Eyewitness Identification Accuracy: The Influence of Olfactory Stimuli Used as a Form of Context Reinstatement

by

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Abstract

The purpose of the current study was to examine the influence of olfactory stimuli used as a form of context reinstatement on eyewitness identification and recall accuracy. Participants (*N* = 184) attended two sessions. In the first session, participants viewed a video of a staged, non-violent theft and then completed the free recall form. Participants returned for the second session one week later where they again completed the free recall form and the lineup task. In each session, participants were randomly assigned to either the scent or no scent condition. It was hypothesized that a match in scent at both sessions would result in the most accurate identification decisions. A trend was found for a higher correct identification rate and a higher correct rejection rate when encoding and retrieval sessions matched versus mismatched. Scent did not influence the number of descriptors or proportion of accurate descriptors recalled. Overall, the results from the current study suggest that scent may have a minimal influence on eyewitness accuracy when used as a form of context reinstatement. Implications and future directions are discussed.

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On August 16, 1983, an 82-year-old woman (referred to as Ms. K.) was suddenly awoken to a man leaning over her in her bed (*People v. Valdez*, 1986). The man was wielding a knife and had told Ms. K. that he would kill her if she did not cooperate. The man then removed Ms. K.'s pajamas and proceeded to sexually assault her. Ms. K. begged the man to stop but he continued to assault her. After 15- to 20-minutes, the man finally left Ms. K.'s home. Ms. K. later recalled that during the sexual assault, the man had smelled strongly of garlic. This prominent odour could have potentially acted as a cue to help Ms. K. later identify the man who had assaulted her.

Memory is often viewed as an accurate and detailed representation of past experiences. The process of encoding and retrieving information, however, is influenced by a variety of factors that impact accuracy when remembering an event (Sanders, 1984; Thomson, 1981; Wells, Memon, & Penrod, 2006). Despite the known inaccuracies of memory, eyewitness identifications are heavily relied upon as evidence in the justice system (Wells et al., 2006). To date, 365 individuals from the United States have been exonerated based on DNA evidence, and in 69% of these cases, eyewitness misidentification was the reason for wrongful conviction (Innocence Project, 2019). It is important that eyewitness identifications are accurate, as innocent individuals can be convicted while the criminal remains free. One variable that may influence eyewitness memory is olfaction (i.e., scent), as one's sense of smell has been shown to be associated with memory processes (Herz & Engen, 1996).

In order to understand the ways in which eyewitness accuracy can be influenced by scent, it is important to first understand the processes involved in memory (i.e., encoding and retrieval). One phenomenon that has been said to influence how well information is retrieved (i.e.,

remembered) after it is encoded (i.e., stored) is known as context reinstatement (CR). CR is when features of one's environment are similar during encoding of information and then again at retrieval (Sanders, 1984; Wong & Read, 2011). CR will be discussed in terms of how it influences recall memory and facial identification accuracy. Finally, because the olfactory cortex (i.e., the region of the brain involved in sense of smell) is connected to regions of the brain involved in memory; Herz & Engen, 1996), it would be meaningful to examine olfactory stimuli (i.e., scent) in terms of eyewitness identification. If an eyewitness experiences scent as a form of CR, it could enhance their ability to remember details for a crime. Further, if scent can enhance memory then it could potentially help to reduce mistaken eyewitness identifications in the criminal justice system, which is the leading cause of known wrongful conviction (innoncenceproject.org). Thus, the purpose of the present study was to examine whether eyewitness identification (i.e., correct identification or correct rejection in a photographic lineup task) and recall (i.e., proportion of correct descriptors recalled) accuracy can be influenced by olfactory stimuli used as a form of context reinstatement.

Following the occurrence of a crime, an eyewitness may be asked to provide information related to the crime. Further, they may be interviewed about the details of the crime, which involves recall memory, or they may be asked to identify the perpetrator from a lineup, which involves recognition memory (Wells et al., 2006). Neither having an eyewitness recall the details of a crime, nor having them identify the perpetrator(s) is a pure memory process (Wells et al., 2006). That is, there are a variety of factors that influence memory, and thus, depending on the situation, these factors could either enhance or hinder an eyewitness' memory of a crime. Factors that affect recall and recognition memory are known as system and estimator variables (Wells et al., 2006). Specifically, system variables are those factors that are under the control of the

criminal justice system, such as lineup procedure (Wells, 1978). On the other hand, estimator variables are those factors that occur at the time of the crime, such as age of the eyewitness (Wells, 1978). The current study examined the estimator variable of "scent" and examined whether this estimator variable can be used as a system variable to influence recall and identification accuracy.

Structures of the Brain Involved in Memory

There are various forms of memory, all of which are the result of complex processes that occur in the brain. Recognition memory is one's ability to judge previously viewed stimuli as familiar (Manns et al., 2003). Additionally, recognition memory is commonly viewed as being made up of two components (Manns et al., 2003). One component is episodic, which involves one's ability to remember the specific episode in which certain stimuli were viewed. The second component is familiarity, which is one's ability to determine whether certain stimuli were previously presented. Recall memory, however, seems to differ from recognition memory in that it involves a retrieval stage that is more effortful and intentional (Robinson & Johnson, 1996). The processes involved in both recognition and recall memory occur within various structures of the brain.

The amygdala and hippocampus are known to be important brain structures involved in memory. The amygdala is the region of the brain where experience and expression of emotion, and emotional memory occurs (Herz & Engen, 1996). The basolateral nucleus, a region in the amygdala, assists in facilitating the influence that various hormones (e.g., cortisol, epinephrine) have on memory consolidation (McGaugh, 2000). Interestingly, memories that are associated with emotional arousal are typically remembered more easily than experiences that are not as emotionally arousing, due to these hormones (McGaugh, 2000). Thus, the amygdala can become

actively involved in memory processes when a situation is communicated as being emotionally arousing (e.g., when viewing a crime). Following an emotionally arousing event, various hormones are released to assist with memory enhancement and consolidation. The hippocampus on the other hand has been found to assist in selecting and transmitting information in both working memory (i.e., temporary storage of information) and long-term memory (i.e., a more permanent storage of information; Herz & Engen, 1996). Importantly, the amygdala and hippocampus work with other systems in the brain, such as the olfactory system.

Olfaction. The olfactory system is what allows humans to recognize and discriminate among a multitude of scents (Firestein, 2001). Interestingly, the region of the brain that contains the olfactory cortex is directly connected to the region of the brain that contains the amygdala and the hippocampus (Herz & Engen, 1996). Further, the amygdala is separated from the olfactory nerve by only two synapses (i.e., a structure that allows neurons to transmit signals), and the hippocampus is separated from the olfactory nerve by only three synapses (Herz & Engen, 1996). There are no other human sensory systems that have as direct of a connection to structures associated with memory and emotion as the olfactory system does (Herz & Engen, 1996). Moreover, the human olfactory cortex is linked to regions of the brain involved in memory; thus, it makes sense that the olfactory cortex could be involved in various memory processes.

The involvement of the olfactory cortex in memory can be better understood by examining how olfaction interacts with the visual system. Research has shown that there is in fact a connection between the olfactory and visual systems of the brain. For example, one study found that when scents were presented along with semantically congruent visual cues (e.g., an image of an orange along with the scent of an orange), there was a faster and more accurate

detection of olfactory stimuli (Gottfried & Dolan, 2003). As well, when visual cues were congruent, activity within the hippocampus was evoked. This hippocampal activity can be thought of as the retrieval of the semantic associations between scents and visual cues. This supports that there is a strong connection between the visual and olfactory systems in the brain and that visual stimuli that correspond to a scent can enhance olfactory perception.

Tomono, Kanda, and Otake (2011) were interested in examining how an individual's attention to images is influenced by smell presentation. This was done by having participants view various images on a screen. Participant attention to images was assessed with a device that measures gaze duration. Participants were first shown images on a screen, and their gaze duration was measured. Participants were then shown the same images but were also exposed to a scent that corresponded to an image on the screen. It was found that when participants were presented with a scent (e.g., coffee), they spent more time gazing at a corresponding image (i.e., coffee cup), than they did when no smell was presented. This suggests that compared with visual stimuli, olfactory stimuli attract more attention. This also suggests that olfactory stimuli might influence eyewitness identification, as it is information that people seem to pay close attention to. Further, after witnessing a crime, an individual may have strong memory for olfactory stimuli that were present during the occurrence of the crime. Moreover, because olfactory stimuli are often salient and because the olfactory cortex is connected to regions of the brain involved in memory, olfaction could potentially influence an eyewitness' memory for a crime.

Herz and Engen (1996) conducted a systematic review in which they examined both the similarities and differences between olfactory, visual, and verbal memory. Importantly, olfactory memory is the memory that is associated with a scent, as well as one's memory for a scent. The researchers found that scents that are contextually distinct work as efficient memory retrieval

cues. It also was suggested that when a certain emotion is experienced while being exposed to a scent, the usefulness of that specific scent as a retrieval cue would be strengthened. Finally, it was found that compared to other sensory information (i.e., visual or verbal information), memories evoked by scents are more emotionally powerful. This is relevant in an eyewitness context because witnessing a crime is often an emotional event, and emotion has been found to increase one's ability to retrieve the details of an event (Kensinger, 2009).

Similarly, Schab (1991) conducted a systematic review on olfactory memory. Schab looked at research that examined both long-term and short-term memory. It was found that compared to both visual and verbal stimuli, participants were less likely to forget odours during testing. This held true regarding both short-term memory (i.e., 30 seconds) and long-term memory (i.e., 1 year). Overall, it appears that compared to other sensory information (i.e., visual and verbal stimuli), scents are remembered more easily over time. This suggests that olfactory memory is a distinct memory system. The existence of olfactory memory can be better understood with an explanation of the phenomenon known as the Proust effect.

Specifically, the Proust effect is the idea that bodily senses can assist in the retrieval of memories (Matute & Vadillo, 2009). For example, smelling an apple pie as an adult may suddenly bring back memories associated with baking apple pies with your grandmother as a child. Or, the smell of freshly cut grass might bring back memories of summertime. As it is known that olfactory perception is receptive to context, it is likely that context has a strong effect on olfactory memory (Herz & Engen, 1996). It would be meaningful to examine olfactory stimuli used as a form of context reinstatement (CR) because the olfactory cortex is directly connected to the amygdala and hippocampus, regions of the brain where various memory processes occur (Herz & Engen, 1996). Additionally, it has been shown that olfactory stimuli are

information that humans tend to easily recognize and remember. Further, scent may be an effective form of context reinstatement because it has such a strong influence on memory. To date, no study has examined the influence of olfactory stimuli used as a form of CR on eyewitness identification accuracy.

