to false memory formation than young adults, especially when false information is socially presented. Finally, the Stroop task also showed that older adults had a higher susceptibility to error.

Age Differences in False Memory

Imagine one night, your grandmother is woken by rustling in her kitchen. Alarmed, she goes to investigate. As she makes her way to the kitchen, she sees a heavyset White male wearing a black hooded sweatshirt running to his car and speeding down the road. Her neighbor is on the sidewalk calling the police, making her and your grandmother the only eyewitnesses available to testify if a suspect is caught. Due to this, the pressure is on your grandmother to make sure her memory is accurate so that the correct person is convicted. The police officer asks your grandmother for her report of the incident and makes remarks such as “I would imagine he was a young, athletic man judging by how fast he escaped from your house.” Later that day, her neighbor mentions while they are discussing the event: “I think he was wearing a blue shirt with stripes on it. Who knows though, it was dark out.” When your grandmother testifies at a later time, will her memory for the event be consistent with what she witnessed, or will her reports be contaminated by the suggestive information given by the police and neighbor? While the previous example may seem unrealistic, it is relatively common for individuals to be wrongly accused of actions due to errors in eyewitness memory. Due to errors such as this, the Innocence Project was founded in 1992, which is a non-profit legal organization that is committed to exonerating wrongly convicted people (Innocence Project, n.d). The organization does this through DNA testing and to reform the justice system in order to prevent future wrongdoings. Through the work of the Innocence Project, it has been estimated that between 2.3% and 5% of all prisoners are innocent, and that the leading cause of wrongful convictions is faulty eyewitness testimony (Innocence Project, n.d).

The majority of what we know about how misleading suggestions have the ability to impact eyewitness memory has been gained from laboratory studies using paradigms such as the *misinformation effect paradigm* and the *social contagion paradigm.* The misinformation effect is observed when an individual incorporates inaccurate post-event information that has been suggested to them from an external source such as a summary statement or misleading questions (Loftus, 1999). These misleading suggestions interfere with the original memory of a witnessed event. In the initial example, I described a scenario where your memory was susceptible to misleading information that was given by the officer. The *social contagion paradigm* is a similar approach used by researchers to investigate specifically how different social interactions can influence eyewitness memory (Roediger et al.,2001). In the earlier example, this paradigm is a parallel to the part of the scenario where the neighbor introduced you to false information during the course of a neighbor-to-neighbor social interaction. This social contagion effect, or finding that exposure to misinformation about an event introduced by a co-witness during an interaction, has been studied multiple times, which continues to prove the strength of this memory distortion (Meade & Roediger, 2002).

The present study is designed to explore how the impact of external suggestion on eyewitness memory differs across age groups particularly within the context of the social contagion paradigm. It will be an initial exploration of how the social dynamic of a cross-group interaction may influence eyewitness memory. In a co-witness reporting design, confederates will be introduced to false details about a witnessed event. The confederates will be the same age or same race as the participants (same-group interactions) or a different age or different race (cross-group interactions). While previous work has indicated that confederate age can influence the social contagion effect (e. g., Davis & Meade, 2013), the impact of cross-race interactions has not been studied. Thus, we will observe whether the race, age, or both factors combined will influence later incorrect reporting of the suggested details.

Memory and Aging

As people age, there are various aspects of life that begin to change, one of them being one's memory. Memory can be broadly defined as the ability to take in new information, store information in the human brain, and use the stored information to recall past experiences. The ways in which these abilities could change over time was thought about as early as 700 BC when a Greek philosopher began to realize that his intellectual capacities began to diminish between the ages of 56-63 (Park & Festini, 2016). A Roman poet discussed the degradation of memory over time as he wrote "Time robs us of all, even of memory" (Park & Festini, 2016). Some of the earliest experimental findings with age differences began with differences in verbal learning paradigms. In 1929, a researcher documented age-related differences in memory for digit-symbol pairs (Park & Festini, 2016). It was demonstrated that adults between the ages of 60-82 exhibited worse memory than those of 34-59, with people aged 12-17 having the best memory performance (Park & Festini, 2016; Kausler, 1991). Other early findings suggested that older adults were less likely to use imagery or create memory strategies when trying to remember paired associates, compared to younger adults (Park & Festini, 2016). The study of memory and age has gained significance over the years in order to better understand the process and its repercussions.

As early as the 1960s, researchers began to discover that participants demonstrated increasingly slower processing time for an extensive range of cognitive tasks with older age (Park & Festini; Birren, 1965). This resulted in the hypothesis that slowed processing speed was a result of age deficits, including memory. The researcher Salthouse (1996), proposed that older adults are deficient in two important mechanisms that are correlated with age-related differences in attention, memory and reasoning. The first idea was that older adults have an increased difficulty with performing higher level tasks since they take a longer time to process the earlier operation. Secondly, they are unable to consider as many task-relevant components together compared with younger adults (Salthouse, 1996).

Since these early findings, research has shown significant evidence to demonstrate that memory is not a single function. Instead, it may be described in terms of different memory systems that all have different aging effects (Luo & Craik, 2008). One type of memory is explicit memory, which are memories that can be intentionally and consciously recalled. For example, your memory of riding a bike, falling over the handlebars and skinning your knee would be an explicit memory. The other type of memory is implicit memory, which is a form of memory that cannot be consciously recalled, for example motor and muscle memory needed to keep balance in order to know *how* to ride a bike. Explicit, conscious, memory can be further divided into two categories: semantic and episodic memory. Semantic memory involves recalling facts and figures such as your date of birth or your mother's maiden name. In contrast, episodic memory is more of a subjective *experience,* going beyond fact to include context, sensory information, emotion and other autobiographical elements. (Dickerson & Eichenbaum, 2009). Episodic memories can be compared to episodes of a TV series that is about you. You can recall the "episode" of the first time you asked someone out, your favorite trip to the amusement park from two years ago, and what you ate for breakfast yesterday. Episodic memories can also be much more significant. For example, in investigative procedures eyewitnesses are called upon to provide testimony on their episodic memory, and errors can literally have life-changing consequences for multiple parties in these scenarios.

