Contribution of Role Recollection and Perpetrator Identification to the Accuracy of Multi-perpetrator Eyewitness Testimonies

By

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature: Signed by candidate Date: 12/02/2021

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Abstract

Eyewitness testimonies serve as heavily weighted evidence in criminal investigations. Despite this, research has demonstrated the fallibility of eyewitness memory, especially for crimes involving more than one perpetrator. The task for multi-perpetrator eyewitnesses is unique as they not only have to identify perpetrators, but describe the roles played in the crime and then assign an action to each perpetrator. This study examined factors affecting perpetrator identification, role recollection, and perpetrator-role pairing. Participants (N = 216) watched a staged video of a crime and then completed online tasks based on what they saw. At encoding, participants viewed one, two, or five perpetrators. Participants were either required to identify perpetrators from line-ups or were given images of each offender. In addition, they were either required to describe each perpetrator's role or were given this information. For methodological reasons, no perpetrator-absent line-ups were included in the current research as participants who viewed this kind of line-up had no potential for scoring along the perpetrator-role pairing measure. The results suggest that, as the number of perpetrators increases, participants made fewer correct identifications, role recollections, and pairings. However, there was no significant difference in identification accuracy between the one-and two-perpetrator conditions. The findings also show that while receiving experimenter-defined roles yields more accurate pairings, receiving photographs of the perpetrators does not. Future research is needed into the pairing process, the findings of which could be used to improve police procedure for interviewing multi-perpetrator eyewitnesses.

Contents

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In June 2016, Khulekane Mthethwa and Sindisile Myemane were convicted of a robbery committed by three perpetrators (Mthethwa and Another v S, 2020). The criminal investigation relied on eyewitness testimonies, which were later proven to be unreliable. Consequently, in November 2020 both men won their appeal and their respective sentences of 30 and 40 years in prison were overturned.

Although eyewitness identifications serve as integral pieces of evidence in the conviction and sentencing of perpetrators, scientific advances such as DNA testing have demonstrated that 69% of wrongful sentences can be attributed to misidentifications (Innocence Project, 2020). The phenomenon of mistaken identifications has piqued psychologists' interests, resulting in a large corpus of eyewitness literature (e.g., Loftus, 2018; Shepherd, 1983). However, dating back to 1977, fewer than 20 published studies have explicitly tested eyewitness memory for multiple perpetrators, which is incongruent with the documented frequency of this type of crime (e.g., Clifford & Hollin, 1981; Egan et al., 1977). For example, in a study on the experiences of rape survivors, Maw (2013) noted the prevalence of sexual assault committed by multiple offenders. This finding highlights how neglecting to consider multi-perpetrator cases results in a misrepresentation of sexual abuse in South Africa. Maw's findings echoed earlier findings: For example, Swart et al. (2000) found that up to 27% of reported rape cases in Johannesburg involved multiple perpetrators, while other data suggests that this figure could approach 50% in the broader South African context (Horvath & Kelly, 2009). Crime statistics from the United States of America from 2008 suggest that approximately 20.50% of known violent crimes that year were committed by more than one perpetrator (Source Book of Criminal Justice Statistics, 2008). In addition, the 2013 – 2014 Victims of Crime Survey (Statistics South Africa, 2014) stated that all of the five reported hijacking cases were committed by multiple perpetrators. In addition, Nortje (2018) also reported that figures from this survey suggest that the rates of multi-perpetrator crimes within South Africa are higher than those internationally.

As well as identifying culprits, multi-perpetrator eyewitnesses are required to describe the different roles played by different perpetrators in the crime, which aids in determining the sentence each one will receive. Thus, there is a need for further research into the accuracy of

perpetrator identification and role recollection on the part of multi-perpetrator eyewitnesses. Previous evidence suggests that most eyewitnesses' identification and role assignment accuracy decreases as the number of perpetrators increases (Nortje, 2018).

Components of Multi-Perpetrator Eyewitness Memory

Factors affecting the reliability of eyewitness memory can be categorised as either estimator or system variables (Wells, 1978). Estimator variables are uncontrollable factors related to the crime itself, for example the accomplice's gender (Tredoux et al., 2004). System variables are factors like police guidelines that can be regulated and improved by both researchers and the criminal justice system (Tredoux et al., 2004).

The present study investigated system variables relating to how forensic information is retrieved from multi-perpetrator eyewitnesses. Specifically, this entailed investigating the accuracy of three components of the memory of the crime: (a) perpetrator identification, (b) role recollection and, (c) perpetrator-role pairing. Although multi-perpetrator eyewitnesses are required to delineate the specific offence committed by each perpetrator (i.e., the perpetrator-role pairing) when reporting a real crime, so far there has been little scientific research into this process (Hope et al., 2013; Wells & Pozzulo, 2006). In most multi-perpetrator eyewitness studies participants do not have to recall each role played in the crime because only memory for the main offender is tested (e.g., Clifford & Hollin, 1981; Megreya & Bindemann, 2011; Wells & Pozzulo, 2006). For example, in one study participants were just instructed to "identify the main perpetrator committing the laptop theft, and not the accomplice" (Megreya & Bindemann, 2011, p. 445). This is problematic as in real-life scenarios witnesses would be required to describe each perpetrator's role. Furthermore, there is a dearth of literature on the factors that potentially affect the accuracy of perpetrator-role pairings, even though research has shown that this form of evidence is especially fallible (Nortje, 2018). Nortje (2018) found that while the accuracy of both perpetrator identifications and role descriptions decreases as the number of perpetrators increases, role assignment was the component of eyewitness memory most vulnerable to error.

All three forms of evidence – role recollection, perpetrator identification, and perpetrator–role pairings - are important to the direction the investigation takes, help determine eyewitness reliability, and affect sentencing outcomes (Hobson et al., 2012). Perpetrator-role pairings, however, are not independent of the other two types of evidence, and therefore

determining what effects perpetrator identification and role recollection have on perpetrator-role pairings is of paramount importance.