Context Reinstatement and Its Role in Memory

Context reinstatement and recall memory. Encoding and retrieval are two processes involved in memory. Encoding is the process in which perceived information becomes stored in the form of a memory within the brain (Tulving & Thomson, 1973). Retrieval, however, is the process in which an individual remembers information that was previously stored as a memory (Tulving & Thomson, 1973). Further, recall (e.g., remembering details of a crime) and recognition (e.g., identifying the perpetrator of a crime from a lineup) of information are two distinct forms of retrieval (Tulving & Thomson, 1973). The present study examined both recall (i.e., memory for details of the crime and perpetrator) and recognition (i.e., memory for the perpetrator's face). Importantly, the process of encoding and retrieving information occurs within context (Hanczakowski, Zawadzka, & Coote, 2014). Context refers to information that is present during encoding and retrieval, but it is not the focus of encoding or retrieval (Hanczakowski et al., 2014). For example, the focus of encoding might be a teacher giving a lesson in a classroom. Contextual information, however, might be the chalkboard, desks, and the colour of the walls.

Specifically, context reinstatement (CR) refers to the idea that there is improved efficiency of information retrieval when features of a person's environment are similar during both information encoding and then at retrieval (Sanders, 1984; Wong & Read, 2011). Models of episodic memory within the field of cognitive neuroscience can help to explain the processes

involved in context reinstatement. These models suggest that the ability to remember certain information requires the reactivation of brain patterns (in the hippocampus) that were active while encoding occurred, and that increased similarity in neural processing at encoding and retrieval results in improved memory (Norman & O'Reilly, 2003). The processes underlying context reinstatement also can be explained by the encoding specificity principle (Tulving & Thomson, 1973). This principle suggests that how information is stored influences how it is later retrieved. Tulving and Thomson (1973) give the example that information encoded about a target word may or may not include information about the association between the target word (e.g., banana) and some other word (e.g., apple). If information about the association is encoded (i.e., that they are fruits), the other word (i.e., apple) may act as a retrieval cue for the target word (i.e., banana). If information about the relation is not encoded, the other word will not act as a retrieval cue. Thus, the most effective cue for retrieving a target item would be information that has been stored alongside the target item.

In an early study, Smith (1979) examined the influence of context cues on recall memory. In Experiment 1, participants ($N = 30$) attended one, 30-minute session. The 30-minute session was separated into three, 10-minute sessions. In the first session, participants focused on learning word lists. In the second session, participants were asked to sketch the room that they were in, from two different viewpoints. In the third session, participants were given 10 minutes to write out all the words that they could remember from the list. Importantly, there were three rooms that participants were randomly assigned to for each session. The rooms were labelled A, B, and C. For example, a participant may have been assigned to room A in session one, room B in session two, and room C in session three (i.e., the participant would have been assigned to the group 'ABC'). It was found that more words were recalled by those in the same-context group (e.g.,

ABA) compared to those in the different-context groups (e.g., ABB, ACB). This suggests that physical context reinstatement (i.e., being tested in the same room in which the words were first learned) can enhance one's ability to recall words.

Relatedly in another study, Godden and Baddeley (1975) examined whether recall memory could be influenced by context reinstatement by manipulating whether the learning and test phases occurred on land or underwater. Participants were 18 members of a scuba diving club. Each participant was presented with a list of 36 words (e.g., defend, hammer, trouble) that was presented in blocks of three words at a time. A two-second interval occurred between each word, and a four-second interval between each word block. The word list was presented to each participant two times. Importantly, the word lists were presented to participants either underwater or on dry land. After the list was presented twice, there was a delay period. Following the delay period, participants were asked to write out as many words as they could remember. The researchers found that word lists learned underwater were better recalled underwater, and vice versa. Various other studies have found support for these findings (Rooy, Pipe, & Murray, 2007; Vollmar, Noachtar, & Hanslmayr, 2015), suggesting that context reinstatement has a positive effect on one's ability to recall information.

In a more applied forensic context, Hershkowitz et al. (1998) looked at whether context cues elicited by being at the scene of an alleged sexual abuse could increase the amount of information a victim recalled. Fifty-one children aged four to thirteen years old participated in the study. Participants all reported being victims of sexual abuse. Each participant was interviewed at the researcher's office and then at the location in which the alleged abuse occurred. It was found that visiting the location at which the alleged abuse occurred resulted in the victims recalling additional information related to the sexual abuse (however, the researchers

did not specify whether this information was accurate). This suggests that reinstatement of the context of a prior event may make it easier for individuals to recall additional information related to that event. This information could be useful within the forensic context, such that providing context cues may help victims/witnesses better remember the details of a crime. However, because the researchers did not mention whether the information that was recalled was accurate, context reinstatement may simply lead individuals to recall *more* information.

Orbach, Hershkowitz, Lamb, Sternberg, and Horowitz (2000) later conducted a similar study to examine the influence of context reinstatement on the recall memory of sexual abuse victims. Participants were interviewed in the location at which their alleged sexual abuse occurred. Unlike the findings from Hershkowitz et al. (1998), there was found to be no significant differences in the number of details reported by those interviewed in the researcher's office compared to those interviewed at the location of the abuse. That is, context reinstatement did not appear to enhance the victim's memory of their sexual abuse. However, Orbach et al. (2000) suggested that contextual cues might not have enhanced information retrieval because the environments in which the abuse occurred (e.g., a shopping mall) could have changed in important ways following the abuse (e.g., new stores could have opened, or renovations could have been done). Orbach et al. (2000) suggested that the increased information retrieval found to occur in Hershkowitz et al. (1998) could be due to the fact that participants were first interviewed in an office and then at the scene of the abuse. Thus, the increased information retrieval could have been due to being interviewed twice, rather than due to contextual cues. These findings suggest that under certain circumstances, contextual cues may increase the number of details recalled and under other conditions have no influence.

In another study examining the influence of context reinstatement on recall memory, Smith, Handy, Angello, and Manzano (2014) presented participants with thirty words on a screen, with a video playing in the background. The videos were five-second clips of everyday scenes, such as a park, or cars driving on a highway. After the video, participants were shown another video (that did not contain the thirty words) of the same context, a similar context, or a different context as the encoding task. Further, in the same context condition, participants were shown the same video that they had watched during the encoding task. In the similar context condition, participants were shown a video that was similar to the context of the video from the encoding task. That is, a fifteen-second video was created of which the first five seconds were used for the video in the encoding task and the last five seconds were used for the similar context. In the different context condition, participants viewed a completely different video than they had viewed during the encoding task. Participants were then asked to recall words that were presented during the original video. It was found that when presented with the same context video, participants recalled significantly more words than when shown either the similar or the different context video. Thus, in the current study it was predicted that participants who received context reinstatement (i.e., those who experienced a match in scent in both sessions) would recall more details of the perpetrator than participants who did not receive context reinstatement.

Overall, previous research supports the idea that context plays an important role in recall memory, such that having the same context during learning and test improves one's ability to recall certain information. However, under certain circumstances, context reinstatement may simply increase the amount of details recalled rather than increase the amount of *accurate* details recalled.

Context reinstatement and identification accuracy. Context reinstatement may also enhance one's ability to "recognize" information, and even to recognize a previously seen face. Importantly, facial recognition may be impacted by context reinstatement more so than other types of recognition (Dalton, 1993). This is because a face is oftentimes a more novel stimulus than other experimental stimuli, such as words (Dalton, 1993). Further, when tested with more familiar stimuli (e.g., words), previously established mental representations may act as cues, rather than the environmental cues that were introduced during the experiment. Thus, when tested with novel stimuli, environmental cues are more likely to be impactful (Dalton, 1993). Therefore, it is likely that context reinstatement would have a strong effect on the recognition of a novel face, such as the target used in the current study.

In an early study, Baddeley and Woodhead (1982) were interested in examining whether facial recognition could be enhanced through the use of context cues (Experiment 3). Stimuli consisted of 48 photographs of male faces. Twenty-four of these photographs were chosen as targets, and the other 24 photographs acted as distractors. During the learning phase, participants (N = 86) were asked to look through a booklet that contained the photographs of the 24 targets. Underneath each photograph of the target was a written context (e.g., "barman in village pub"). During the testing phase, participants were shown photographs of the 24 targets and 24 distractors. Of the 24 targets, six displayed the same contextual information, six displayed new contextual information, six displayed old contextual information that had been mismatched from the learning phase, and six contained the words "no information". In regard to the 24 distractors, 12 contained contextual information from the learning phase (but not used anywhere else in the testing phase), six contained new contextual information, and six contained the words "no information". Participants were asked to indicate whether they had seen each face before. It was

found that familiar context (i.e., contextual information that had also been shown during the learning phase) increased the likelihood that a participant would indicate they had seen a face previously, regardless of whether they actually had. Various other studies have found similar results (e.g., Dalton, 1993; Russo, Ward, Geurts, & Scheres, 1999). Thus, in the current study it was predicted that compared to those in the mismatched context condition, participants in the matched context conditions would be more accurate in their identifications when the target was presented in the lineup, but more likely to identify an innocent person when the target was absent from the lineup.

Similar to the current study, Cann and Ross (1989) were interested in examining whether olfactory stimuli could be used as a type of context cue to improve facial recognition. In this study, participants ($N = 63$) viewed 50 faces and were asked to rate the attractiveness of each face. This task was completed in a room containing either a pleasant or unpleasant scent. Two days later, participants viewed 100 faces (50 old, 50 new) and were asked to indicate for each face, whether they recognized the face from the previous session. Participants completed the second session in a room containing either the same or different scent as they were exposed to during the first session. It was found that participants recognized significantly more faces when the same scent was presented in the first and second session. Interestingly, there was found to be a high false alarm rate when a different scent was present in the second session. The researchers suggest that this may have occurred because the presence of any scent may lead to increased activation. This increased activation resulted in higher hit rates *and* false alarm rates, and thus, decreased discriminability. Given these results, it is predicted that the reinstatement of scent in the current study will increase both hit rates in target-present lineups and false alarm rates in target-absent lineups.

In a more recent study, Hanczakowski, Zawadzka, and Macken (2015) examined the effect of context reinstatement on facial recognition. In Experiment 1, participants (N = 46) were shown 48 face-contextual photograph pairs (i.e., a face shown to the right of a contextual photograph, such as an image of a beach) for 5 seconds each and were asked to memorize the images. During the test phase, participants were shown two faces (a target and a foil face) on either side of the contextual photograph. Importantly, there were three within-participant conditions that included: a reinstated condition, a re-paired condition, and a novel condition. In the reinstated condition, the same face and contextual photographs were shown in each phase. In the re-paired condition, a different face was presented with the same contextual photographs during the test phase. Finally, in the novel condition, new contextual photographs were shown during the test phase. Results indicated greater facial recognition accuracy in the reinstated condition (.72) compared to the re-paired condition (.62), further supporting that context reinstatement may influence facial recognition. Given these results, it was predicted that in the current study, context reinstatement would enhance participants' ability to identify the perpetrator from a lineup.