It is generally understood that semantic and episodic memory are distinct from one another, but highly interacting and share at least some neurological underpinnings (Renoult & Rugg, 2020). Episodic memory is supported by the medial temporal lobe (MTL), which includes the hippocampus (Dickerson & Eichenbaum, 2009). The hippocampus appears to be critical for both short-term and long-term episodic memory (Dennis et al., 2008). The hippocampus importantly interacts with multiple cortical and subcortical structures. Various studies on both animals and humans have been performed that show that cortical components of this system have valuable functions in aspects of perception and cognition. The MTL is responsible for mediating the organization of memories, where the details are stored in these cortical areas (Dickerson & Eichenbaum, 2009). The prefrontal cortex also plays a role in episodic memory. The prefrontal cortex houses our executive functions, which are the abilities to engage in self-regulation and inhibition. Executive functions play a role in episodic memory by allowing people to mentally "time travel" and connect experiences to the appropriate context (Wheeler et al., 1997). When there is damage to the hippocampus, MTL or the prefrontal cortex structures of the memory system due to deterioration or damage, there is seen to be a compromise in episodic memory.

Although there is debate in the field as to what developmental time period different types of memory begin to decline, many researchers agree that semantic memories tend to stay relatively stable, however episodic memories become increasingly more difficult to create and maintain as we age (Salthouse, 2009). It is suggested that the decline in episodic memory is attributable to age-related changes in the MTL and the prefrontal cortex (PFC) (Devitt & Schachter, 2016; Schacter et al., 1997). These changes would make older adults particularly vulnerable to various episodic memory errors, such as those that could be made in an eyewitness memory scenario (cf., Thomas et al., 2014). For example, consider the earlier example of witnessing a burglar running away from your grandmother's house. If she later testified that she remembered an athletic male with a striped shirt, she would be committing an episodic memory error by incorporating external suggestions into her reports.

Understanding False Memory

It is a common misconception that episodic memory works like a video recording. However, decades of research have found that our memory is notoriously untrustworthy. Although witnesses can often be very confident that their memory is accurate when identifying a suspect, the malleable nature of human memory and visual perception makes eyewitness testimony one of the most unreliable forms of evidence. Research has been directed at understanding the factors that can contribute to faulty episodic memory, particularly in contexts where an individual is witness to an accident or crime such as in the earlier anecdote. While this is a very important topic to study, it is a challenging one because studying eyewitness memory for real crimes is nearly impossible. This is because crime scenes are not a situation that can be experimentally controlled. Due to this difficulty, a number of lab paradigms have been developed that have allowed researchers to learn more about the conditions that are most or least likely to lead to faulty eyewitness memories as well as demographic groups that are most susceptible to false memories, and the neurological substrates that underlie these memory processes. Across a number of these paradigms, age related differences in false memory have been observed with cognitive aging associated with increased susceptibility to various kinds of false recollections (Schacter et al., 1997). Specifically, research has found that when comparing young and older adults in regard to true and false memories on recall and recognition tasks, older adults typically show a reduction in true memories, and an increase in false memories, and further that they have difficulties recollecting the source of information, which makes them vulnerable to confusing perceived and imagined experiences as well as memory distortions on a number of different types of tasks as will shortly be discussed.

Aging and False Memory

Previous studies examining false memories and aging have shown that these memories are more likely to occur when new items share perceptual or semantic similarities with those presented during encoding. These discoveries are further investigated on a neurobiological level using functional magnetic resonance imaging and a false memory task (Dennis et al., 2008). This was done by scanning young and older participants during a word recognition task using the DRM paradigm. The DRM paradigm (see Roediger & McDermott, 1995 and further discussion below) is commonly used to study false memory creation, with a methodology that requires participants to study lists of semantically related words and then take memory tests on the lists. Dennis et al. (2008) presented participants with a recognition task that included studied words and new words referred to as critical lures (Dennis et al., 2008). During correct recognition of studied words, known as true memory, older adults showed weaker activity than young adults in the hippocampus but stronger activity than young adults in the retrosplenial cortex (Dennis et al., 2008). These hippocampal reduction findings are consistent with age-related deficits in recollection. The increase in the retrosplenial cortex shows that the older adults relied on alternative recollection-related regions, due to their decline in other brain regions (Dennis et al., 2008). When investigating incorrect recognition of critical lures, or false memories, older adults displayed stronger activity than younger adults in the left lateral temporal cortex. This region is involved in semantic processing, demonstrating that older adults have a decline in recollection processes, which is mediated by the hippocampus (Dennis et al., 2008). Their increased tendency to have false memory shows their reliance on semantic processing.

Magnetic resonance further allowed researchers to measure the volume of brain structures in older adults and to relate the results to memory performance. Raz et al. (1998) performed research demonstrating that older adults with smaller brain volume in their hippocampal region, tended to have impaired explicit memory. There was further analysis of white matter integrity in the brain, which revealed poorer memory in older adults with hyperintensity of the matter (DeCarli et al., 1995; Van Petten, 2004). These structural methods were able to be further observed with diffusion tensor imaging, which helped to draw conclusions about brain structure and memory performance.

There have been further biological factors that have been recently explored such as the development of in vivo β-amyloid and tau imaging, which help researchers to explore the relationship between neuropathological insults and the correlation to one's memory. Through these experiments, it has been seen that greater levels of amyloid have been associated with worse episodic memory (Hedden et al., 2013) as well as deficits in cognition and altered patterns of activation with memory encoding (Mormino et al., 2012). The results of these types of imaging is very up-and-coming, however, future work will help researchers to better understand neuropathology with both typical and atypical memory performance, false memories that occur in contexts similar to those that represent eyewitness scenarios (Park & Festini, 2016).

Laboratory Paradigms to Study Faulty Eyewitness Memory

The DRM Paradigm. The Deese-Roediger-McDermott (DRM) paradigm was created in order to study false memories in a controlled, scientific setting (Roediger & McDermott, 1995). This paradigm relied upon associative memory, which is the ability to learn and remember the relationship between items. Through this study, subjects studied lists of 12 words which were composed of semantic associates (e.g., bed, rest, awake), and one non-presented word (e.g., sleep) (Roediger & McDermott, 1995). When the participants were given immediate free recall tests, the non-presented associates were recalled about 40% of the time and were recognized in the future with confidence (Roediger & McDermott, 1995). In the following experiment, a false recall rate of 55% was reported when an expanded set of lists was used. The results of this paradigm demonstrated a powerful illusion of memory, showing how people remember events that never actually occurred simply by being exposed to related information. This happens since these false memories are generated through automatic associations that are seen within the given words and the non-presented word. Individuals making errors on this task may have trouble distinguishing between actual recollection and a more subjective feeling of familiarity generated from association.