Multiple Perpetrator Line-up Identification

Encoding

It has been well-established in the relevant literature that as the number of offenders committing a particular crime increases, the accuracy of perpetrator identification decreases (e.g., Clifford & Hollin, 1981). However, the exact mechanism underpinning this effect has been debated (Megreya & Bindemann, 2011). It has been suggested that the "multiple face disadvantage" (Hobson & Wilcock, 2011, p.287) stems from a high perceptual load at encoding (Greene et al., 2017; Megreya & Bindemann, 2011). The perceptual load theory purports that individuals are only able to attend to a set number of details, and this affects the retrieval of this information at a later stage (Cartwright-Finch & Lavie, 2007). It has also been demonstrated that individuals have a particular limit to the number of faces that they can effectively process to facilitate subsequent recognition (Jenkins et al., 2003). If too many faces are present at encoding, a witnesses' perceptual capacity could be exceeded, potentially leading to inaccurate perpetrator identifications (Cartwright-Finch & Lavie, 2007). Furthermore, in their model of working memory, Baddeley and Hitch (1974, p.74) proposed that individuals can only store a certain number of units of information in working memory at any one time. Specifically, according to Cowan (2010), an individual's working memory capacity is between three and five units of information. The amount of detail that characterises multi-perpetrator crime scenes, for example perpetrators' faces and their individual weapons, could overwhelm this working memory storage capacity (Greene et al., 2017; Vanderwal, 1996). As such, working memory is implicitly vulnerable to the intrusion of irrelevant details as its capacity could be filled with distracting information before the encoding of relevant details can occur (Laldin, 1997; Megreya & Bindemann, 2011; Mulligan, 1998).

The perceptual overload and working memory theories have shown that once memory capacity has been exceeded, encoding could be disrupted. In particular, the process of encoding faces could be vulnerable to error. This is problematic as it could affect multi-perpetrator eyewitnesses' ability to retrieve information at the recognition stage.

Recognition

Another possible explanation as to why multi-perpetrator identifications have proven to be fallible is the particular strain placed on eyewitness memory resources at the recognition phase (Jacob, 1994; Lamont et al., 2005). Being presented with many faces at recognition could also create a heavy perceptual load (Lamont et al., 2005). A heavy load at recognition can therefore be defined as many faces, which collectively take attention away from individual line-up members (Lamont et al., 2005). Consequently, eyewitnesses are obliged to divide their attention between many line-up members during the identification stage, which could negatively affect their attempts to compare multiple faces concurrently (Lamont et al., 2005). In real-world criminal cases, witnesses are often asked to identify perpetrators from a photographic line-up, which includes the suspect/s and other known innocent individuals (Wells & Pozzulo, 2006). There is much uncertainty around the best procedure for administering multi-perpetrator line-ups (Nortje, 2018; Tupper et al., 2019). Line-up instructions are often not specifically adapted for multi-perpetrator crime scenarios (Hobson et al., 2012; Nortje, 2018; Tupper et al., 2019), and certain criminal police guidelines remain unclear as to the number of suspects to include in a line-up. To address this issue, Wells et al. (2020) recommend that only one suspect should appear in a line-up. In contrast, other countries such as South Africa, have guidelines that dictate that a second suspect can be placed in the same line-up if there is sufficient similarity in physical appearance between the suspects (Du Toit et al., 2011; PACE CODE D, 2011). However, it remains difficult to define and measure this requirement of physical similarity (Nortje, 2018). In a survey on police procedure in South Africa, Nortje (2018) reported that 74.67% of police had previously placed more than one suspect in a line-up. Furthermore, in a survey on police procedure in Sweden, Belgium and Norway, 65% of police officers reported that they would place each suspect in a separate line-up if they were investigating a two-perpetrator crime (Tupper et al., 2019). The remaining 35% stated that they would include both suspects in a single line-up (Tupper et al., 2019). This could prove problematic as face recognition research indicates how attentional resources may become strained due to the perceptual bias afforded to this unique category of stimuli (Vuilleumier, 2000). For example, Bindemann et al. (2005) determined that participants found it difficult to shift their attentional focus from images of faces when these were included amongst other distracting items. In addition, Mestry et al. (2017) found that participants' accuracy and their decision-making time increased when they were tasked with

identifying a second face in visual processing tasks. Furthermore, research suggests that even when participants are cued to focus on a particular face, distractor faces still sequester processing resources, creating a persistent form of interference (e.g., Bindemann et al., 2007**;** Jenkins et al., 2003). Bindemann et al. (2005) also found evidence that faces can only be processed serially; meaning that in order to identify multiple perpetrators, an eyewitnesses' attention would need to be divided between line-up images one-at-a-time, in order to identify the offender.

Thus, the difficult task of identifying perpetrators from a line-up containing multiple faces, all of which compete for attention, could present a highly-demanding perceptual load. This could impair an eyewitnesses' recognition even under ideal encoding conditions.

Perpetrator-Role Pairing

Although research suggests a complex interaction between the encoding of multiple perpetrators and subsequent offender identification, it is unclear as to the extent each of these processes affect multi-perpetrator eyewitnesses' perpetrator-role pairings. Some researchers have argued that the additional memory load at the recognition stage could potentially confound witnesses' performance as their accuracy is not necessarily indicative of their encoding level alone (Metzger, 2002). By removing the recognition task through providing images of the perpetrators instead, the cognitive burden placed on a multi-perpetrator eyewitness could be alleviated as they would then not have to view a line-up and not be required to make comparisons between images to identify the offender. This could occur in real-life situations in which the police are certain of the perpetrators' identities, but are unsure of each of their distinct roles in the crime. For example, there could be CCTV footage of the perpetrators leaving a crime scene, which would provide evidence of the perpetrators' identities, but only eyewitness accounts of their actions during the crime. By eliminating the double-disadvantage of being exposed to a high perceptual load at both encoding and recognition, improvements in the accuracy of perpetrator-role pairings may be observed. Conversely, the multiple-perpetrator effect could be so robust that even if the perceptual load at recognition were removed, the adverse effect of many faces at encoding would remain. Thus, even if images of the perpetrators were provided at recognition this would not be able to compensate for the impoverished memory of the crime. In addition, by removing the recognition element, witnesses would be unable to make comparisons between line-up members as they would only be provided with images of the perpetrators. This could prove detrimental to identification accuracy as research has shown that

the process of making relative judgments helps establish a network of memories associated with the crime (Wixted & Mickes, 2014). For example, a participant who was presented with a series of line-up members could focus on a specific feature such as eye colour as a criterion to compare line-up members. During this process, eye colour could then trigger further memories relating to this offender, for example the action they committed. However, participants who are not required to complete the recognition stage would not have the opportunity, and possible benefit of this comparative process.

Thus, even if participants are presented with images of the offenders without having to make identifications, it is unclear whether this will improve perpetrator-role pairings if particular elements of the crime scene were not originally encoded.

Role Recollection

Encoding

There is little data on the ability of multi-perpetrator eyewitnesses to accurately describe the roles played in a criminal event. Such descriptions are a pre-requisite component for perpetrator-role pairings. Therefore, it is important to gain insight into how this information is encoded. As discussed above, crimes involving more than one perpetrator are typically complex scenes in which many stimuli compete for attention. Consequently, it is particularly difficult for eyewitnesses to divert their visual processing resources from the offenders' faces in order to focus on other potentially important elements of the scene (Bindemann et al., 2005). Thus, there may be gaps of attentional focus on details of the crime, which is problematic as this could result in insufficient encoding and poor memory of the elements of the event.