Finally, in a meta-analysis examining facial identification studies, Shapiro and Penrod (1986) examined which variables had the greatest influence on identification accuracy. The meta-analysis included 190 studies with 19 variables being examined on hit rates (i.e., correct identification) and false alarm rates (i.e., incorrect identification). One of these variables was context reinstatement. Out of all the variables, it was found that context reinstatement resulted in the largest effect for hit rates (d = 1.91). As well, context reinstatement resulted in a negative effect for false alarms (d = -0.44), which means that false alarm rates were higher for those who

received context reinstatement than those who did *not* receive context reinstatement. These results suggest that context reinstatement can influence facial identification accuracy.

The influence that context reinstatement has been shown to have on facial identification has important implications in an eyewitness context. Moreover, it has been found that eyewitness identification accuracy can be altered by contextual changes from encoding to retrieval, such as the presentation of a lineup in a different location than where the crime was witnessed (Thomson, 1981). If features of one's environment are similar across where the crime was witnessed and then where the identification is requested, the eyewitness may be more accurate in making an identification of the perpetrator than if the contexts differed.

Krafka and Penrod (1985) tested this idea by examining the influence of context reinstatement on eyewitness identification in a real-world setting. Participants consisted of 85 cashiers who were employed by liquor stores, convenience stores, and small grocery stores. A confederate would enter the store acting as a customer. The confederate would bring a soda can to the checkout and would ask the cashier whether they could purchase the soda with a ten-dollar traveller's cheque. The confederate would then provide two forms of identification, as well as his written signature on the cheque. Next, the confederate would draw attention to his appearance by commenting on how different he now looks from his photograph on his identification. Within the next 24 hours, a second confederate (SC) entered the store and described himself as a law intern. The SC asked if the cashier could identify a man who had been in the store in the last 24 hours. The SC also told the cashier that the man would have bought something small and paid for it using a ten-dollar traveller's cheque. The SC then told the cashier that he did not know what the man looked like but asked whether he/she could identify the man from a photographic lineup. Half of the lineups were target-present, and the other half were target-absent. Prior to viewing

the lineup, half of the participants were exposed to context reinstatement by being asked to think about exactly what happened when the man was in the store, and to try to think about what the man's face looked like. Additionally, physical cues (i.e., a photocopy of the confederate's non-photo identification and a traveller's cheque similar to what the confederate would have used) were used to reinstate context. It was found that those in the context reinstatement condition were significantly more accurate in their identifications when viewing a target-present lineup. When shown a target-absent lineup, however, context reinstatement had no influence on identification accuracy. These findings suggest that participants experienced an effective match in ensemble information (i.e., information that is formed by combining item and context information) at learning and test (Murnane, Phelps, & Malmberg, 1999), as hit rates were influenced by contextual changes. Various other studies have found similar findings (Davies & Milne, 1985; Searcy, Bartlett, Memon, & Swanson, 2001; Maras & Bowler, 2012; Smith, Leach, Cutler, 2013), suggesting that context reinstatement is influential in an eyewitness context.

Relatedly, Cutler, Penrod, and Martens (1987) looked at how context reinstatement might influence eyewitness identification accuracy. During the encoding phase of the study, participants ($N = 290$) watched a video of a staged liquor store robbery. After watching the video, participants were asked to write down the details of the crime and the physical description of the robber. Participants then returned either 2 days, or two weeks later for the retrieval phase. During the retrieval phase (i.e., viewing a photographic lineup), participants were randomly assigned to either receiving context reinstatement (CR) or not. Those in the CR condition were exposed to various forms of CR that included: mnemonic instructions, original description review, and snapshot display. The mnemonic instructions consisted of having the participant mentally reinstate the context of the crime, report all of the details of the crime, recall the crime

from different perspectives, and recall the events of the crime in different orders. The original description review consisted of having participants read the descriptions they provided immediately after watching the video. Finally, the snapshot display consisted of having participants view photographs of the inside of the liquor store and of the cashier at the counter. Context reinstatement was found to improve identification accuracy for participants who completed the study after a two-week delay, but did not influence the identification accuracy of participants who completed the study after a two-day delay. This may have occurred because making an identification after a two-week delay is more difficult than making an identification after a two-day delay. Thus, context cues provided in the two-week delay would be more useful when retrieving information. Given these results, it was expected that in the current study, context cues (i.e., scent) would influence eyewitness identification accuracy following the one-week delay.

Despite various findings that have demonstrated the influence of context reinstatement on eyewitness identification, context reinstatement may sometimes have a negative effect on identification accuracy. Wong and Read (2011) studied both the positive and negative effects of context reinstatement on eyewitness identification. They asked 160 participants to watch a video showing a staged theft. One week later, participants returned and were tested in either the same or a different room as when they watched the video during the first session. During testing, each participant viewed either a target-present or target-absent simultaneous lineup (i.e., all lineup members were shown to the witness at once). First, participants were asked if any of the individuals in the photographs were familiar to them. Then they were reminded of the video that they watched in the first session and were asked to try to identify the perpetrator in the lineup. It was found that compared to participants tested in a different room, those who were tested in the

same room were most likely to state that there was a familiar face in the lineup. Interestingly, this occurred for both target-present and target-absent lineups. In terms of identification accuracy, those tested in the same room were significantly more accurate in their identification when the target was present. However, context reinstatement did not influence participants' rejection rates (i.e., stating that the perpetrator is not present) when viewing a target-absent lineup. Additionally, participants in the same context condition were 1.4 times more likely to choose a person from the target-absent lineup than those in the different context condition. This suggests that context reinstatement may be beneficial for identification accuracy when viewing a target-present lineup, but detrimental when viewing a target-absent lineup.

Sanders (1984) suggests that context cues might increase the probability of positively identifying innocent targets by increasing eyewitness confidence, which could lead to mistaken identifications. Further, context reinstatement has been found to enhance participants' judgments of familiarity about individuals shown in a lineup, regardless of their identification accuracy (Sanders, 1984). Various other studies have found similar results (Wong & Read, 2011; Hanczakowski et al., 2014). Given these results, it was predicted that in the current study, participants in the matched context conditions would make fewer correct rejections (i.e., lower accuracy) with a target-absent lineup than those in the mismatched context condition.

Although context reinstatement may have a negative effect on identification under certain circumstances, these findings support that context reinstatement can influence one's ability to identify faces. This makes context reinstatement an important factor to consider in terms of an eyewitness context. Further, context reinstatement can either hinder or enhance one's ability to recognize faces, which may affect one's identification accuracy on a lineup task. Ultimately, having a better understanding of context reinstatement in an eyewitness context could help to

better understand the veracity of an eyewitness identification, thus, helping to reduce wrongful convictions.

ICE theory. Murnane, Phelps, and Malmberg (1999) proposed the Item, Associated Context, and Ensemble (ICE) theory as a way to explain inconsistencies in the findings on context-dependant recognition. ICE theory divides recognition into three categories of information: item, associated context, and ensemble. Item information refers to information that is the focus of a task being performed, associated context refers to environmental information that is not the focus of a task being performed, and ensemble information refers to information that is created by combining item and context information. ICE theory posits that when there is a match in associated context at learning and test, context effects will exist for hit rates and false alarm rates, but not discriminability (i.e., the ability to discriminate between target and distractor items). If, however, there is a match in associated context and ensemble information at learning and test, context effects will exist for hit rates, false alarm rates, and discriminability. Rather than testing ICE theory in the current study, ICE theory was used to inform hypotheses and results.

Target-Present Versus Target-Absent Lineups

Eyewitness research has also found that lineup content (e.g., whether the perpetrator is present in the lineup) can lead to misidentifications (Wells & Olson, 2003). When an eyewitness is asked to view a lineup, they are shown a set of photographs that contain the suspect along with a set of foils. Foils are photographs of individuals who are known by police to be innocent (Fitzgerald, Price, Oriet, & Charman, 2013). Foils are chosen by being matched to the physical appearance of the suspect or by being matched to the eyewitness description of the suspect, or a combination of these two strategies (Wogalter, Malpass, & McQuiston, 2004). Foils are included in the lineup to minimize the misidentification of an innocent suspect as they are already known

to be innocent to police (Wogalter et al., 2004). Further, foils help to reduce misidentifications because identification decisions are spread out from the suspect. When viewing a lineup in a research study, eyewitnesses are shown either a target-present or target-absent lineup. A target-present lineup contains a photograph of a guilty suspect along with foils, and a target-absent lineup contains a photograph of an innocent suspect along with foils (Wells & Olson, 2003). These two types of lineups are used to understand influences on correct identification (i.e., accuracy with a target-present lineup) and correct rejection (i.e., accuracy with a target-absent lineup).

In a target-present lineup, the only three possible outcomes are to make a correct identification (i.e., identifying the guilty suspect), to make a foil identification (i.e., identifying an innocent foil), or to make an incorrect rejection (i.e., making no identification when the guilty suspect is present; Wells, 1993). When shown a target-present lineup, the only correct response is to identify the guilty suspect.

Similar to a target-present lineup, there are three possible decisions that can be made in a target-absent lineup. In a target-absent lineup, eyewitnesses may make a false identification (i.e., identifying the innocent suspect), a foil identification (i.e., identifying a foil), or a correct rejection (i.e., making no identification when the guilty suspect is absent; Wells, 1993). When shown a target-absent lineup, the only correct response is for the eyewitness to reject the lineup (i.e., make no identification). In the real world, a target-present lineup would be shown when police have apprehended the perpetrator of the crime and included him/her in the lineup. A target-absent lineup, however, would be shown when police erroneously apprehend an innocent person. The current study included both a target-present lineup as well as a target-absent lineup to assess identification accuracy in terms of correct identifications and correct rejections.

Lineup Procedure. The simultaneous lineup whereby witnesses are shown all the lineup members at the same time is one of the most commonly used lineup procedures in the world, such that 44.2% of lineups used in the criminal justice system are simultaneous lineups (Beaudry & Lindsay, 2006; Wells, 1993). Hence, the current study used a simultaneous lineup to obtain identification decisions. Although it should be noted that in Ontario and Canada more broadly, there is a tendency to present lineups in a sequential manner (i.e., one at a time whereby the witness is required to make a decision per face before the next face is shown; Lindsay & Wells, 1985).

Eyewitness Confidence

Eyewitness confidence (i.e., the reported certainty in one's ability to remember the details of a crime or make a decision on a lineup task) is another factor known to influence identification accuracy (Brewer & Wells, 2006). In response to an open-ended question asking how confident an eyewitness is in their lineup decision, confidence is typically rated on a scale from 0 (not very confident) to 100 (very confident). In one study, Lindsay et al. (2013) assessed eyewitness confidence on a scale from 0 to 100 and found support for the confidence-accuracy relationship, such that higher confidence ratings were associated with more accurate decisions.