The Misinformation Effect Paradigm. More relevant to the idea of eyewitness memory, Loftus and Palmer (1974) were interested in examining whether memory for a fictional event could be manipulated by verbal suggestions. This experiment involved subjects viewing films of automobile accidents and then answering questions. One critical question varied between participants. Some participants were asked the question “About how fast were the cars going when they *smashed* into each other?”, while other participants were asked the same question with the word *smashed* replaced by terms such as *collided* or *bumped* (Loftus & Palmer, 1974). Interestingly, participants who were exposed to *smashed* reported higher estimates of speed than participants in the other conditions. The subjects were retested a week later and the participants who received the verb “smashed” were more likely to answer “yes” to the question, “Did you see any broken glass?”, even though there was no broken glass present (Loftus & Palmer, 1974). Through this study, it was demonstrated that questions asked subsequent to an event can lead to reconstruction in one’s memory of an event.

In follow up work, Loftus and colleagues developed a slightly different method which is known as the misinformation effect paradigm. This paradigm extended the work of Loftus and Palmer (1974) by demonstrating that not only can memory be altered by leading suggestions, but outright false suggestions can also alter eyewitness memory when delivered through leading questions or post-event information (Loftus, Miller and Burns, 1978).

After engaging in various types of research regarding false memory, Loftus investigated the possibility of implanting an entire false memory into the minds of people for events that never occurred in an ethically permissible way. When exploring this idea, her research partner assembled booklets that had four short narratives that each described childhood events. The partner's family were enrolled in the study and were asked to remember as many details as possible from each of the stories (Loftus and Pickrell, 1995). The participants were unaware that one of the stories was false, where the false story described a scene of their younger brother getting lost in a shopping mall (Loftus and Pickrell, 1995). Throughout the experiment, the younger brother was asked to describe the stories he read in which he began to incorporate the *false* story into his reports, while also inventing his own details into the story. The conclusion of the experiment involved the participants being told that there was a false story incorporated, in which the younger brother was unable to identify which story was false (Loftus and Pickrell, 1995).

Loftus and Pickrell (1995) then performed a formal study adapted from the original Lost in the Mall experiment. This study asked the same question, which was whether people could be led to believe that they had been lost in a shopping mall as a child even if they had not been. At the conclusion of the study, about 25% of the participants reported remembering a false event (Loftus and Pickrell, 1995). Similarly to the prior study, the participants were then told that one of the given events was false. With this, some participants failed to identify the incorrect event and rather selected one of the true events to be false. This study is referred to as "existence proof" for false memory creation while also providing evidence that false memory can be formed from a suggested event being incorporated into existing memories (Loftus and Pickrell, 1995).

In the typical misinformation experiment, there is no direct social presence. Misleading information is typically delivered in an impersonal written form, either embedded in questions that are assumed to have come from the experimenter or in a detailed narrative from a supposed observer of the original event. In either case, subjects may expect that information placed in the questions or narrative is correct, because either the experimenter presented the information, or a person that is able to remember details did (Meade & Roediger, 2002) (Loftus, 1993). This is important to understand in order to differentiate from the social contagion paradigm used in the present study.

The Social Contagion Paradigm. Contrary to the process used in the misinformation effect paradigm, the misleading information is provided to subjects directly by confederates who seem, to the actual subject, to be in the same situation during recall. A related false memory paradigm was developed by Roediger and colleagues which involved the use of a confederate. A confederate is an individual(s) who appears to be a fellow participant, but in reality serves a purpose for the research team. The researchers performed four experiments to examine social influence on false memories where subject and confederate pairs together studied six common household scenes, such as a kitchen (Roediger et al., 2001). Each pair then participated in a collaborative recall test, where each individual took turns recalling items from each of the scenes. During this collaborative recall task, the confederate reported incorrect items that were not present in the actual scene, but were plausible, for half of the scenes. These scenes were referred to as contagion scenes. The other half of the scenes served as control scenes. The scenes that served as contagion and control were counterbalanced across participants. Memory on control scenes was important because it served as a way to measure spontaneous reports of each the items suggested on contagion scenes in the absence of suggestion. Soon after, the individual subject took an individual memory test where they recalled as many items as possible from each of the six original scenes, and then a recognition test where they were exposed to both studied, suggested, and new items and had to attribute each item to its correct source - either the scenes, the confederate, both the scenes and confederate, or that is was a new item.

The results of the study showed what is termed the *social contagion of memory effect.* The researchers analyzed the recall and recognition tests to estimate the impact of the confederate's inaccurate suggestions on participants' memory. On the recall test, recall of critical items was greater on contagion compared to control scenes. Further, on the source recognition test participants misattributed the suggested details to the scenes more often than they misattributed control items to the scenes (Roediger et al., 2001). It was also observed that when the false memory did occur, the participant was more likely to report that they "knew" the suggested item was in the scenes rather than claiming they actually remembered seeing it (Roediger et al., 2001). This outcome is typical in experiments such as the one performed. The reasoning for this has been understood to be related to retrieval from semantic memory or global familiarity of the event (Tulving, 1985). Even when participants were warned that their partners may have introduced false details, the social contagion effect persisted. (Meade & Roediger, 2002). This data is able to support the idea that false memories are able to be transmitted between people via the social contagion of memories.

Several factors have been shown to moderate false memory in variations of the social contagion paradigm. For example, Echterhoff et al. (2005) found that when participants were explicitly warned before a final memory test that the source providing post-event information was untrustworthy or incompetent, the social contagion effect was reduced. However, in organic social interactions outside of the laboratory, eyewitnesses are not given explicit warnings about a co-witness's unreliability. When an eyewitness does not know a co-witness, the eyewitness may rely upon indirect social cues to form heuristic judgments about the co-witness's credibility and competence. This is important to note for the present study, as the participant is making judgement on the confederate during the collaborative recall. The judgement made by the subject is valuable, as it may have impacted their decision on whether or not to incorporate the items the confederate recalled. The effects of this were investigated in the present study in regard to the cross-race interaction as well as the age of the participant. For example, research has shown that people tend to perceive individuals from their in-group as more credible and trustworthy than individuals from an out-group (e. g., Doosje, Branscombe, Spears, & Manstead, 2006). Andrews and Rapp (2014) examined how in-group membership can impact social memory. To investigate this, participants were paired with either in-group or out-group confederates who introduced inaccurate information about a co-witnessed event. In-groups were established by pairing participants with confederates who they believed had similar artistic preferences and perceptual processing styles. Andrews and Rapp (2014) found that the social contagion effect was reduced when the confederates were members of participants' out-groups. Similarly, co-witness pairs who know one another may be perceived as more trustworthy and credible. This may increase the social contagion effect. For example, French, Garry, and Mori (2008) found that romantic partners who unknowingly exposed one another to false information about a witnessed event during a collaborative memory test reported more false details on a later independent memory test compared to co-witness pairs who were strangers.