Recollection

There are also uncertainties about the mechanism underlying eyewitnesses' memory for the roles played by different perpetrators of a crime. This aspect of multi-perpetrator eyewitness testimonies has been largely neglected in the literature. This could be because the task of describing multiple roles played by the different perpetrators does not apply to single-perpetrator scenarios.

Perpetrator-Role Pairing

The sparsity of current insight into role descriptions at the encoding and recollection stages extends to the dearth of knowledge about how these processes affect the accuracy of perpetrator-role pairing. According to associative memory theories, details of the same event can

be encoded in such a way that they are intrinsically linked (Gillund & Shiffrin, 1984). These links then form a complex network of memories that are connected to one another (Gillund & Shiffrin, 1984). As a result, the retrieval of one memory can trigger these associations thereby cueing the memory of a detail in the same network (Gillund & Shiffrin, 1984). In the context of multi-perpetrator crimes many details of the shared criminal event are presumably connected and encoded in a complex way. Thus, the associative memory theory could explain the possibility that being provided with descriptions of the correct roles played during the crime could activate a network of associated memories, thereby aiding in the retrieval of relevant information (Gillund & Shiffrin, 1984). As such, experimenter-defined roles could compensate for poor encoding. However, other research has suggested that if such role information was not originally encoded by the witness, it cannot function as a retrieval cue for other details (Hollingworth & Henderson, 2002). Alternatively, the process of detailing the various roles featured in a particular crime could enable source monitoring (Kask, 2020). The source monitoring theory claims that details from the same context often become intertwined in memory (Johnson et al., 1993). As such, it is easy to make source monitoring errors by attributing the origin of a detail to an incorrect, but closely related memory. Multi-perpetrator eyewitness memory is vulnerable to such source monitoring errors as many important details all share the same origin, namely the criminal event. It is possible that the task of role recollection could force witnesses to focus on information related to specific perpetrators, rather than on the general criminal event. Consequently, actively describing each perpetrators' role could enable participants to recall precise details related to the same source, in other words the specific perpetrator who performed that action in the crime.

Thus, even after being provided with role descriptions, participants' perpetrator-role pairings could remain poor as the level of encoding still may not be deep enough to capitalise on associative memory and source monitoring cues.

Rationale and Aims

In criminal investigations the conviction of perpetrators often hinges on eyewitness testimonies. However, the fallibility of eyewitness memory has long been recognised. Due to the heavy cognitive load at both encoding and recognition, eyewitnesses of multi-perpetrator crimes are especially vulnerable to making mistakes.

Despite the importance of perpetrator identifications, role recollections and perpetrator-role pairings, both their individual and combined impact on the accuracy of multi-perpetrator

eyewitness testimony has been largely unexamined. Specifically, there is little research into what effect the number of perpetrators committing the crime has on a witness' ability to (1) describe the roles played in the crime, and (2) link each offender to their action. In addition, the extent to which these streams of evidence are influenced by one another has received little attention. There have also been few experiments that have portioned out the accuracy of perpetrator-role pairings when the identity of the perpetrators is known, and accurate descriptions of their roles in the crime have been provided by the experimenter. As a result, there is no clear insight into whether a multi-perpetrator eyewitness' ability to provide certain accurate details can predict their accuracy when required to provide other, potentially overlapping information. Hence, the current research aims to answer four questions:

1. What effect does the number of perpetrators at encoding have on identification accuracy?
2. What effect does the number of perpetrators at encoding have on role recollection accuracy?
3. Does being provided with accurate role recollections affect perpetrator-role pairing?
4. Does being provided with the perpetrators' identities affect perpetrator-role pairing?

To address these questions, the following hypotheses will be tested:

1. As the number of perpetrators at encoding increases, the accuracy of perpetrator identifications will decrease.
2. As the number of perpetrators at encoding increases, the accuracy of role recollections will decrease.
3. The accuracy of perpetrator-role pairings will increase when experimenter-defined roles are provided.
4. The accuracy of perpetrator-role pairings will increase when photographs of the perpetrators are provided.

Methods

Design and Setting

Factors

All participants in this study watched a video of a simulated crime that was committed by either one, two, or five perpetrators.

Within the two-perpetrator and five-perpetrator conditions, participants were randomly assigned to one of four experimental conditions. Of the participants who viewed a crime committed by two or five perpetrators respectively, half were asked to provide a written description of the roles played by each perpetrator, whereas the other half did not provide a written description. This was done to control for whether participants were required to complete the role recollection task, or were provided with experimenter-defined roles. Furthermore, half of the participants were allocated to a condition where they made line-up identifications, whereas the other half did not perform the identification tasks. This was done to control for whether participants were required to complete the perpetrator identification task, or were provided with images of the perpetrators.

All participants who watched a crime committed by either two perpetrators or five perpetrators were given a role-pairing task where they had to match each perpetrator with their role performed in the video. The nature of the role-pairing task differed according to which of the four experimental groups they were assigned.

Participants in the one-perpetrator group viewed a version of the mock crime video featuring a single offender and were then asked to identify this perpetrator from one line-up. This group is often neglected in Eyewitness research involving multiple perpetrators. However, the inclusion of a one-perpetrator condition is necessary to establish a baseline accuracy for when encoding demands are low. The inclusion of a one-perpetrator condition in the design only added one additional experimental group, comprising the first level of the Number of Perpetrators factor. The Role Recollection factor was irrelevant to this group as the single perpetrator's action represented the entirety of the crime, thus there was only one unique role to describe.

Therefore, this experiment had a 3 x 2 x 2 between-subjects factorial design. The first factor, Number of Perpetrators, was based on how many perpetrators appeared in the mock crime video shown to participants (one-perpetrator vs. two-perpetrators vs. five-perpetrators). The second factor, Perpetrator Identification, described whether participants were required to identify the offenders from line-ups, or were provided with photographs of the perpetrators (perpetrator identification required vs. perpetrator identification given). Similarly, the third factor, Role

Recollection, was based on whether participants were required to recall the role played by each perpetrator, or whether they were provided with accurate descriptions of each offender's action (role recall required vs. role recall given). Consequently, there were nine experimental groups in total.

Participants were randomly assigned to one of the nine experimental groups (see Table 1).