Importantly, many courts have deemed eyewitness confidence as one of the main criterions that can be used to assess eyewitness accuracy (e.g., *Neil v. Biggers*, 1972). Studies have found a strong association between eyewitness confidence and eyewitness accuracy, such that eyewitnesses who report greater confidence in their identification are often found to be more accurate in that identification (Wixted & Wells, 2017). This means that the identification made by a highly confident eyewitness may be more heavily relied upon as evidence than the identification made by a less confident eyewitness. However, it is imperative to note that some

studies have found that eyewitness confidence is a weak predictor of identification accuracy (e.g., Brewer & Wells, 2011; Penrod & Cutler, 1995). This association is commonly referred to as the confidence-accuracy relationship. Interestingly, the confidence-accuracy relationship has been shown to differ depending on whether the eyewitness is a "chooser" (i.e., those who make a selection from the lineup) or a "non-chooser" (i.e., those who reject the lineup), such that there is often a greater confidence-accuracy relationship for choosers than for non-choosers (Brewer & Wells, 2006; Sauer et al., 2010). For example, one study found a confidence-accuracy relationship of 0.58 for choosers and a confidence-accuracy relationship of 0.08 for non-choosers (Sporer, 1992).

In early research, Sporer et al. (1995) conducted a meta-analysis to examine the correlation between eyewitness confidence and identification accuracy. The meta-analysis included 30 studies that examined the confidence-accuracy relationship with both target-present and target-absent lineups. Overall, there was found to be a moderate correlation for the confidence-accuracy relationship (r = .29). However, when the researchers examined choice (i.e., choosing a person from the lineup or not) as a moderator, there were differences in the confidence-accuracy relationship of choosers (i.e., those who identify someone from the lineup) compared to that of non-choosers (i.e., those who do not identify someone from the lineup). Further, it was found that the confidence-accuracy correlation of choosers (r = .41) was significantly higher than non-choosers (r = .12).

In a more recent study, Palmer, Brewer, Weber, and Nagesh (2013) were interested in examining the potential moderators of the confidence-accuracy relationship. In study 1, participants were exposed to a researcher acting as a target. The researchers manipulated the amount of time that the participant viewed the target (i.e., 5 seconds versus 90 seconds) and the

retention interval (i.e., participants viewed a lineup immediately or one week later). Participants were randomly assigned to view either a target-present or target-absent lineup. After making a decision on the lineup task, participants were asked to rate their confidence in their decision on a scale from 0 (not very confident) to 100 (very confident). It was found that for choosers, identification accuracy increased with participant confidence, supporting the confidence-accuracy relationship. However, there was found to be little evidence for the confidence-accuracy relationship for non-choosers. Thus, the confidence-accuracy relationship may only exist under certain circumstances, such as when an eyewitness makes an identification from a lineup. In the current study, participants rated their level of confidence following their identification decision, to examine the confidence-accuracy relationship. In the current study, it was predicted that the greater confidence a participant had in their decision, the more accurate that decision would be. Additionally, it was predicted that this confidence-accuracy relationship would be stronger for choosers than non-choosers.

Overview of Study

The present study examined the influence of olfaction (i.e., scent) used as a form of context reinstatement on eyewitness memory; both recall and identification. Participants were exposed to either a scented room or a “scent free” room for the encoding phase of the study. One week later, participants returned for the testing phase in either a scented room or a “scent free” room. Recall and identification were examined as a function of context reinstatement for scent.

Hypotheses

Below are the main hypotheses of the current study:

1. Participants assigned to the matched scent condition (i.e., those who received the scent in session 1 and 2) will have a higher correct identification rate when viewing a target-present lineup and a lower correct rejection rate when viewing a target-absent lineup, compared to those in the matched no scent condition (i.e., those who did not receive the scent in session 1 and 2) and those in the mismatched condition (i.e., those who received the scent in only session 1 or session 2).
2. Participants assigned to the matched scent condition will have the greatest increase in the recall of perpetrator descriptors and will have the greatest increase in the recall of accurate perpetrator descriptors, followed by those in the matched no scent condition, and then those in the mismatched condition.
3. Participants in the matched scent condition will be the most confident in their identification decision regardless of choosing and accuracy, followed by those in the matched no scent condition, and then those in the mismatched condition.
4. The greater confidence that a participant has in their decision on the lineup task, the more accurate that decision will be.
5. Participants who make an identification (i.e., choosers) will have a greater confidence-accuracy relationship than participants who do not make an identification (i.e., non-choosers).

Method

Participants

Undergraduate students (*N* = 184) enrolled in a psychology course at Carleton University were recruited via an online participation pool (i.e., SONA system). Two-hundred and fifty-three people initially participated in the study; however, 25 participants were excluded because they did not pass the scent questionnaire and two participants were excluded because they personally knew one of the lineup members. Additionally, 42 participants did not return for session 2. Thus, analyses were based on 184 participants. Participant ages ranged from 16 to 52 years (M_{age} = 19.32, *SD* = 3.40) and most participants were women (79.7%). Additionally, most participants identified as being Caucasian (53.7%), whereas 10.6% identified as Black, 10.2% East Asian, 8.5% West Asian, 7.3% mixed race, 5.3% South Asian, 2.0% Southeast Asian, 1.6% Latin American, and 0.4% Aboriginal. Each participant gave consent to participate in the study, and demographic information from each participant was obtained (Appendix D). The current study consisted of two-parts lasting 30 minutes per session. The second session took place after a seven-day delay following the first session. Participants received 1% bonus course credit (0.5% per session) for taking part in the study.

Design

The current study used a 2 (lineup type: target-present vs. target-absent) x 2 (scent during encoding task: no scent present vs. scent present) x 2 (scent during retrieval task: no scent present vs. scent present) between-participants factorial design. The dependent variables were eyewitness identification accuracy (i.e., correct identification in target-present lineups, and correct rejection in target-absent lineups) and eyewitness confidence rating. The change from

session 1 to 2 in the total number of details recalled for the perpetrator and the change from session 1 to 2 in the proportion accurate of those details were also examined.

Materials

Deceptive informed consent form. Prior to participating in the study, students were asked to complete a mildly deceptive consent form (Appendix A). The consent form explained that participation would require watching a video and answering questions about the video.

Scent. Participants were randomly assigned to receive the scent or no scent in each session. Participants in the *matched scent* condition received the scent in both sessions, participants in the *matched no scent* condition did not receive the scent in either session, and participants in the *mismatched* condition only received the scent in either the first session or the second session. Importantly, the mismatched condition was counterbalanced. The scent used was a mild, pleasant smell (i.e., vanilla) that was released from a plug-in air freshener. All participants were told that scent might be present during their participation.

Pilot testing of scent. To ensure that the scent was pleasant, volunteers ($N = 40$) were asked to rate one of four scents (i.e., vanilla, floral, citrus, and cinnamon) (Appendix B). Ratings were made on a Likert scale that ranged from 1 (*pleasant*) to 7 (*unpleasant*). There were no differences in pleasantness ratings of vanilla ($M = 2.20$, $SD = 1.03$), floral ($M = 2.60$, $SD = 1.17$), citrus ($M = 1.60$, $SD = 0.70$), and cinnamon ($M = 2.10$, $SD = 1.29$), $F(3, 36) = 1.48$, $p = .24$. Volunteers also were asked to identify the scent, of which 70% correctly identified vanilla, 60% correctly identified floral, 0% correctly identified citrus, and 6% correctly identified cinnamon. Thus, vanilla was chosen as the scent for the present study, as it was the most identifiable and was rated as being highly pleasant.

Crime video. Each participant was shown a silent video that was approximately one minute in length. The video depicted a staged, non-violent theft that occurred on campus. Further, the video showed a confederate male sitting on a couch. The lens focused on the man for about four seconds, and then zoomed in closer to the man's face for approximately ten seconds. The lens then zoomed back out and showed the man looking suspiciously at a laptop that was left unattended on the table beside him. The man then gets up from the couch, takes the laptop, and leaves the scene.

Secondary informed consent form. After viewing the video, participants were asked to complete the secondary informed consent form (Appendix C). The purpose of the secondary informed consent form was to inform participants of the true purpose of the study, to explain the nature of the participant's involvement for the remainder of the study (i.e., completing various forms and the lineup task), and to explain why mild deception was necessary.

Demographics form. After completing the secondary informed consent form, participants completed a demographics form in which they provided information regarding their age, gender, and ethnicity (Appendix D). Participants had the option of refusing to provide any demographic information.

Free recall form. After completing the demographics form in the first session and before completing the lineup task in the second session, participants completed the free recall form, which asked them to describe the details they remembered about the perpetrator of the crime (Appendix E).

Scent questionnaire. After completing the free recall form in the first session and after completing the lineup task in the second session, participants completed the scent questionnaire (Appendix F). This form was to ensure that those in the "no scent" condition did not detect the

scent (i.e., vanilla), and that those in the "scent" condition detected the vanilla scent throughout the study.

Third informed consent form. Upon returning for the second session, participants completed the third informed consent form (Appendix G). This form outlined the task requirements for the second session.

Photographic lineups. Six 4 x 6-inch photographs taken of volunteers resembling the target were used in the lineup task. Five of these photos were used as the foil replacement in all of the lineups, while the sixth photograph was used as the "target-replacement" in the target-absent lineup. In the target-present lineup, a 4 x 6-inch photograph of the target was used. An additional card labelled "not here" was included as a rejection option. All the photographs were coloured head and upper body photographs against a white background. Each photographed person displayed a neutral facial expression.

The lineup used in the current study was tested for lineup bias according to the guidelines proposed by Malpass (2015). This test examined whether the suspect stood out compared to the lineup foils (Malpass, 2015). Further, the test gives the proportion of mock witnesses who selected the suspect and the proportion of mock witnesses who are predicted to select the suspect by chance. The test indicates that the lineup may be biased if the critical ratio exceeds 1.96 (α = .05). For the current study, the critical ratio was 0.35, suggesting that the lineup used in the current study was unbiased.

Simultaneous lineup response form. The photographs were simultaneously presented in two rows during the lineup tasks. Each row contained three photographs. The "not here" card was placed below the two rows of photos. The location of the target or replacement photograph in the lineup was randomly determined. Participants were provided with the following

instructions before viewing the lineup: "*Think back to the video. Think back to what the criminal looks like. I am going to show you some pictures. Please look at the pictures. The criminal's picture may or may not be here. If you see the criminal's picture, please place a check mark in the box that corresponds with the criminal's lineup number. If you do not see the criminal, please place a check mark in the box labeled 'not here'. Now let's look at the pictures*" (Appendix H).

Study checks form. Following completion of the lineup task and completion of the scent questionnaire, participants completed the study checks form (Appendix I). Participants were asked various questions to ensure that they were not aware of the true nature of the study before participating and that they did not know any of the lineup members.