In addition to attempting to understand how various elements of the social interaction might affect the perceived credibility of the confederate and influence the social contagion effect, prior research has also explored the underlying cognitive and neurological mechanisms that could be involved in making these types of memory errors. In order for the social contagion effect to be avoided, people must be able to engage in executive control. When drawing on memories of prior experiences, memory theorists have made an important distinction between two ways that this occurs. One way includes the recollection of contextual details that surround a previous encounter with a stimulus, otherwise known as source memory. The second way is a general sense of familiarity that allows one to determine whether the stimulus was previously encountered (Dobbins et al., 2002). In everyday life, it is common to experience item memory combined with source memory failure. This combination plays a valuable role in faulty eyewitness identification.

The Source Monitoring Framework

The social contagion effect, and results from studies employing other eyewitness memory paradigms, can be interpreted within the source monitoring framework that Johnson, Hashtroudi, and Lindsay (1993) present. An important concept that each subject engages in when participating in the present study is source monitoring. The ability to identify the source of a memory is critical for many cognitive tasks. The participants of the present study engage in this task when they perform the final recall and recognition tasks and have to distinguish between the sources of their memories. If the participant is unable to do so correctly, it results in an error. Source monitoring relates to the conditions or *source* under which a memory is acquired, such as the social context of the event (Johnson et al., 1993). The source-monitoring hypothesis suggests that the criteria used by the subjects to attribute a memory to a particular source will vary with factors such as the purpose of the memory, any present biases or the importance of the material (Johnson et al., 1993). The concept refers to the processes that are involved in making connections about the origins of memories, knowledge or beliefs. This is especially relevant in laboratory studies, where the participant needs to differentiate between items they recognize or recall from a studied scene. When an individual is unable to specify source information, they may have difficulty in a simple task such as remembering whether the person you are about to tell a joke is the one who originally told you the joke to begin with (Johnson et al., 1993).

The relationship between source monitoring and recognition are seen to be drawn from the same heuristic and systematic processes. This is because both the non-studied and studied words on recognition tasks are often familiar to the subjects from sources outside of the experiment. Due to this, recognition judgments often involve a degree of source monitoring such that the subjects have to attribute memories of studied items to the studied scene (Johnson et al., 1993). The source monitoring framework argues that information from various sources can potentially be used in recall and while retrieving information from one's memory, the participant may recall recent information and incorrectly identify its source to an earlier event (Roediger et al., 2001). Similarly, in the social contagion paradigm subjects recall information about the scenes they recently viewed on the final recall test; however, the collaborative recall test with the confederate serves as a possible source of error since the confederate has recalled some erroneous information. On the later test, the subject can potentially attribute the erroneous reported items to the original scenes, rather than correctly attributing it to the confederate (Roediger et al., 2001). The proposed source monitoring framework predicts that the more closely related the confederate's statements are to the original scene, the more likely the social contagion effect will occur and vice versa (Johnson et al., 1993; Roediger et al., 2001).

Source monitoring has also been examined in relation to age-related deficits, which is of importance in the present study. One theoretical account of memory for source information is the reality monitoring model proposed by Johnson and Raye (1981). This model is a set of processes that is interested in discriminating between externally derived and internally generated information within one's memory (Johnson & Raye, 1981). Externally derived memories are those that consist of sensory information, such as color, while internally generated memories are more based on the information about the cognitive operations that are involved when the memory was established (Hashtroudi et al., 1989).

The study that was performed by Hashtroudi et al., (1989) used the reality monitoring framework to examine source monitoring in older adults. The main objective was whether older adults generally have a deficit in remembering the source of information or whether age deficits limit the types of source monitoring. To test this, subjects were given a list of words that came from a variety of different sources. After studying the words and engaging in various tasks, they were given a memory test where they had to indicate the source of the item (Hashtroudi et al., 1989). The results of the experiment showed that older adults were able to discriminate between internally-generated and externally derived memories, but also led to the indication that older adults have a specific rather than general deficit in remembering the source of information (Hashtroudi et al., 1989). Instead, older adults showed deficits in discriminating between memories of the same class, which include external and internal source monitoring.

The reality monitoring model suggests that these age deficits may occur for two different reasons. The first reasoning suggests that older adults may have difficulty with the critical information dimensions that discriminate between memories. Secondly, there may be an age deficit in the processes that involve reasoning or judgment. Importantly, these results suggest that the deficit that older adults have in source monitoring may be correlated on the importance of sensory and cognitive operations that are involved when specifying the source of a memory (Hashtroudi et al., 1989).

The Present Study

The primary goal of the present study was to explore some of the factors that may lead individuals to be more or less susceptible to external suggestions in the social contagion of memory paradigm. Specifically, I examined two factors that can influence the social context in which suggestions are delivered in the paradigm. The first was the age of the participant and the second was the racial group status of confederate used to deliver suggestions. In regard to the age component of the experiment, it was hypothesized that older adults would demonstrate greater false memory on both recognition and recall tests when compared to young adults. It was further hypothesized that white participants will be less susceptible to misleading information presented by members of a racial out-group compared to members of a racial in-group. It was also suspected that this effect of co-witness race would be more evident in older adult participants, since this generation may maintain stronger racial biased compared to young adults. A secondary aim of the study was to examine whether age groups would differ in their level of executive functioning by having the participants perform the Stroop Task. This task was of importance since it was able to give a brief estimate of the individuals ability, since episodic memory and source monitoring involve executive functioning.

Method

Participants

There were a total of 69 participants, 34 in the young adult group and 35 in the older adult group. The young adult participants were gathered from the Assumption College undergraduate students and the participants from the older adult group were gathered from the Worcester community. The young adults varied in age from 18-24 and the older adults were aged 60+. Of the young adults who participated, 79% were female and 21% were male. Additionally, 74% identified as White, 15% as Black, 9% as other and 3% as Asian. Of these participants, 80% identified as non-Hispanic and 15% classified as Hispanic. Of the older adults who participated, 69% were female and 31% were male and all of these subjects classified as white and 91% classified as non-Hispanic.

Materials and Procedure

The experimental procedure was the same for both young and older adults. Following the consent procedure, participants first completed the first phase of the social memory task. This task involved participants observing an original event. The stimuli for this event included pictures of neutral household scenes such as a kitchen and office. The household images were taken from Meade and Roediger (2002).