Table 1

Experimental Groups (*n* = 24)

Perpetrator Identification	Role Recollection	
	Role recollection given	Role recollection required
Perpetrator identification given	Two perpetrators Five perpetrators	Two perpetrators Five perpetrators
Perpetrator identification required	Two perpetrators Five perpetrators	One perpetrator Two perpetrators Five perpetrators

Note. *n* = number of participants in each experimental group. There were 216 participants (*N* = 216) in total. Although the single-perpetrator group (*n = 24*) is included in the table, participants in this group were only required to make one identification from a line-up and were exempt from the other two experimental conditions, the role recollection and perpetrator identification conditions.

In typical eyewitness experiments, both line-ups containing the perpetrator (perpetrator-present [PP])[1] and those in which the perpetrator is not present (perpetrator-absent [PA]) are used. This is more representative of a real-life criminal situation in which the police cannot always assure the presence of the 'true' perpetrator in the line-up. In such instances the police would conduct PA line-ups (Jacob, 1994). In laboratory experiments, foils (known innocent individuals) are placed in both PP and PA line-ups; however, PP line-ups also contain the perpetrator (i.e., the 'true' perpetrator), whereas in PA line-ups, the perpetrator is replaced with a special foil, known as an innocent suspect. Therefore, it is impossible to make a correct

[1] The terms "target absent" (TA) and "target present" (TP) are usually used in Eyewitness literature, however in the current research, PP and PA were used to avoid confusion.

identification from PA line-ups, since the perpetrator is not present; instead, the correct decision for PA line-ups is to reject these parades.

The current research, however, was specifically focused on investigating the accuracy of perpetrator-role pairings, a process which requires positive identifications from PP line-ups before participants can link the offenders to their criminal action. Specifically, perpetrator-role pairing cannot be scored as accurate for PA conditions, because identifications from these types of line-ups would be considered inaccurate. Furthermore, the comparison of role-pairing accuracy between participants who received photographs of the perpetrators and those who viewed line-ups was only viable for PP line-up conditions. Participants who were provided with photographs would not be comparable to those who viewed PA line-ups in which the offender was not present.

Although many eyewitness studies include PA line-ups in their designs, this was not appropriate for the current research, which was not limited to perpetrator identifications. PA conditions precluded two of the study hypotheses: Hypothesis 3 and Hypothesis 4. Both hypotheses hinge on perpetrator-role pairings, but positive perpetrator identifications are a pre-requisite for perpetrator-role pairings and can only be made from PP line-ups.

Dependent Variables

For this study there were three dependent variables, all of which were derived from participants' performance on their assigned tasks. The first dependent variable was Accuracy of Perpetrator Identification, meaning whether participants could correctly identify a perpetrator from a line-up. Accuracy of Perpetrator Identification was only applicable to conditions in which participants were required to make a line-up identification instead of being provided with photographs of the perpetrators.

The second dependent variable was Accuracy of Role Recollection, meaning the accuracy of participants' role description for each perpetrator. Accuracy of Role Recollection was only applicable to conditions in which participants were required to generate their own role descriptions instead of being provided with experimenter-defined roles.

The third dependent variable was Accuracy of Perpetrator-Role Pairing, meaning whether participants were able to correctly link each perpetrator to their action in the crime. This variable was only relevant to participants in the two-and five-perpetrator groups. Accuracy of Perpetrator-Role Pairing was only measured under the following conditions:

(1) Participants who made correct line-up identifications and were provided with a set of pre-defined, known-to-be correct roles,

(2) Participants who made correct line-up identifications and generated correct role descriptions,

(3) Participants who were provided with photographs of the perpetrators and a set of pre-defined, known-to-be correct roles,

(4) Participants who were provided with photographs of the perpetrators and generated correct role descriptions. This is because accurate perpetrator identifications and role recollections are pre-requisite components for a correct perpetrator-role pairing.

Participants

To determine the sample size, G*Power 3.1.9.2 was used (Faul et al., 2009). The sample consisted of a total of 216 participants (N = 216), with 24 participants in each group (n = 24).

Sample Characteristics

Most of the sample identified as female (70%, male = 28.37%, non-binary = 0.93%). The sample also self-identified as follows: 37.21% as White, 32.09% as Black, 24.19% as Coloured[2], 3.26% as Indian, 0.47% as Asian and 2.79% as Other. The participants had a mean average age of 23.93 years *(SD* = 10.39).

Participants were recruited via a convenience sample technique through two University of Cape Town platforms. An advertisement (Appendix A) was placed on the Psychology Department's Student Research Participation Program (SRPP) Vula site, and was emailed to the larger UCT student population via the Department of Student Affairs. In addition, the advertisement was posted on various social media platforms, including Facebook and Instagram. In return for completing the study, participants were entered into a raffle for a R250 Takealot voucher. One winner was drawn per every 50 participants.

There were no exclusion criteria for the study.[3]

Materials

[2] The term 'Coloured' originated in the Apartheid era in South Africa and was used to classify individuals who were of mixed Black and White descent. The term is problematic as it does not only refer to a biological category, but has a strong impact on people's lives (for example, where they lived and went to school). In addition, the term 'Coloured' also refers to a specific cultural identify. The term is still used today for purposes of redress as official Government policy.

[3] Participants who had impaired vision or corrected to normal sight were not excluded from the study.

This study consisted of two phases, encoding and recognition, each of which required different materials.

Encoding Stage

Mock Crime Video. During the encoding phase, participants watched a silent video depicting a non-violent and victimless car theft committed in a UCT parking lot (see Figure 1 for an example). Three versions of the mock crime video were filmed, with either one, two, or five perpetrators (representing the three levels of the Number of Perpetrators factor). Each of the perpetrators played a unique role (see Table 2), which was kept constant across all of the videos. For example, Perpetrator One played the same role in all three versions of the video. In order to generate the role descriptions in the table, four individuals watched the mock crime video and were asked to describe what each offender did. Thereafter, their responses were aggregated to produce a modal role description for each perpetrator. This was done by retaining only the descriptors that at least 50% of the mock witnesses agreed upon. For example, the description only stated that a perpetrator stole an object if at least two of the four mock witnesses reported this specific information.

The video used in the one-perpetrator condition depicted the following: The perpetrator left his car (the getaway car) and approached the only other car in the parking lot (the target car). He then opened the unlocked, passenger door and stole a backpack from the front seat. Thereafter, he returned to the getaway car. He was in close view for five seconds during which his face was clearly visible. In total, the video of the single-perpetrator crime was 15 seconds long.