Debriefing form. Upon completion of the study, participants were debriefed (Appendix J). The debriefing form outlined the purpose of the study, the research questions and hypotheses, as well as the researcher's contact information.

Procedure

Participants were recruited online from Carleton University via SONA system. When signing up for the study, participants were instructed to sign-up for two sessions that were seven-days apart.

Session one. Upon entering the laboratory, participants were given a deceptive informed consent form (Appendix A), such that they were unaware that they would be acting as an eyewitness to a staged theft. Participants who provided consent were then led to a room containing a mild, pleasant scent (i.e., vanilla) or no scent. Participants then watched the crime video. After viewing the video, participants were given the secondary informed consent form

(Appendix C), which explained the true nature of the study (i.e., that they would be acting as an eyewitness). Once participants completed the secondary informed consent form, they were asked to complete a demographics form (Appendix D). Then, participants completed the free recall form (Appendix E). As a manipulation check, participants were then asked if they noticed any scent in the room and if so, to state what it was (Appendix F). After completing all forms, participants were thanked for their participation and were reminded to return for their second session exactly one week later.

Session two. Upon returning for the second session one week later, participants were asked to complete the third informed consent form (Appendix G), which explained that they would be asked follow-up questions from session one. After completing the third informed consent form, participants were again led to a room containing either a mild, pleasant scent (i.e., vanilla) or no scent. Each participant was then asked to complete the free recall form (Appendix E). Then, participants were presented with either a target-present (i.e., containing a guilty suspect) or target-absent (i.e., containing an innocent suspect) photographic simultaneous lineup task (Appendix H). Once the participant made their decision, they were asked to rate their confidence in their decision. Then, participants were asked to complete the "scent questionnaire" (Appendix F), followed by the study checks form (Appendix I). Finally, participants were asked to read the debriefing form (Appendix J) and were thanked for their participation.

Importantly, the conditions were blocked, such that only one condition was completed on each day. This was done so that participants were not exposed to scents from other conditions.

Results

Identification Data

Identification accuracy (Hypothesis 1). It was hypothesized that those in the matched scent condition would have a higher correct identification rate when viewing a target-present lineup and a lower correct rejection rate when viewing a target-absent lineup, compared to those in either the matched no scent condition or the mismatched condition. A hierarchical binary logistic regression was conducted to examine whether the presence of context reinstatement, target presence, and the product term representing the two-way interaction predicted overall identification accuracy (correct identifications and correct rejections [correct] = 1; false identifications, foil identifications, and false rejections [incorrect] = 0). Block 1 included both main effects (i.e., context reinstatement and target presence). Block 2 included both main effects and the interaction term.

There was no main effect of context reinstatement, Wald's $\chi^2(2) = 1.87$, $p = .39$, and no main effect of target presence, $b = .40$, $SE = 0.30$, Wald's $\chi^2(1) = 1.78$, $p = .18$, $e^b = 1.49$ (95% CI [0.83, 2.68]). The interaction between context reinstatement and target presence also was non-significant, Wald's $\chi^2(2) = 0.14$, $p = .93$. These results suggest that context reinstatement and target presence did not impact eyewitnesses' lineup identification accuracy. Table 1 displays the decision rates made by participants in each condition.

Table 1.

Proportion of Identification Decisions (N = 184) Based on Target Presence and Context Reinstatement Condition

Target Presence	Decision Type	Context Reinstatement Condition		
		Matched Scent	Matched No Scent	Mismatched
Target-Present	Correct ID	.61 (*n* = 19)	.61 (*n* = 19)	.53 (*n* = 16)
	False Rejection	.26 (*n* = 8)	.23 (*n* = 7)	.27 (*n* = 8)
	Foil ID	.13 (*n* = 4)	.16 (*n* = 5)	.20 (*n* = 6)
Target-Absent	Correct Rejection	.52 (*n* = 16)	.55 (*n* = 17)	.40 (*n* = 12)
	False ID	.06 (*n* = 2)	.03 (*n* = 1)	.07 (*n* = 2)
	Foil ID	.42 (*n* = 13)	.42 (*n* = 13)	.53 (*n* = 16)

Note. ID = Identification

Recall Data

Data coding. A coding manual was created by having two independent raters view the video and then create a list of accurate perpetrator descriptors. Recall accuracy was based on participants' responses to a statement asking them to write what they remembered about the perpetrator from the video. Age, weight, and height descriptors were considered correct if responses were within a pre-determined range (i.e., age = +/- 3 years, weight = +/- 10 lbs., height = +/- 2 inches). To assess inter-rater reliability, 20 randomly selected responses were coded by the primary researcher and then coded a second time by a trained volunteer. Discrepancies between the coders were discussed and then the coders decided how to code those descriptors. Intraclass correlation coefficients (ICC) were then calculated for the total number of descriptors and the total number of correct descriptors. Any final discrepancies were then discussed until ICC values were within the acceptable range (i.e., 0.8 to 1.00; Pozzulo & Warren, 2003). Table 2 displays the final ICC values.

Table 2.

Interrater Reliability of Recall Coding as Shown by the Intraclass Correlation Coefficient (ICC)

	ICC Value (Absolute Agreement)	95% Confidence Interval
Total Number of Descriptors	1.00	(0.98-1.00)
Number of Correct Descriptors	1.00	(0.99-1.00)

Recall accuracy (Hypothesis 2). Two separate ANOVAs were conducted to examine whether the presence of context reinstatement influenced the change in total descriptors and the change in proportion of correct descriptors recalled (Hypothesis 2). The total number of descriptors recalled in session one and session two, and the total number of correct descriptors recalled in session one and session two were coded for each participant. Thus, a score for the change in total descriptors from session one to session two and a score for the change in proportion of correct descriptors from session one to session two were calculated for each participant. There were 60 participants in each context condition (30 target-present, 30 target-absent), however, only the first 30 participants from each context condition were coded. The primary researcher coded all responses.

Context reinstatement did not influence the change in the total number of descriptors recalled, $F(2,87) = 1.59$, $p = .21$, suggesting the context reinstatement did not enhance one's ability to recall descriptors. Additionally, context reinstatement did not influence the change in the proportion of correct descriptors recalled, $F(2,87) = 0.27$, $p = .77$, suggesting the context reinstatement did not enhance participants' accuracy when recalling descriptors. Table 3 displays means and standard deviations for the change in total descriptors and change in proportion of correct descriptors based on the context reinstatement condition. Table 4 displays the average number of descriptors recalled and the number of accurate descriptors recalled in each condition at session 1 and 2.

Table 3.

Means and Standard Deviations (N = 90) of the Change in Total Descriptors and the Change in Proportion Correct Descriptors Based on each Context Reinstatement Condition

	Δ Total Descriptors		Δ Proportion Correct	
	M	*SD*	*M*	*SD*
Matched Scent	-1.37	0.26	-0.02	0.11
Matched No Scent	-0.77	0.39	0.00	0.13
Mismatched	-0.53	0.36	-0.01	0.13

Note. Δ = session 2 – session 1

Table 4.

Means and Standard Deviations (N = 90) of the Total Number of Descriptors and the Proportion of Correct Descriptors Recalled in Sessions 1 and 2 Based on each Context Reinstatement Condition

	Average Total Descriptors (SD)		Average Proportion Correct (SD)	
	Session 1	Session 2	Session 1	Session 2
Matched Scent	8.57 (2.21)	7.20 (2.25)	0.91 (0.10)	0.86 (0.11)
Matched No Scent	8.30 (2.32)	7.53 (2.61)	0.88 (0.13)	0.89 (0.15)
Mismatched	7.47 (2.70)	6.93 (2.65)	0.89 (0.13)	0.89 (0.12)

Recall as a predictor of identification accuracy. As it was predicted that context reinstatement would influence lineup identification accuracy, exploratory analyses were conducted to examine whether recall was predictive of identification accuracy. A binary logistic regression was conducted to examine whether the total number of correct descriptors recalled in session two was predictive of identification accuracy. There was no main effect of total number of descriptors recalled, $b = .09$, $SE = .09$, Wald's $\chi^2(1) = 1.03$, $p = .31$, $e^b = 1.09$ (95% CI [0.92, 1.30]), suggesting that number of descriptors recalled was not predictive of identification accuracy on the lineup task.

A second binary logistic regression was conducted to examine whether the proportion of accurate descriptors recalled in session two was predictive of identification accuracy. There was again no main effect of recall accuracy, $b = .10$, $SE = .09$, Wald's $\chi^2(1) = 1.30$, $p = .26$, $e^b = 1.11$ (95% CI [0.93, 1.32]), suggesting that the proportion of accurate descriptors recalled was not predictive of identification accuracy on the lineup task.

Confidence

Context reinstatement and confidence (Hypothesis 3). It was predicted that those in the matched scent condition would be the most confident in their lineup decision, followed by those in the matched no scent condition, and then those in the mismatched condition. A one-way analysis of variance (ANOVA) was conducted to examine whether context reinstatement influenced eyewitness confidence, regardless of choosing and accuracy. Context reinstatement was not found to be a significant predictor of confidence, $F(2, 181) = 0.70$, $p = .50$. That is, context reinstatement did not increase participants' reported confidence in their lineup decision.

Confidence-accuracy relationship (Hypothesis 4). It was predicted that the greater confidence a participant had in their lineup decision, the more accurate that decision would be. A binary logistic regression was conducted to examine whether confidence predicted overall identification accuracy (correct identifications and correct rejections [correct] = 1; false identifications, foil identifications, and false rejections [incorrect] = 0). Confidence was found to significantly predict accuracy, such that for each one unit increase in confidence, the estimated odds of making an accurate decision increased 1.03 times, $b = .03$, $SE = 0.01$, Wald's $\chi^2(1) = 10.14$, $p = .001$, $e^b = 1.03$ (95% CI [1.01, 1.06]). This finding supports the confidence-accuracy relationship.

Choosers versus non-choosers (Hypothesis 5). It was also predicted that choosers (i.e., those who made an identification) would have a greater confidence-accuracy relationship than non-choosers (i.e., those who did not make an identification). It is interesting to analyze data according to choosers and non-choosers because there are known differences in the confidence-accuracy relationship depending on whether the witness selects an individual from the lineup (Brewer & Wells, 2006; Sauer et al., 2010). Thus, two separate binary logistic regression analyses were conducted to examine whether the confidence-accuracy relationship differed between choosers and non-choosers. For choosers ($N = 116$), the confidence-accuracy relationship was significant, such that for each one unit increase in confidence, the estimated odds of the witness making an accurate decision increased 1.04 times, $b = .04$, $SE = 0.01$, Wald's $\chi^2(1) = 11.13$, $p = .001$, $e^b = 1.04$ (95% CI [1.02, 1.07]). For non-choosers ($N = 68$), the confidence-accuracy relationship was non significant, Wald's $\chi^2(1) = 0.02$, $p = .90$.