After the participant completed the study phase, they filled a four minute retention interval by completing a brief demographic questionnaire and a brief measure of verbal fluency (Benton et al., 1994). Immediately following these tasks, they completed the second phase of the social memory test. In this phase, they were exposed to misinformation about the earlier studied scenes from a ‘co-witness.’ The co-witness was not another live participant, however, it was a fictional part of the research procedure. As part of this fictionalized aspect of the procedure, participants were told that they were randomly paired with a partner from a research session conducted during the previous semester, who had given permission for the research team to share information about them and their performance on the upcoming memory task with a future partner (the current participant). The participant/fictional co-witness (FCW) ‘interaction’ consisted of a collaborative recall task. To begin the task, participants were presented with packets that contained a 3x5 glossy photograph of the partner, as well as the partner’s fictional name and age. Pictures were taken from The Chicago Face Database (Ma et al., 2015) and depicted individuals from the chest up against a neutral background. Four male faces (two black and two white) were used as partner stimuli. Two were chosen from each group to ensure that any observed effects could not be attributed to a specific image. The packet also included a set of index cards, that contained fictionalized handwritten responses. The participant was informed that these were provided by their partner during their earlier research session. Participants were instructed after being prompted by the name of a scene (e.g., Kitchen) to take turns with their partner recalling items from the scene. Since the fictional partner was not present, the participant was instructed to read aloud items that were written down earlier for the partner. The participant alternated between providing their own response, and reading one from an index card, until six responses from each individual had been recorded by the researcher.

Immediately following the collaborative recall task, the participants completed a computerized version of the Stroop Color and Word Test, which is a neuropsychological test that is used for both experimental and clinical purposes (Stroop, 1935). The task is used to assess the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a second stimulus (Scarpina & Tagini, 2017). The task requires this in order to disengage from automatic processing to engage in the task at hand, naming the color, and is commonly used as a behavioral measure of executive functioning. In this version of the task, participants were presented with words and said aloud the name of the color that the word was printed in as quickly and accurately as possible. Voice responses were recorded and time stamped. Thirty-six items were presented on a screen, randomized but equally distributed across four font colors: blue, yellow, green, and red. A third of the trials, also randomized for each participant, were *congruent* (BLUE presented in blue font). A third were *incongruent* (RED presented in blue font). A third were control trials, where a neutral stimulus (XXXX) was presented in colored fonts. Accuracy and response times were measured.

Finally participants completed an individual memory test. The memory test consisted of two parts. The first part was a free recall test where participants listed as many items as they could remember from each scene. They had two minutes per scene to recall. The second part was a computerized recognition test where participants were exposed to items from the scenes and new items and judged whether they recognized each item from the earlier study phase. There were four alternatives that participants had to choose from for each item: they recognized it from the scenes, they recognized it from their partner, they recognized it from both the scene and partner, or they did not recognize the item. Following the final memory test, participants were fully debriefed and compensated.

Results

Recall Test

Recall Accuracy

Recall accuracy was measured as the average number of items reported that were studied in the scenes. It tested their ability to recall different types of scenes. A 2 (partner race: same, different) x 2 (age group: young, older) x 2 (item type: contagion, control) mixed ANOVA was conducted on recall accuracy. The analysis revealed a significant main effect of age group, F (1, 65) = 28.585, $p < .01$, $\eta_p^2 = .305$. Young adults recalled more words per scene (M = 7.3) than older adults (M = 5.3). The main effect of partner race was not significant, F (1, 65) = .504, p = .480, nor the interaction effect between the two, F (1, 65) = .005, p = .944.

The within-subjects part of the analysis observed the impact of item type. The analysis revealed a significant main effect of item type, F (1, 65) = 4.356, p = .041, η_p^2= .063. Recall of items from scenes that accompanied exposure to contagion items (M = 6.180) was slightly lower than recall of items from control scenes that did not accompany exposure to suggestion (M = 6.500). The interaction effect of item type and partner race approached significance, F (1, 65) = 3.352, p = .072. Recall accuracy is presented in Figures 1 and 2.

False Recall of Contagion Items

False recall was defined as the proportion of suggested contagion items recalled. A 2 (partner race: same, different) x 2 (age group: young, older) x 2 (item type: control, contagion) mixed ANOVA was conducted on false recall. Only the within-subjects main effect of item type was significant, F (1, 65) = 56.91, p = .000, η_p^2= .467. The interaction effects between item type and each of the between group variables were not significant: item type by age group, F (1,65) = .980, p = .326, item type by partner race, F (1,65) = .128, p = 0.722, three-way interaction, F (1,65) = .477, p = .492.

In terms of between subjects main effects, none were significant: age group, F (1, 65) = .067, p = .797, partner race, F (1, 65) = 1.94, p = .169, age group by partner race interaction, F (1, 65) = .002, p = .967. False recall is presented in Figures 3 and 4.

Recognition Test

Recognition Accuracy

Recognition accuracy was defined as the proportion of all test trials answered correctly by participants. For example, on a trial presenting a suggested item, the correct response would be “partner only”. A 2 (partner race: same, different) x 2 (age group: young, older) between-subjects ANOVA was conducted on recognition accuracy. The analysis revealed a significant main effect of age group, F (1, 64) = 10.272, p = .002, η_p^2 = .14. Young adults (M = .61) were more accurate than older adults (M = .51). The main effect of partner race was not significant, F (1, 64) = .393, p = .533, nor the interaction effect, F (1, 64) = .010, p = .922. Recognition accuracy is presented in Figure 5.

False Recognition of Contagion Items

False recognition was defined as the proportion of test trials where there was any false recognition of contagion items, which were the experimental items presented on the note cards. Two responses on the recognition test indicated social contagion of memory: first, if a contagion item was identified as an item from the ‘scene only’, second, if a contagion item was identified as an item from ‘both the scene and the partner’s note cards’. A 2 (partner race: same, different) x 2 (age group: young, older) x 2 (type of error made: scene only, partner and scene) mixed ANOVA was conducted on false recognition. The analysis revealed a significant main effect of age group, F (1, 64) = 4.457, p = 0.039, η_p^2= 0.065. Young adults (M = 0.17) had fewer false memories compared to older adults (M = 0.237). The main effect of partner race was not significant, F (1, 64) = .283, p = 0.597, nor the interaction effect, F (1, 64) = .014, p = .906.

The only within-subjects main effect was error type, F (1, 64) = 16.026, p = <.01, η_p^2 = 0.200. Participants more often reported that the source of suggested items was both the partner and the scenes ((M = .280) compared to the scenes only (M = .122). The interaction effect of error type and age group was not significant, F (1, 64) = .166, p = .685, nor the interaction effect of error type and partner race, F (1, 64) = .218, p = .642, nor the interaction effect between error type, age group and partner race, F (1, 64) = .009, p = .925. False recognition is presented in Figures 6 and 7.