The videos of the two-perpetrator, and five-perpetrator mock crimes were lengthened to 30 and 75 seconds respectively to (1) allow for each perpetrator to be in close view for 5 seconds, and (2) control for the attentional demands of the videos. In the two-perpetrator crime video, Perpetrator Two left the getaway car with Perpetrator One and walked to the back of the target car. Once there, he stole a box from the boot before returning to the getaway car. In the five-perpetrator video, Perpetrator Three left the getaway car and approached Perpetrator Two who was behind the target car. Perpetrator Three then looked in the boot and stole a tyre before also returning to the getaway car. Perpetrator Four left the getaway car and stole a bicycle that was lying beside the target car. He then cycled off the scene. Perpetrator Five acted as a lookout

Figure 1

Screenshot of a Mock Crime Video used in the Study

Note. This is a scene from the one-perpetrator version of the crime.

and directed the four other perpetrators during the crime. Thereafter, Perpetrator Five inspected the target car for the last time before returning to the getaway car.

Two versions of each crime video were filmed, each with a different combination of perpetrators to control for perceptual differences in the offenders' appearance that could affect recognition. There were eight actors in total and two of them were featured in both versions of the video.

Table 2

The Actions of the Perpetrators in the Mock Crime Video

Perpetrator's Role	Three Versions of the Mock Crime Video		
	One-perpetrator	Two-perpetrators	Five-perpetrators
Perpetrator One: Stole the backpack from inside the target car and went back to the getaway car	X		
Perpetrator Two: Dug in the boot of the target car, stole a box and went back to the getaway car	X	X	
Perpetrator Three: Stole a tyre from the boot of the target car, and went back to the getaway car	X	X	X
Perpetrator Four: Found a bicycle lying behind the cars and cycled away from the scene	X	X	X
Perpetrator Five: Acted as a lookout, spoke to three of the perpetrators, looked around the target car, and went back to the getaway car	X	X	X

Note. 'X' indicates the presence of a specific perpetrator in a version of the mock crime videos.

Distractor Task. Participants received an article on theft at UCT, followed by a comprehension test on the topic (Appendix B).

Recognition

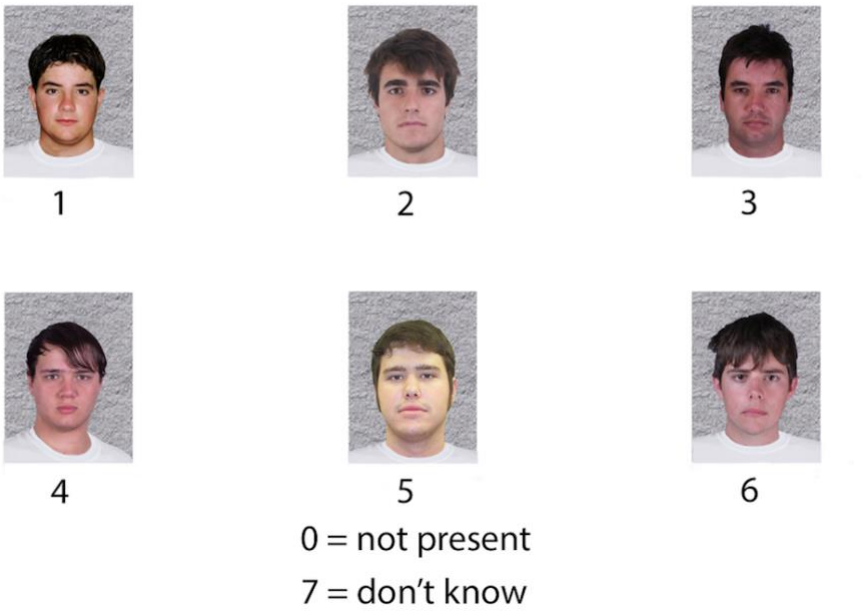
Line-up Arrays. The line-ups were built according to the procedure outlined by Malpass et al. (2007). Initially, photographs of the eight perpetrators were taken on the day that the mock crime videos were filmed. A photographer familiar with a set of standardised guidelines (Appendix C) was used to ensure that the photographs were comparable to those from a database belonging to the Eyewitness Research Group, UCT. A sample of eight independent individuals were briefly shown a photograph of each perpetrator for five seconds and then completed a short distractor task. Subsequently, they were required to provide a physical description of the perpetrators until there were descriptions for each one. These eight descriptions were then

aggregated to produce one modal description per perpetrator. As with the role descriptions, this was done by retaining only the perpetrator descriptors that at least 50% of the mock witnesses agreed on.

Thereafter, the eight modal descriptions, one per perpetrator, were given to a second independent sample (n = 8). They were required to choose six photographs (from a database belonging to the Eyewitness Research Group, UCT), which most closely resembled the modal descriptions for each perpetrator. Each photograph could be selected only once, meaning that there was only one match per modal description. They were instructed not to select the same photograph more than once throughout the task. Then, the sample was asked to rate how closely each selected photograph matched the modal description on a scale from 0 to 10. The most frequently selected photographs for each perpetrator were used as the foils in the respective line-ups, and in the event of a tie, the photographs with the highest ratings were chosen. None of the foils were repeated across the line-ups and the position of each line-up member was chosen randomly. Furthermore, two versions of each line-up were constructed, with the position of the perpetrator being the only difference in order to control for placement effects. The photographs used in the line-ups were edited using Adobe Photoshop (www.adobe.com) to maintain consistency across clothing, image size, as well as to remove any artefacts from the images. See Figure 2 for an example. Thus, in total, there were 16 line-ups.

Figure 2

Example Line-up



Note. This is a line-up for the third perpetrator and he appears in line-up position four.

Procedure

The current study followed the ethical guidelines for psychological research as stipulated by the Department of Psychology Research Ethics Committee and ethical approval was granted before the initiation of the experimental stage (Appendix D). The experimental procedure is shown in Figure 3.