Discussion

The purpose of the current study was to examine the influence of olfactory stimuli used as a form of context reinstatement in combination with target presence, on eyewitness memory. Eyewitness memory is influenced by a variety of factors, which is problematic as misidentifications can result in wrongful convictions (innocenceproject.org). Importantly, there are three phases of memory: encoding, storage, and retrieval (Tulving & Thomson, 1973), all of which are vulnerable to error (Cutler, 2006; Loftus & Loftus, 1980). During the encoding phase, perceived information becomes stored in the form of a memory. During the storage phase, information is stored until needed. Finally, the retrieval phase is the process in which previously stored information is either recalled or recognized. A change in contextual information at encoding and retrieval is one factor that can influence memory accuracy (Wong & Read, 2011).

Context cues are stimuli that are present prior to or during memory retrieval that can either enhance or hinder memory performance (Davies & Thomson, 1988). Specifically, context reinstatement (CR) is when environmental context is similar during encoding of information and then again at retrieval (Sanders, 1984; Wong & Read, 2011). Further, CR influences how well information is retrieved (i.e., recognized or recalled) after it is encoded (i.e., stored). Olfactory stimuli used as a form of CR was examined in the current study because the olfactory cortex is connected to regions of the brain where various memory processes occur (i.e., the hippocampus and amygdala; Herz & Engen, 1996). Additionally, olfactory stimuli are information that humans tend to easily recognize and remember (Schab, 1991; Tomono, Kanda, & Otake, 2011). As smell and memory are closely associated, it was anticipated that scent would have a strong effect on eyewitness accuracy when used as a form of context reinstatement.

Eyewitness Identification

Contextual changes between learning and test have complex effects on recognition accuracy (Smith, 1988). It is plausible that changes in scent at learning and test could influence eyewitness identification, as scent is contextual information that is often salient (Schab, 1991; Gottfried & Dolan, 2003) and because the region of the brain responsible for smell (i.e., the olfactory cortex) is connected to memory regions of the brain (Herz & Engen, 1996). Scent present during the occurrence of a crime could later act as a contextual cue to enhance eyewitness accuracy if that same scent is presented during a lineup task.

A primary goal of the present study was to examine whether scent could be used as a form of context reinstatement to influence eyewitness identification accuracy. It was hypothesized that participants in the matched scent condition would be the most accurate on the lineup task when the target was present in the lineup but least accurate when the target was absent from the lineup. This was predicted because previous research has suggested that context reinstatement can inflate eyewitness confidence, making the eyewitness more likely to identify an innocent suspect (e.g., Sanders, 1984; Hanczakowski et al., 2014). Further, when the target is absent from the lineup, the reinstatement of scent during the lineup could inflate participants' feelings of familiarity and thus confidence, making them more likely to erroneously choose a person from the lineup.

These predictions were somewhat supported such that compared with the mismatched condition, the matched scent and matched no scent conditions were in the expected direction, namely higher correct identification rates in target-present lineups. That is, the two conditions involving context reinstatement (i.e., matched scent and matched no scent conditions) resulted in greater identification accuracy than the condition in which context was not reinstated (i.e.,

mismatched condition). However, these differences were not statistically significant. Power analysis suggests that for a small effect, at least 60 participants per condition are required. In the current study, I was expecting a large effect and collected data from approximately 30 participants per condition. Having sufficient power for a small effect may have produced the context reinstatement effect.

In the target-absent conditions, correct rejection rates were higher in the matched conditions than the mismatched conditions, albeit non significantly. It is possible that in the absence of a visual memory match on the lineup, the scent match increased participants' willingness to reject the lineup. With a larger sample size this trend may have been significant. In general, target-absent lineups tend to be more difficult for participants, possibly due to demand characteristics including the pressure to make a selection. The match between encoding and retrieval may have provided the additional benefit that witnesses need to reject absent lineups. Further research should explore this notion.

The Outshining hypothesis provides a possible explanation for the weak context effects found in the current study. The Outshining hypothesis suggests that with recognition memory, the test items presented may "outshine" environmental context (Eich, 1980; Smith, 1988). Further, it is suggested that a recognition test provides strong cues (i.e., test items), thus, weakening the influence of any environmental context (Russo, Ward, Geurts, and Scheres, 1999). Specifically, when an eyewitness is presented with a target-present lineup (or with a target-absent lineup in which the suspect closely resembles the target) context effects may not be present. This is because the target item (or the item resembling the target item) will act as a cue for retrieval of target information. However, it is possible that there could be instances in which a

target may not act as a strong recognition cue, and thus context cues would be effective (Cutler & Penrod, 1988).

However, the Outshining hypothesis is in contrast with Murnane and Phelps' (1994) general context model of recognition. The general context model proposes that the effect of context will remain the same or increase as the strength of the test items increases, as long the strength of context is held constant (Murnane & Phelps, 1994). Using a global activation model, Murnane and Phelps (1994) examined the conditions under which context would be influential on recognition. They found that context effects would be nonexistent or small when testing takes place in a context that was present during learning but differs in some way from the original context. This could explain the small effects found in the current study. In the current study, participants in the mismatched condition were only exposed to the scent in one session. Although the two sessions would have differed in scent, participants were tested in the same rooms in which learning took place. Thus, it is plausible that scent did not have a large effect on recognition memory because the testing phase took place in an environmental context that was somewhat familiar.

Murnane, Phelps, and Malmberg (1999) also proposed the Item, Associated Context, and Ensemble (ICE) theory as a means of explaining the inconsistencies in the literature on context-dependent recognition memory. Importantly, ICE theory separates recognition into three types of information: item, associated context, and ensemble. Specifically, item information is information that is the focus of the task being performed, associated context is environmental information that is not the focus the task being performed, and ensemble is information that is formed by combining item and context information. ICE theory suggests that if there is a match in both item and associated context at learning and test, there will be context effects for hit rates

and false alarm rates, but not discriminability (i.e., the ability to discriminate between targets and distractor items). However, if there is a match in associated context and ensemble information at learning and test, there will be context effects for hit rates, false alarm rates, and discriminability.

Much the same as the ensemble component of the ICE theory, the Integration hypothesis (Baddely, 1982) also suggests that target items and context must be integrated into one single item for a retrieval cue to be effective. Murnane, Phelps, and Malmberg (1999) note that the lack of context effects found in previous studies (e.g., Murnane & Phelps, 1993, 1994, 1995) was likely because ensemble information was not formed due to the absence of meaningful context information. This is important to note as information that is more meaningful is remembered more easily (Baker & Santa, 1977). Further, Murnane, Phelps, and Malmberg (1999) found context effects for hit rates, false alarm rates, and discriminability when context was rich in meaning. They state that this is because an ensemble is more likely to form when context is meaningful. One would expect that if scent were an effective form of context reinstatement, effects should be found with any scent. However, depending on the situation, certain scents may act as more effective cues. In the present study, vanilla may not have been a meaningful scent in terms of the event taking place (i.e., the staged theft). If for example, participants watched a video in which a person was baking cookies, the vanilla scent may have acted as a more effective cue, as it would have provided a more meaningful context.

Similar to this, Fernandez and Glenberg (1985) conducted a series of eight experiments to examine the effect of context reinstatement on recall and recognition memory. Interestingly, there was no support for an advantage of same context during study and test within the eight experiments. The researchers suggest that they did not find an effect because the environmental context in laboratory studies may be too unrelated to the event being remembered, whereas, real-

life environmental context is more closely associated with occurring events. In the current study, it may have been that participants did not strongly associate the vanilla scent with the crime video, and so the vanilla scent may not have acted as a strong contextual cue. Further, it may be that when witnessing a real-life crime, scents may be more closely related to the event that is occurring and thus, may have a stronger effect on recognition memory.

Eyewitness Recall

A secondary goal of the present study was to examine whether scent used as a form of context reinstatement would affect the total number of perpetrator descriptors that participants recalled, as well as the proportion of correct descriptors recalled. Importantly, context reinstatement has been shown to have a reliable effect on recall memory (Smith & Bjork, 1978; Smith, 1979; Smith & Vela, 2001). Thus, it was hypothesized that the matched scent condition would result in the most descriptors recalled and the most accurate descriptors recalled, followed by the matched no scent condition, and then the mismatched condition.

Contrary to these predictions, it was found that context reinstatement did not influence the total number of descriptors or the proportion of correct descriptors recalled. Interestingly, all conditions resulted in an average decrease in the total number of descriptors recalled from session one to session two, indicating that participants forgot descriptors throughout the delay period. Specifically, the matched scent condition resulted in the greatest decrease in the total number of descriptors recalled, followed by the matched no scent condition, and then the mismatched condition. However, these differences were not statistically significant. As well, there was seemingly no change in the proportion of correct perpetrator descriptors recalled in any of the three conditions.

These findings are again surprising, considering the abundance of research examining the effect of context reinstatement on recall memory (e.g., Smith, Glenberg, & Bjork, 1978; Smith, 1979; Smith & Vela, 2001). It was expected that context would have a stronger effect on recall memory than recognition memory because there are no cues presented during a recall task. Thus, environmental context cues would likely be more effective at helping an individual remember studied information. However, recall involves an arguably more difficult retrieval process than recognition. Further, researchers have examined reaction times of both recall and recognition memory processes and have found that recall involves a significantly longer retrieval phase than recognition (Nobel & Shiffrin, 2001). Recall is typically a longer and more difficult task than recognition because of a lack of cues. Thus, the lack of any recall context effects in the current study could be due to the more difficult nature of the task, in combination with a relatively long delay (7 days). The results from the current study indicate that smell has a minimal effect on recognition, and so it could be that the effect is too weak to be found when examining the effect on recall memory.

Additionally, the lack of any recall context effects could again be explained by components of the ICE theory of context-dependant memory (Murnane, Phelps, & Malmberg, 1999) and the Integration hypothesis (Baddeley, 1982). Further, participants may not have formed a strong and meaningful association (i.e., ensemble) between the target and the context, such that they did not associate environmental context with the perpetrator shown in the video. Thus, experiencing the matched environment (i.e., matched scent or matched no scent) in session two may not have provided a cue to recall details of the perpetrator if the environmental context was not originally associated with the perpetrator.

Finally, exploratory analyses were conducted to examine whether recall was predictive of identification accuracy. It was found that recall was not a predictor of identification accuracy. However, this finding is not surprising as some researchers have noted that recall accuracy should not be used as an indication of eyewitness identification accuracy (e.g., Wells, 1985). One possibility for why recall was not predictive of identification accuracy in the current study could be that the processes involved in formulating verbal descriptions is unrelated to the processes involved in encoding a face (Ellis, 1984). Additionally, it could be that the cues required for recall of information are too unrelated to the cues required for recognition of information (Tulving & Watkins, 1977).