Stroop Interference

Reaction times to name each color were measured as the time between the onset of the visual stimulus and the beginning of the participant's speech response. Only trials that participants responded to correctly were included in the interference analysis. Stroop interference was calculated as the average reaction time to incongruent trials minus average reaction time to neutral trials. A 2 (partner race: same, different) x 2 (age group: young, older) between-subjects ANOVA was conducted on interference scores. The main effect of age group was significant. Older adults (M = 319.8) demonstrated greater Stroop interference compared to younger adults (M = 175.2), F (1, 64) = 22.52, p < .01, $\eta_p^2 = .26$. The main effect of partner race was not significant, F (1, 64) = .022, p = .882, nor the interaction effect, F (1, 64) = .229, p = .634. Stroop interference is presented in Figure 8.

Discussion

The main objective of this present study was to investigate how the social dynamic of a cross-group interaction may influence eyewitness memory. Although there are several studies that have been done to research the misinformation effect and the social contagion paradigm, there has not been any done that study the impact of cross-race interactions. Thus, this study observed whether racial bias had the ability to alter whether or not individuals would incorporate information into their original memory. In addition, the study observed whether or not older adults or younger adults are more susceptible to forming false memories in hopes of better understanding methods to potentially reduce these incidents from occurring.

Importantly, a standard misinformation effect was demonstrated in the data. This means that participants were less accurate on final test trials that had been targeted with misinformation when compared to neutral trials. Also supporting the original hypothesis was the finding that young adults demonstrated better performance on a number of the measure of memory, including recall accuracy, recognition accuracy, and false recognition. The Stroop task also demonstrated that older adults are more susceptible to interference effects on the task than young adults. However, contrary to the original hypothesis, there was no significant difference in participants with same racial partners having greater false memory.

While there were not significant results that demonstrated racial bias, it is important to take note that some of the tests may have been underpowered. The test that showed results that were close to a significant value for the hypothesis of participants with same race partners having greater false memory was the recall accuracy test. The value of $p = .072$ was not significant, but it is possible that the analysis was underpowered. If it were to be a potential trend, the data suggests that the participant was paired with a partner of the same race, there was not any significant difference between the accurate items recalled when they were presented with both control and contagion items. However, when both young and old adults were paired with Black partners, they recalled fewer contagion items than with the control items. These results suggest that people with different race partners may result in a negative impact by misinformation more than people who are given White partners.

Another interesting finding that was observed was that the results of the present study showed an age difference on recognition, however, there was no age difference in recall. This result is one that typically goes against past research studies (e.g. Meade & Roediger, 2002). One possible explanation to this may be because recall is a more difficult retrieval process. When someone is engaging in recall, they have to use a more evaluative process based on recollection rather than familiarity. Due to this, it is not the same retrieval process that occurs during a recognition task. In a recognition task, the participant has the ability to rely on familiarity. When the participant mistakes familiarity for recollection, it causes an error. In order to further investigate these results, more participants will have to be collected to better understand and interpret the findings.

The fallibility of one's memory has led to a lot of attention from both the media and researchers. The initial paradigm of the misinformation effect was able to demonstrate how individuals frequently report experiencing incorrect information into the original event, when these details never occurred (Loftus et al., 1978). The concern arose due to the effect being detrimental in situations where memory accuracy is of extreme value, such as eyewitness testimony. Due to this, it has caused researchers to investigate further into memory in order to identify potential procedures to reduce misinformation effects (Huff et al., 2013). Research has led to the understanding of possible sources of error that lead to the social contagion effect, such as source monitoring (Johnson et al., 1993). The identification of these errors has led to researchers telling participants to focus on the source information during the test and also warning participants about misinformation (Huff et al., 2013; Chambers & Zaragoza, 2001).

In a recent experiment done by Huff, Davis & Meade (2013), they explored an additional method to protect an individual's memory from misleading details. When improving memory performance, the use of testing has been extensively researched. The research has led to the verbal-learning literature demonstrating a consistent improvement in memory when participants completed additional tests, called hypermnesia (Huff et al., 2013; Erdelyi & Becker, 1974). Another coined term is the testing effect, which refers to the increase in correct memory for participants who are tested instead of additional study (Karpicke & Roediger, 2008). Of interest was whether initial testing also would benefit false memory. This idea produced the question of whether completing a memory test before one receives misinformation would enhance memory for the event thereby reducing misinformation effects (Huff et al., 2013).

This hypothesis was supported from early work, such as experiments done by Loftus (1977). This experiment included participants viewing a green car driving past an accident scene. The results demonstrated that participants were less likely to report misinformation when they were initially tested on the color of the car before they received misinformation, such as the car was blue (Huff et al., 2013; Loftus, 1977). These results were further supported by an unpublished study that Loftus did (1979) where participants who completed a free recall test before they were exposed to misinformation had fewer false memory items on the final test compared to those who did not complete this initial test (Huff et al., 2013). With this evidence, there are also researchers that have shown that initial testing can increase the potential for the subject to incorporate details from misinformation. A study done by Chan and colleagues (Chan et al., 2009) also investigated this idea but discovered results that showed heightened false memory, later referred to as retrieval enhanced suggestibility (RES) (Huff et al., 2013).

Huff, Davis and Meade (2013) extended previous research on initial testing and misinformation effects by exploring it in the context of the social contagion paradigm. The main findings of the experiment demonstrated that whether the participant was initially tested or not did not have an impact on the formation of an RES effect or a protective effect from incorporating false details (Huff et al., 2013). With this, a second experiment was performed where the researchers replicated the social contagion paradigm, however; the participants were now given corrective feedback on their initial recall tests (Huff et al., 2013). The results of this piece of the study demonstrated that this alteration produced the same rates of false recall of contagion items on a final test. Overall, the study revealed that initial testing did not provide protection against misinformation on a final source-monitoring recognition test. Critically, however, participants who completed the initial test were deemed less likely to falsely attribute contagion items to the scenes (Huff et al., 2013). The results also gave suggestion that the protective effect that the initial testing provided was only directed towards the source recognition test since the instructions for the test indicated strong attention to the item's source (Huff et al., 2013). The conclusion of the testing to avoid false memories led to the suggestion of initial testing in the social contagion paradigm, however, it depends on the type of test that is given.