The experiment was administered using Qualtrics software[4] (www.qualtrics.com). Once participants opened the Qualtrics link sent to them they were randomly assigned to one of the nine conditions. They were asked to indicate which device they were using (laptop/desktop, smartphone or tablet). In addition, participants were instructed that they needed a strong internet connection for the duration of the experiment, and notified that once they exited Qualtrics they could not re-open the link at a later stage. Once participants acknowledged that they understood

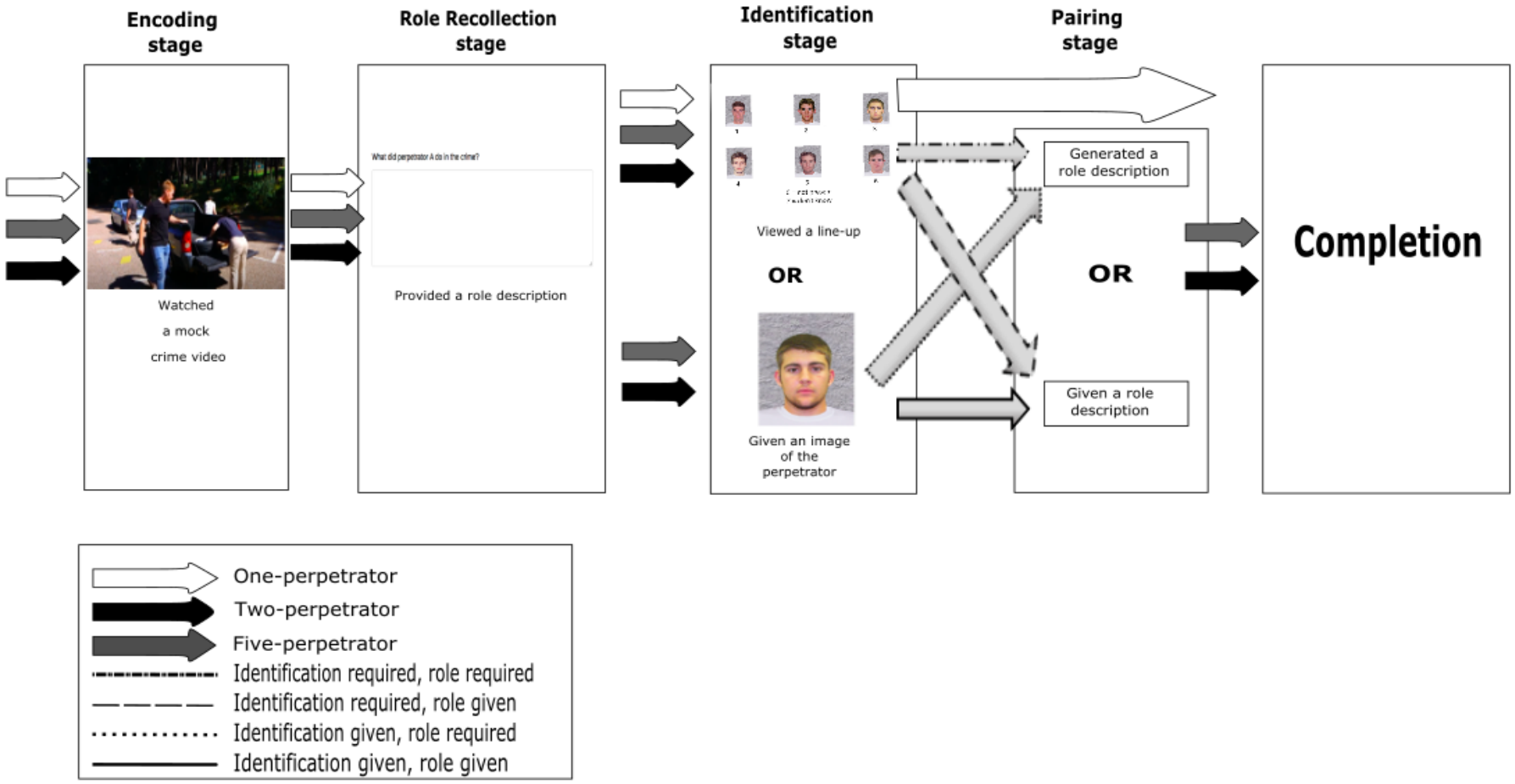
[4] This study was originally intended to be conducted in a laboratory. However, it is not uncommon to administer eyewitness experiments online (e.g., Carlson et al., 2017).

and agreed to these requirements they were asked to complete a consent form (Appendix E) and provide certain demographic information (Appendix F).

At the beginning of the experiment participants were instructed to watch a video only one time, which would begin immediately after they clicked on the link provided. After participants viewed a specific version of the video (one-perpetrator vs. two-perpetrators vs. five-perpetrators) they were asked to complete a short filler task. Thereafter, they were required to provide an account of what they saw in the video in the form of a general statement. Participants were then asked to provide a physical description of each perpetrator. Next, participants received instructions congruent with their experimental group (Appendix G) and these instructions were kept similar across conditions. Participants completed a combination of role recollection, perpetrator identification and perpetrator-role pairing tasks depending on their experimental group.

Figure 3

Illustration of the Experimental Procedure



Note. As indicated in the figure, the one-perpetrator condition did not complete the perpetrator-role pairing task as they only viewed a single perpetrator. The different arrows and lines indicate the various experimental conditions.

Perpetrator Identification

Participants in the five groups who were required to identify perpetrators were instructed that they would be presented with a line-up that may or may not contain a perpetrator who appeared in the video. Line-ups were presented to participants in a random order. Each participant viewed one line-up per perpetrator and was told how many line-ups they would be presented with in total. In addition, they were informed that they could only select one perpetrator from each line-up, alternatively, participants could select the 'Don't Know' or 'Not Present' options if they did not recognise anyone from the line-up. After viewing each line-up, participants were asked to rate how confident they were in their decision, on a scale from 0-100, regardless of whether they selected a line-up member or selected the 'Not Present' option. Participants who selected the 'Don't Know' option skipped the confidence rating task and were taken to the instructions for the following line-up. This procedure was repeated for participants in the two-and five-perpetrator conditions until they had viewed all the line-ups. Participants in the second level of the Perpetrator Identification condition did not complete this task as they were given photographs of the perpetrators at the pairing stage instead of making their own identifications.

Perpetrator-Role Pairing

Regardless of their experimental condition, all participants who viewed two or five perpetrators were required to link each offender to their criminal action. Participants who were required to identify perpetrators were shown individual photographs of the line-up member they selected immediately after the line-up task. If participants selected the 'Don't Know' option then they did not complete the perpetrator-role pairing for that specific line-up. Participants who were not required to make an identification from a line-up were also shown individual photographs of the perpetrators. Thus, participants in both levels of the Perpetrator-Role Pairing condition viewed individual photographs of either the line-up member they selected or photographs of the perpetrators that the researcher provided (see Figure 4 and Figure 5). Beneath the photographs, participants were shown descriptions of the role played by each perpetrator in the crime. These roles were either self-generated or provided by the researcher depending on the participants' Role Recollection condition. Thereafter, participants were required to link each perpetrator to their action by selecting one of the role descriptions displayed. After each pairing, participants were asked to rate how confident they were, on a scale of 0-100, that the individual in the photograph played the role they selected. This procedure was repeated for participants in the two-and five-perpetrator conditions until they had linked each perpetrator to their role.