Eyewitness Confidence

Confidence-accuracy relationship. Another goal of the current study was to examine the relationship between eyewitness confidence and identification accuracy. Researchers have found that the greater confidence an eyewitness reports in their lineup decision, the more accurate that decision will be (Sporer et al., 1995; Wixted & Wells, 2017). This association is termed the confidence-accuracy relationship. However, it is important to note that some researchers have found confidence to be a weak predictor of eyewitness accuracy (e.g., Brewer & Wells, 2011; Penrod & Cutler, 1995). It was hypothesized that greater eyewitness confidence would be associated with greater eyewitness identification accuracy. This hypothesis was supported, such that eyewitnesses who reported greater confidence in their lineup decision were more accurate in their decision. This suggests that confidence is predictive of identification accuracy.

The confidence-accuracy relationship has also been shown to differ depending on whether the eyewitness is a “chooser” (i.e., makes a selection from the lineup) or a “non-chooser” (i.e., rejects the lineup), such that the confidence-accuracy relationship is often stronger for choosers

than non-choosers (Brewer & Wells, 2006; Sauer et al., 2010). It was hypothesized that the confidence-accuracy relationship would differ for choosers and non-choosers, such that choosers would have a greater confidence-accuracy relationship than non-choosers.

This hypothesis also was supported as there was shown to be a significant confidence-accuracy relationship for eyewitnesses who chose a lineup member, but no significant confidence-accuracy relationship for eyewitnesses who rejected the lineup. This suggests that confidence is not an indicator of accuracy for lineup rejection responses. This further adds to the literature on the confidence-accuracy relationship such that it suggests that eyewitness confidence should only be viewed as an indication of identification accuracy when the eyewitness identifies a person from the lineup. As well, eyewitness confidence should not be used as the sole indicator of eyewitness accuracy as there are various factors that could potentially inflate eyewitness confidence, such as context reinstatement.

Context reinstatement and confidence. Finally, as there is evidence that confidence is predictive of identification accuracy, the current study examined whether context reinstatement influences eyewitness confidence. Research has found that context reinstatement may increase participants' perceptions of familiarity (Wong & Read, 2011), which could thus increase participant confidence (Sanders, 1984; Hanczakowski et al., 2014). It was hypothesized that participants in the matched scent condition would be most confident in their lineup decision, followed by those in the matched no scent condition, and then those in the mismatched condition.

This hypothesis was not supported, such that context reinstatement did not influence eyewitness confidence. The lack of any context reinstatement effects could again be because participants may not have formed a meaningful association between the studied information and

context, thus, reinstating the context may not have increased participants' feelings of familiarity enough to increase their confidence in their lineup decision. As well, scent may not have influenced confidence when used as a form of context reinstatement because it may simply have such a minimal effect that it was not detected in the current study.

Limitations and Future Directions

It is important to discuss limitations of the current study. Laboratory studies cannot entirely mimic the real-life scenario in which a person witnesses a crime. Further, the current study provided an ideal eyewitness environment such that participants were aware that they would be watching a video. Additionally, participants completed the study individually, in a relatively low stress environment, with few distractions. This is again contrary to the environment that a real-life eyewitness often experiences.

Future research should continue to examine the ways in which contextual changes affect eyewitness recall and recognition accuracy. Specifically, research that examines scent as a form of context reinstatement should examine whether a more meaningful scent (in terms of the target item) acts as a more effective retrieval cue. Findings from Tomono, Kanda, and Otake (2011) support the idea that scent should be meaningful in terms of the target item. Tomono and colleagues found that participants spent more time gazing at images that corresponded to the scent that they were being presented. For example, participants spent more time gazing at an image of a coffee cup when presented with a coffee scent. This suggests that the coffee scent provided a more meaningful context when participants were shown a related image. To further test the role scent may play on eyewitness memory, scent should be more relevant to the target event. For example, the smell of popcorn at a movie theatre where a criminal event occurs.

Implications

The results of the current study suggest that smell may have a minimal effect on eyewitness memory, specifically in the context of eyewitness recall and identification. However, the scent in the current study was pleasant and not connected to the target event. Before completely dismissing the role of scent on eyewitness memory, it is important to consider stronger, more relevant odours, in particular with a population (i.e., adolescents) that is likely to frequent locations with strong odours. Adolescents are individuals who are most likely to be victims or witnesses to a crime. Results from the 2014 General Social Survey on Victimization found that individuals aged 15- to 24-years were significantly more likely to be a victim or witness to a crime compared to individuals aged 25-years or older (Statistics Canada, 2015). Additionally, individuals aged 15- to 29-years have reported experiencing higher rates of violent victimization (Perreault, 2015). In addition, it is likely that adolescents frequently spend time in places where various scents are prominent and where crimes could occur (e.g., a movie theatre, amusement park, or party). Consider the scent of marijuana at a party where a sexual assault has taken place. Moreover, certain scents are “stronger” than others perhaps producing stronger associations and possibly being more helpful at the time of recall and identification. Further work is needed to more fully understand the role of scent and eyewitness memory across witnesses of various ages.

Conclusions

Overall, the findings of the current study contribute to the literature on context reinstatement, specifically in the eyewitness context. Results indicate that scent may have a minimal effect on eyewitness memory when used as a form of context reinstatement. The

minimal effect of scent in the current study may have been as a result of the scent chosen; i.e. a vanilla scent may not be a particularly meaningful cue in the context of the staged theft that participants viewed in an artificial setting. On the other hand, it is possible that scent has no meaningful impact on both recall and identification accuracy. In this case, not every aspect of one's environmental context would have a large influence on encoding and retrieval phases of memory. Further work is needed in the area to better understand the role scent may play in the context of eyewitness memory.

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Appendix A

Deceptive Informed Consent Form

The purpose of informed consent is to ensure that you understand the purpose of the study and the nature of your involvement. Informed consent must provide sufficient information such that you have the opportunity to determine whether or not you wish to participate in the study.

Present study: Did I Just See What I Think I Saw?

Research personnel: The following people will be involved in this research project and may be contacted at any time: Bailey Fraser (Principal Investigator, baileyfraser@cmail.carleton.ca, 613-520-2600, ext. 3695), Chelsea Sheahan (Investigator, Chelsea.sheahan@carleton.ca, 613-520-2600, ext. 3695), or Dr. Joanna Pozzulo (Faculty Advisor, joanna.pozzulo@carleton.ca, 613-520-2600, ext. 1412).

Concerns: If you should have any ethical concerns about this study, please contact, Dr. Bernadette Campbell (Chair, Carleton University Research Ethics Board-B, by email: bernadette.campbell@carleton.ca, or by phone 613 520-2600 ext. 4080). You can also contact the Carleton University Research Compliance Office at ethics@carleton.ca for any other concerns. For all other questions about the study, please contact the researchers.

Purpose: The purpose of this study is to examine your perceptions of a video.

Task requirements: You will be asked view a video and then complete questionnaires regarding that video.

Duration and locale: Testing will take place in Room 111, Social Sciences Research Building, Carleton University. This study will be completed in two testing sessions occurring two days apart. Each session will last 30 minutes.

Token for participation: You will receive a 0.5% increase in your final grade of PSYC 1001, PSYC 1002, PSYC 2001, PSYC 2002, NEUR 2001, or NEUR2002 for participating in session one of this study.

Potential risk/discomfort: There are no potential risks involved in this experiment. Should you experience any unease, you have the right to withdraw from the study and still receive course credit.

Anonymity/Confidentiality: All the information you provide will be strictly confidential. Data will only be used for research at Carleton University. Your answers will NOT be linked to your name or signature (i.e., consent form) and your responses will be coded in such a way that you cannot be identified.

Protection of Personal Information: This Informed Consent Form will be kept in the Lab for seven years. It will be placed in a room that has restricted access and is kept locked and closed at all times. At the seven-year mark, it will be shredded and disposed of.

Right to withdraw: Your participation is strictly voluntary. At any point during the study you have the right not to complete certain questions or to withdraw from the study without any penalty whatsoever.

This study has received clearance by the Carleton University Psychology Research Ethics Board (16-***).

Signatures: *I have read the above form and hereby consent to participate in this study. The data in this study will be used for research publications and/or teaching purposes. I am aware that the data collected in this study will be kept strictly confidential and anonymous. My signature indicates that I understand the above and wish to participate in this study.*

Participant's Name (print): _____

Participant's Signature: _____

Researcher's Name (print): _____

Researcher's Signature: _____

Date: _____

Appendix B

Scent Ratings Form

Please rate the scent on each of the following scales.

Sweet						Sour
1	2	3	4	5	6	7
Pleasant						Unpleasant
1	2	3	4	5	6	7
Savory						Unsavory
1	2	3	4	5	6	7
Flavourful						Bland
1	2	3	4	5	6	7
Fresh						Stale
1	2	3	4	5	6	7
Appealing						Repulsive
1	2	3	4	5	6	7
Fragrant						Pungent
1	2	3	4	5	6	7
Good						Bad
1	2	3	4	5	6	7
Attractive						Unattractive
1	2	3	4	5	6	7
Floral						Plain
1	2	3	4	5	6	7
Sweet						Sour
1	2	3	4	5	6	7
Delicious						Distasteful
1	2	3	4	5	6	7
Calming						Agitating
1	2	3	4	5	6	7

Please identify the scent that you smell : _____

Appendix C

Secondary Informed Consent Form

The purpose of informed consent is to ensure that you understand the purpose of the study and the nature of your involvement. Informed consent must provide sufficient information such that you have the opportunity to determine whether or not you wish to participate in the study.

Present study: Did I Just See What I Think I Saw?

Research personnel: The following people will be involved in this research project and may be contacted at any time: Bailey Fraser (Principal Investigator, baileyfraser@cmail.carleton.ca, 613-520-2600, ext. 3695), Chelsea Sheahan (Investigator, Chelsea.sheahan@carleton.ca, 613-520-2600, ext. 3695), or Dr. Joanna Pozzulo (Faculty Advisor, joanna.pozzulo@carleton.ca, 613-520-2600, ext. 1412).

Concerns: If you should have any ethical concerns about this study, please contact, Dr. Bernadette Campbell (Chair, Carleton University Research Ethics Board-B, by email: bernadette.campbell@carleton.ca, or by phone 613 520-2600 ext. 4080). You can also contact the Carleton University Research Compliance Office at ethics@carleton.ca for any other concerns. For all other questions about the study, please contact the researchers.