The present study was limited in a few regards. The first area that showed limitation was the lack of diversity, as the young adult participants were all undergraduate students at Assumption College. Due to this, it is possible that a lot of the students come from similar backgrounds. The older adults were also relatively homogenous. Also, a large limitation of the study was that it interfered with the current global pandemic of COVID-19, therefore halting the experiment and reducing the number of participants. Despite some limitations that arose during the study, the data revealed some interesting results that will spark further inquiry. For example, it would be interesting to further investigate the cross-racial interaction component of the study and expand it to individuals from other places than the Worcester community. One option that would greatly expand the study is turning it into a virtual experiment where people from all around the United States could participate. In order to do this, the confederate used in the experiment would have to be made virtual, along with other aspects of the protocol. Expanding the study to other parts of the world would be fascinating to see how all of these variables interact based on their global location.

In regard to better understanding memory, neuroimaging will also be of significant help to better understand the biological components of memory impairment with age. There has been considerable attention given to ways one can improve their memory as they age, such as cognitive training, in order to provide a boost to their cognitive function with the hopes of delaying the onset of memory decline (Park & Festini, 2017). There have been investigations that observe if there are increases in episodic memory in older adults who have learned new skills, such as digital photography or working an iPad (Park et al., 2014). Park and colleagues (2014) investigated whether sustained engagement in learning new skills would lead to activated working memory, episodic memory, and reasoning, thereby enhancing cognitive function in older adults.

Another scientific way that is being investigated for future use is neurostimulation. This concept is a possible method of enhancing memory. Researchers have recently been examining the influence of a non-invasive technique, known as transcranial direct current stimulation. There have already been results showing benefits of this procedure in young adults and a few older adults (Park & Festini, 2017). One study was able to provide improved verbal recognition memory in Alzheimer’s patients following the procedure. Further research will be necessary on this topic, but it is of interest as a possibility to prevent memory decline.

In sum, this study added an important piece to beginning to understand the factors that influence the social contagion of memory effect, particularly factors that influence the social aspect of the participant-confederate interaction. In addition to age and race, it may also be of interest in future work to consider variables such as intelligence, lifestyle, and genetic background. I think that these variables are of importance when it comes to an individual’s ability to engage in proper executive functioning and may also lead to further discovery about the reasoning for faulty eyewitness memory, particularly those observed in older adults.

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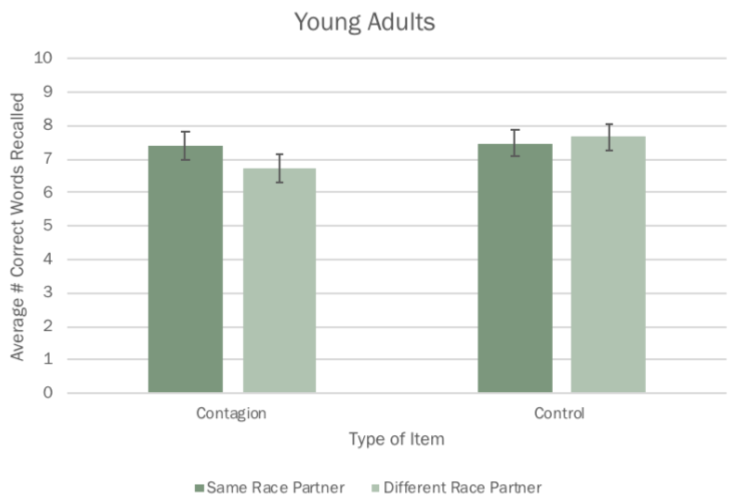
Figure 1

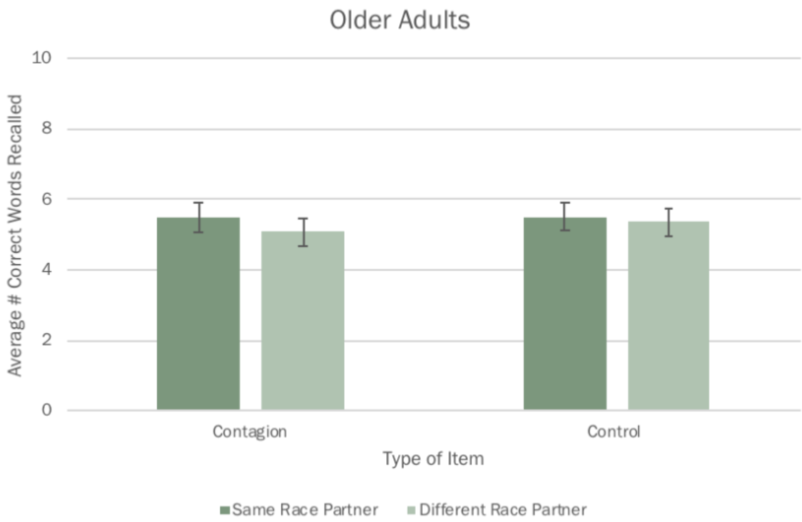
Recall Accuracy for Young Adults as a Function of Item Type and Partner Race



Note. Error bars show standard error.

Figure 2

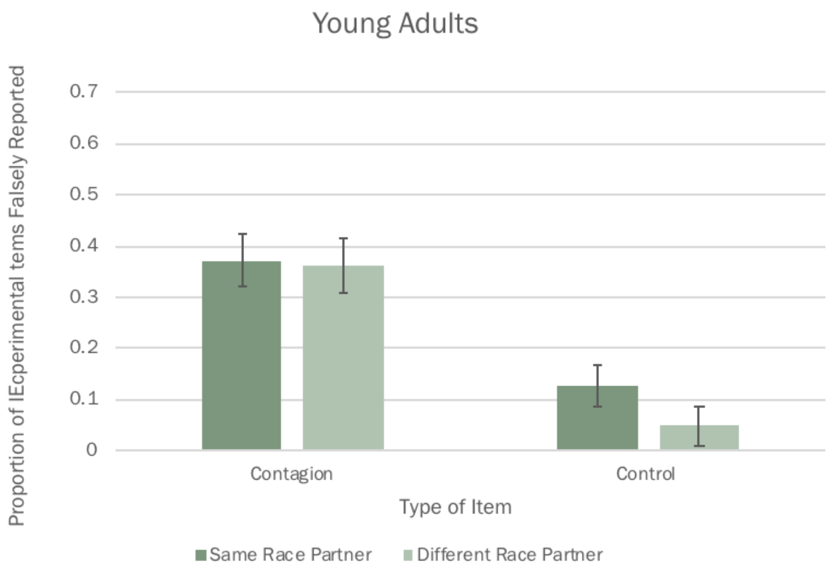
Recall Accuracy for Older Adults as a Function of Item Type and Partner Race



Note. Error bars show standard error.