Figure 4

The Pairing Task for Participants Who Generated Descriptions

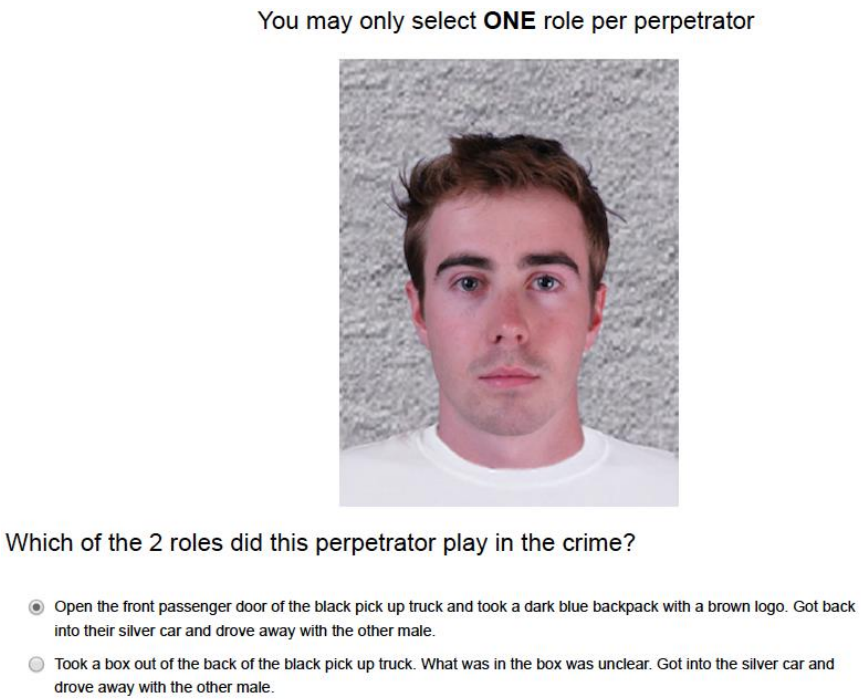
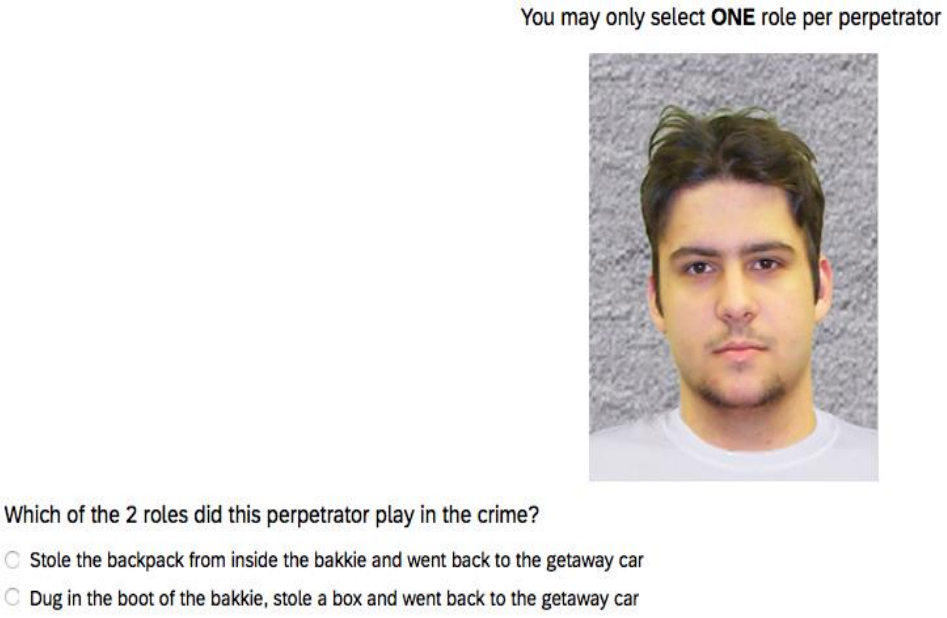


Figure 5

The Pairing Task for Participants Who Were Given Descriptions



Subsequent to completing the various tasks, participants were taken to a final screen where they were thanked for their participation and informed that they would be emailed a debriefing form (Appendix H).

Results

For the present study, participants completed different tasks depending on their experimental condition. Their performance on these tasks was used to assess their perpetrator identification, role recollection and perpetrator-role pairing accuracy. In accordance with the experimental design, each measure was applicable to particular levels of the three factors: Number of Perpetrators, Perpetrator Identification and Role Recollection (supplementary data and tables are reported in Appendix I).

Perpetrator Identification Accuracy

Line-up decisions were scored as Hits if participants made a correct identification and Foil IDs if they selected a foil. In addition, their responses were coded as 'Don't Knows' and 'Not Presents' if they selected these options during the line-up task. Participants were assigned a single binary measure of accuracy (1 or 0) depending on their line-up decision; participants who made a Hit were assigned a score of 1, whereas all other line-up decisions were scored as 0. Since they only viewed one line-up, participants in the one-perpetrator condition could score a maximum of 1; participants in the two-perpetrator and five-perpetrator conditions could make a maximum of two and five correct decisions respectively.

The accuracy of participants' line-up decisions are summarised in Table 7. Each line-up decision contributed one data point. An inspection of this table shows that the percentage of Hits appeared to decrease, whereas the percentage of Foils IDs and Don't Knows increased, as there were more perpetrators at encoding. Although the percentage of Not Present responses appeared to increase as the number of perpetrators moved from one to two, the percentage remained constant between the two-and five-perpetrator conditions.

Table 7

Descriptive Statistics for Perpetrator Identification Accuracy

Number of Perpetrators	*n*	Total Number of Line-up Decisions Made	Participants' Line-up Decision/s			
			Hit	Foil ID	Don't Know	Not Present
One	24	24	62.50% (15)	12.50% (3)	4.17% (1)	20.83% (5)
Two	48	96	36.46% (35)	29.17% (28)	18.75% (18)	15.63% (15)
Five	48	240	21.67% (52)	34.58% (83)	28.33% (68)	15.42% (37)

Note. Total Number of Line-up Decisions Made was calculated by multiplying the number of participants in each group (*n*) by the number of perpetrators they viewed. The percentages of each line-up decision are presented, with the number of each decision in parentheses.

Absolute Perpetrator Identification Accuracy

To further describe the perpetrator identification data, an overall, absolute accuracy was calculated for each participant. Participants were only considered to be absolutely accurate if they correctly identified *all* of the perpetrators they viewed. While 62.50% of participants in the single-perpetrator condition were absolutely accurate, this percentage dropped to 16.67% for participants who viewed two perpetrators. Of the participants who viewed five perpetrators, only one participant correctly identified all perpetrators, thus the absolute accuracy score was only 2.08%.