Purpose: The purpose of this study is to examine your accuracy with remembering who and what you saw. You will be asked to describe the video and then you will be shown some photographs. We also will measure your confidence with this task. When you signed up for this study you were told that the purpose was to examine your perceptions of a video; this was deceptive because the true nature of this study is actually eyewitness accuracy. Eyewitnesses are not made aware when a crime will occur; therefore, the purpose of the deception was to mimic a real-life situation as much as possible. Had you been aware that you were about to watch a crime you may have attended to the video in a different way and your responses would not be representative of most criminal incidents. You have the opportunity to withdraw your data without penalty. However, if you wish to continue with this study, you can give your consent by signing this informed consent form.

Task requirements: You will be asked to answer a few short questionnaires relating to the video you watched.

Duration and locale: Testing will take place in Room 111, Social Sciences Research Building, Carleton University. This study will be completed in two testing sessions that will last 30 minutes per session.

Token for participation: You will receive a .5% increase in your final grade of PSYC 1001, PSYC 1002, PSYC 2001, PSYC 2002, NEUR 2001, or NEUR2002 for participating in session one of this study.

Potential risk/discomfort: There are no potential risks involved in this experiment. Should you experience any unease, you have the right to withdraw from the study without penalty.

Anonymity/Confidentiality: All the information you provide will be strictly confidential. Data will only be used for research at Carleton University. Your answers will NOT be linked to your name or signature (i.e., consent form) and your responses will be coded in such a way that you cannot be identified.

Protection of Personal Information: This Informed Consent Form will be kept in the Lab for seven years. It will be placed in a room that has restricted access and is kept locked and closed at all times. At the seven-year mark, it will be shredded and disposed of.

Right to withdraw: Your participation is strictly voluntary. At any point during the study you have the right not to complete certain questions or to withdraw from the study without any penalty whatsoever.

This study has received clearance by the Carleton University Psychology Research Ethics Board (16-***).

Signatures: *I have read the above form and hereby consent to participate in this study. The data in this study will be used for research publications and/or teaching purposes. I am aware that the data collected in this study will be kept strictly confidential and anonymous. My signature indicates that I understand the above and wish to participate in this study.*

Participant's Name (print): _____

Participant's Signature: _____

Researcher's Name (print): _____

Researcher's Signature: _____

Date: _____

Appendix D

Participant Demographics Form:

Your age:_____

Your sex:_____

Ethnicity: Please indicate which ethnic group you would consider yourself to belong to by checking the appropriate box (optional):

- o White (e.g., European)
- o Black (e.g., African, African American, African Canadian, Caribbean)
- o East Asian (e.g., Chinese, Japanese, Korean, Polynesian)
- o South Asian (e.g., Indian, Pakistani, Sri Lankan, Bangladeshi)
- o Southeast Asian (e.g., Burmese, Cambodian, Filipino, Laotian, Malaysian, Thai, Vietnamese)
- o West Asian (e.g., Arabian, Armenian, Iranian, Israeli, Lebanese, Palestinian, Syrian, Turkish)
- o Latin American (e.g., Mexican, Indigenous Central, South American)
- o Aboriginal Canadian/Native Canadian/First Nations
- o Mixed origin, please specify:_____
- o Other:_____

Appendix E

Free Recall Form

Person Description

Please write down everything that you can remember about the criminal.

Appendix F

Scent Questionnaire

Please answer the following questions.

1. Throughout your participation in the study today, did you notice any smell(s)?

☐ Yes ☐ No

If yes, please describe the smell(s):

_____

_____

Appendix G

Third Informed Consent Form

The purpose of informed consent is to ensure that you understand the purpose of the study and the nature of your involvement. Informed consent must provide sufficient information such that you have the opportunity to determine whether or not you wish to participate in the study.

Present study: Did I Just See What I Think I Saw? (Session 2)

Research personnel: The following people will be involved in this research project and may be contacted at any time: Bailey Fraser (Principal Investigator, baileyfraser@cmail.carleton.ca, 613-520-2600, ext. 3695), Chelsea Sheahan (Investigator, Chelsea.sheahan@carleton.ca, 613-520-2600, ext. 3695), or Dr. Joanna Pozzulo (Faculty Advisor, joanna.pozzulo@carleton.ca, 613-520-2600, ext. 1412).

Concerns: If you should have any ethical concerns about this study, please contact, Dr. Bernadette Campbell (Chair, Carleton University Research Ethics Board-B, by email: bernadette.campbell@carleton.ca, or by phone 613 520-2600 ext. 4080). You can also contact the Carleton University Research Compliance Office at ethics@carleton.ca for any other concerns. For all other questions about the study, please contact the researchers.

Purpose: The purpose of this study is to examine your accuracy with remembering who and what you saw from session one. You will be shown some photographs. We also will measure your confidence with this task. When you signed up for this study you were told that the purpose was to examine your perceptions of a video; this was deceptive because the true nature of this study is actually eyewitness accuracy. Eyewitnesses are not made aware when a crime will occur; therefore, the purpose of the deception was to mimic a real-life situation as much as possible. Had you been aware that you were about to watch a crime you may have attended to the video in a different way and your responses would not be representative of most criminal incidents. You have the opportunity to withdraw your data without penalty. However, if you wish to continue with this study, you can give your consent by signing this informed consent form.

Task requirements: You will be asked to answer a few short questionnaires relating to the video you watched from session one.

Duration and locale: Testing will take place in Room 111, Social Sciences Research Building, Carleton University. This is the last session of a two-part study and will last approximately 30 minutes.

Token for participation: You will receive a .5% increase in your final grade of PSYC 1001, PSYC 1002, PSYC 2001, PSYC 2002, NEUR 2001, or NEUR2002 for participating in session two of this study.

Potential risk/discomfort: There are no potential risks involved in this experiment. Should you experience any unease, you have the right to withdraw from the study without penalty.

Anonymity/Confidentiality: All the information you provide will be strictly confidential. Data will only be used for research at Carleton University. Your answers will NOT be linked to your name or signature (i.e., consent form) and your responses will be coded in such a way that you cannot be identified.

Protection of Personal Information: This Informed Consent Form will be kept in the Lab for seven years. It will be placed in a room that has restricted access and is kept locked and closed at all times. At the seven-year mark, it will be shredded and disposed of.

Right to withdraw: Your participation is strictly voluntary. At any point during the study you have the right not to complete certain questions or to withdraw from the study without any penalty whatsoever.

This study has received clearance by the Carleton University Psychology Research Ethics Board (16-***).

Signatures: *I have read the above form and hereby consent to participate in this study. The data in this study will be used for research publications and/or teaching purposes. I am aware that the data collected in this study will be kept strictly confidential and anonymous. My signature indicates that I understand the above and wish to participate in this study.*

Participant's Name (print): _____

Participant's Signature: _____

Researcher's Name (print): _____

Researcher's Signature: _____

Date: _____

Appendix H

Simultaneous Lineup Response Form

Think back to the video. Think back to what the criminal looks like. I am going to show you some pictures. Please look at the pictures. The criminal's picture may or may not be here. If you see the criminal's picture, please place a check mark in the box that corresponds with the criminal's lineup number. If you do not see the criminal, please place a check mark in the box labeled 'not here'.

☐ Photo 1

☐ Photo 2

☐ Photo 3

☐ Photo 4

☐ Photo 5

☐ Photo 6

☐ Not Here

Please rate your confidence in the accuracy of your decision using a numerical value between 0 (*not at all confident)* and 100 (*very confident):* _____

Appendix I

Study Checks Form

1. Did you know that you would be acting as an eyewitness to a crime before coming to the study session today? Please circle the appropriate response.

   YES NO

2. Did you know anyone from the criminal photo lineup (e.g., one of the boys is your friend)?

   YES NO

3. Before today, have you ever completed a photo lineup identification procedure? If yes, please explain.

   YES NO

4. Have you ever taken a class on eyewitness memory?

   YES NO

Appendix J

Debriefing Form

What are we trying to learn with this research and why is this important to scientists or the general public?

Research has demonstrated a link between context reinstatement and eyewitness identification (Wong & Read, 2011). Context reinstatement (CR) specifically refers to the overall improvement of the retrieval of information when the environment that the person experienced during encoding (e.g., studying) is the same as the environment within which they are tested (Wong & Read, 2011).

It has been argued, however, that while individuals experience the real world by utilizing all 5 senses (i.e., taste, touch, hearing, seeing, and smell), the sense of smell is rarely considered in research involving context reinstatement. More specifically, it has yet to be determined if smell can be used as a method of CR to impact the ability of an eyewitness to make a correct identification of a perpetrator during a lineup identification task. The purpose of this study is to examine if the sense of smell can be utilized as a method of context reinstatement during an eyewitness identification task.

What are our hypotheses and predictions?

It is hypothesized that participants exposed to a pleasant scent during both the encoding and testing phase will be more accurate in the lineup identification task compared to participants who were exposed to a scent in only the encoding phase or only the testing phase.

Where can I learn more?

Tomono, A., Kanda, K., & Otake, S. (2011). Effect of smell presentation on individuals with regard to eye catching and memory. *Electronics and Communications in Japan, 94*, 9–19. doi: 10.1002/ecj.10319

Wong, C. K., & Read, J.D. (2011). Positive and negative effects of physical context reinstatement on eyewitness recall and identification, *Applied Cognitive Psychology, 25,* 2–11. doi: 10.1002/acp.1605

Why didn't you tell me I was going to watch a video of a crime?

We did not tell you that you would be watching a videotape of a theft because we wanted to mimic real life as much as possible and real-life crime happens unexpectedly. Had you been forewarned of the crime aspect of the study, you may have paid attention to the video in a different way and, in turn, this would have influenced your responses to our questions. In this case, your responses would not have been useful to us because they would not be representative of how a real-life witness would experience a similar situation.
Note. The video you watched was completely fictional, no crime was actually committed

What if I feel distress or anxiety after participating in this study?

If you feel any distress or anxiety after participating in this study, please feel free to contact the Carleton University Health and Counseling Services at: 613-520-6674, or the Distress Centre of Ottawa and Region at 613-238-3311 (http://www.dcottawa.on.ca).

What if I have questions later?

If you wish to discuss this research any further feel free to contact any one of the following people: Bailey Fraser (Principal Investigator, Psychology Department, MA Student, baileyfraser@cmail.carleton.ca, 613-520-2600, ext. 3695), Chelsea Sheahan (Investigator, Psychology Department, PhD Student, 613-520-2600, ext. 3695), or Dr. Joanna Pozzulo (Faculty Advisor, Joanna.pozzulo@carleton.ca, 613-520-2600, ext. 1412).

What if I have concerns?

If you should have any ethical concerns about this study, please contact, Dr. Bernadette Campbell (Chair, Carleton University Research Ethics Board-B, by email: bernadette.campbell@carleton.ca, or by phone 613 520-2600 ext. 4080). You can also contact the Carleton University Research Compliance Office at ethics@carleton.ca for any other concerns. For all other questions about the study, please contact the researchers.

At this time, we would like to thank you for taking the time to take part in this study. Your participation has been greatly appreciated!