Figure 3

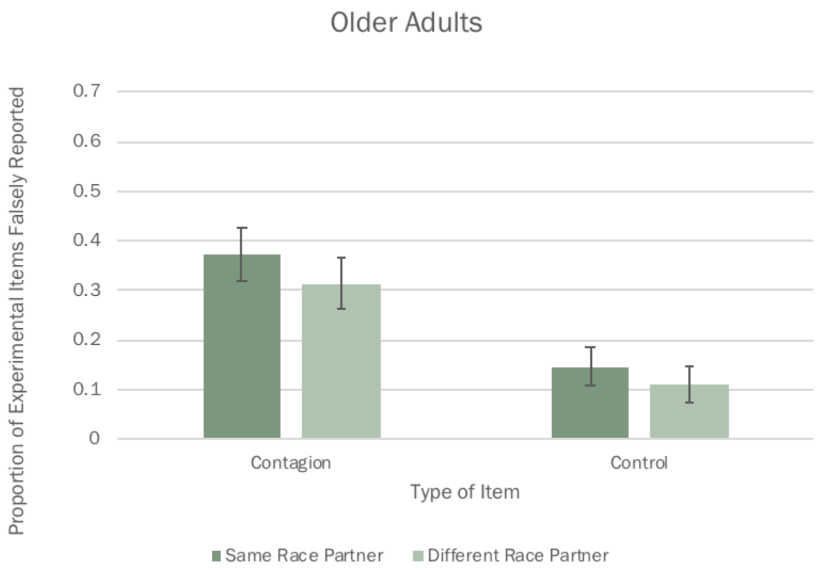
False Recall for Young Adults as a Function of Item Type and Partner Race



Note. Error bars show standard error.

Figure 4

False Recall for Older Adults as a Function of Item Type and Partner Race



Note. Error bars show standard errors.

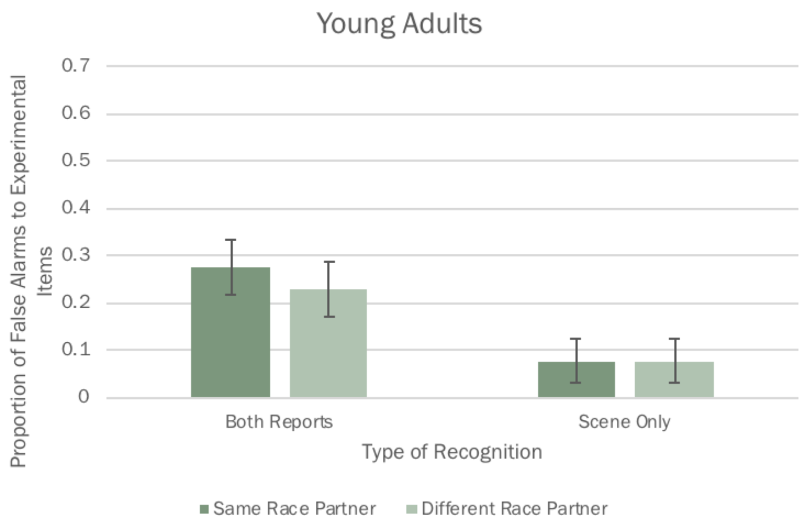
Figure 5

Recognition Accuracy as a Function of Age Group and Partner Race

Note. Error bars show standard error.

Figure 6

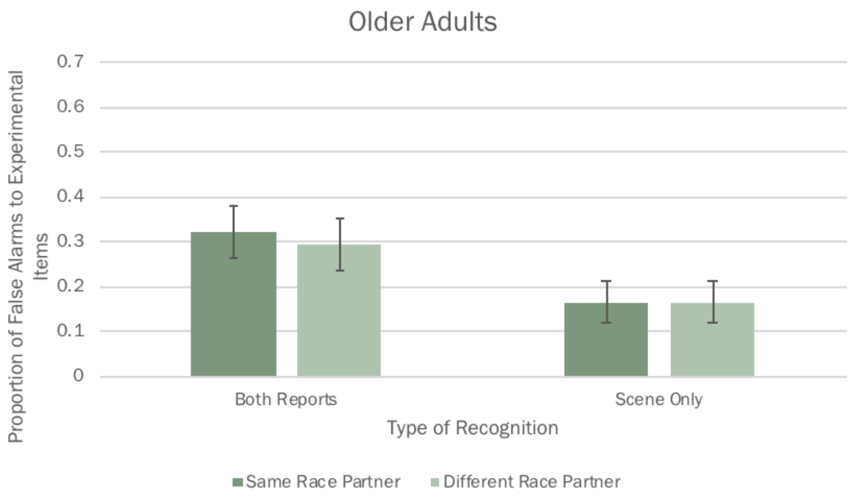
False Recognition in Young Adults as a Function of Error Type and Partner Race



Note. Error bars show standard error.

Figure 7

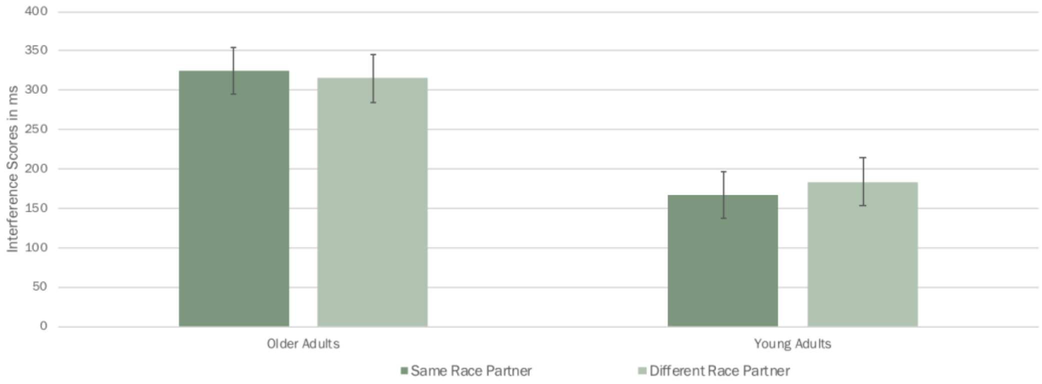
False Recognition in Older Adults as a Function of Error Type and Partner Race



Note. Error bars show standard error.

Figure 8

Stroop Interference as a Function of Age Group and Partner Race



Note. Error bars show standard error.