Mixed Linear Model for Perpetrator Identification Accuracy

Two generalised mixed linear models were run to ascertain how accurate participants were at identifying perpetrators. Participants' experimental group, in other words the number of perpetrators at encoding, was the fixed effect. To account for the repeated measures design, performance on the line-up task/s was nested within participants as the random effect. All analyses were conducted in RStudio Team (2020) using the lme4 package (Bates et al., 2015). This package also provides other model characteristics, such as the Akaike information criterion (AIC), Bayesian information criterion (BIC) and log likelihood, which indicate how well the model fits the data. For all three of these statistics, a smaller value indicates a better-fitting model. In addition, two estimates of R^2 were calculated. Firstly, the R^2_{marginal} value provides an estimate of the variance explained by the fixed effect. Secondly, the $R^2_{\text{conditional}}$ value provides an estimate of the amount of variance accounted for by both the fixed and random effects. Initially, a null model was constructed, which predicted

identification accuracy by the intercept and random intercepts for participants to compensate for the repeated measures design. Thereafter, a second model was constructed that incorporated the fixed effect (experimental group) and the random effect (participant). A chi-square test was used to determine whether there was a significant difference between the deviance scores of each model. The characteristics of, and comparison between, both models are presented in Table 8.

Table 8

Characteristics of the Two Models Predicting Perpetrator Identification Accuracy

Model Name	Model Details	df	AIC	BIC	Loglikelihood	Deviance	ΔX^2
Null Model	Binary_Accuracy ~ 1 + (1 | p_number)		415.66	423.43	-205.83	411.66	
Model 2	Binary_Accuracy ~ 1 + Group + (1 | p_number)	2	401.48	417.03	-196.74	393.48	18.18**

Note. ** indicates a significant p-value. $\Delta\chi^2$ denotes the change in deviance between the two models. 'Model Details' indicates the syntax for each model. The tilde symbol (~) denotes prediction. The number '1' denotes the intercept and '1|' denotes the random effects (i.e., intercepts) grouped by the subsequent term.

The comparison indicated that Model 2 was a significantly better fit for the data, $\chi^2(2) = 18.18$, $p < .001$. Compared to the null model, Model 2 explained between 9% and 32% of the variance in the identification accuracy data ($R^2_{marginal} = .085$, $R^2_{conditional} = .316$). Consequently, Model 2 was used for the rest of the analysis.

Overall, this analysis indicated that there was a significant effect of experimental group, in other words the number of perpetrators, on identification accuracy. Using the Bonferroni method, the experimental groups were contrasted with one another. The findings indicated that there was no difference in identification accuracy between the one-and two-perpetrator groups, $z = 2.20$, $p = .056$. However, the comparison between the two-perpetrator and five-perpetrator groups was significant. Specifically, participants in the two-perpetrator groups performed better than those who viewed five perpetrators, $z = 2.52$, $p = .023$. Of the participants in the two-perpetrator group, 36.46% of line-up decisions were accurate; however, this percentage dropped to 21.67% in the five-perpetrator condition (Table 7).

Confidence Rating Per Line-up Decision

After viewing each line-up, participants were required to use a scale, from 0-100, to rate how confident they were in their line-up decision to make an identification or select 'Not Present'. Participants who selected 'Don't Know' were not required to rate their confidence and were excluded from this analysis. A single confidence score was calculated for each participant by averaging their confidence ratings across each line-up decision they made. If participants selected the 'Don't Know' option for a specific line-up, that line-up was excluded from the averaging calculation. In other words, if a participant in the five-perpetrator condition responded with 'Don't Know' for three line-ups, then only their confidence ratings for the other two line-ups would be averaged. These individual confidence scores were further averaged across participants in the same experimental groups. This yielded mean average confidence ratings per group, which are presented in Table 9. The results from Table 9 show that, as the number of perpetrators increased from one to two to five, participants' average confidence ratings decreased.

Table 9

Average Line-up Decision Confidence Ratings Across the Number of Perpetrators

		Average Confidence in Line-up Decision
Number of Perpetrators	*n*	*M (SD)*
One	23	68.57% (27.37)
Two	44	63.51% (26.14)
Five	45	54.76% (27.64)

Note. Means are presented with standard deviations in parentheses. Confidence intervals could not be calculated because *Average Confidence in Line-up Decision* was a within-subjects variable as some participants completed multiple trials of the line-up task. *n* excludes participants who responded with 'Don't Know' for *all the* line-ups they viewed.

An additional generalised mixed linear model was run to ascertain whether identification confidence altered the relationship between the number of perpetrators, random effects for participants and identification accuracy. To do this, Model 2 (presented in Table 8), which predicted identification accuracy, was compared to a third model. Model 3 included both experimental group and confidence as predictors. A chi-square test was used to determine whether there was a significant difference between the deviance scores of each

model. The characteristics of, and comparison between, both models are presented in Table 10.

Table 10

Characteristics of the Third Model Including Confidence to Predict Perpetrator Identification Accuracy

Model Name	Model Details	df	AIC	BIC	Loglikelihood	Deviance	ΔX^2
Model 2	Binary_Accuracy ~ 1 + Group + (1 | p_number)	2	401.48	417.03	-196.74	393.48	
Model 3	Binary_Accuracy ~ 1 + (1 | p_number) + Group + ID_confidence	1	361.54	380.97	-175.77	351.54	41.95**

Note. ** indicates a significant p-value. $\Delta\chi^2$ denotes the change in deviance between the two models. 'Model Details' indicates the syntax for each model. The tilde symbol (~) denotes prediction. The number '1' denotes the intercept and '1|' denotes the random effects (i.e., intercepts) grouped by the subsequent term.

The comparison indicated that Model 3 was a significantly better fit for the data, $\chi^2(1) = 29.61$ $p < .001$. Compared to Model 2, Model 3 explained between 27% and 45% of the variance in the identification accuracy data ($R^2_{marginal} = .272$, $R^2_{conditional} = .452$). Therefore, Model 3 was used for the rest of the analysis.

Overall, the analysis indicated that in addition to number of perpetrators and random effects for participants, confidence was a predictor of identification accuracy. Using the Bonferroni method, the experimental groups were contrasted with one another. The results suggested that there was no difference in accuracy between those in the one-and two-perpetrator groups, $z = -1.63$, $p = .102$. However, participants in the five-perpetrator group performed worse than those in the two-perpetrator group, $z = -2.79$, $p < .001$.

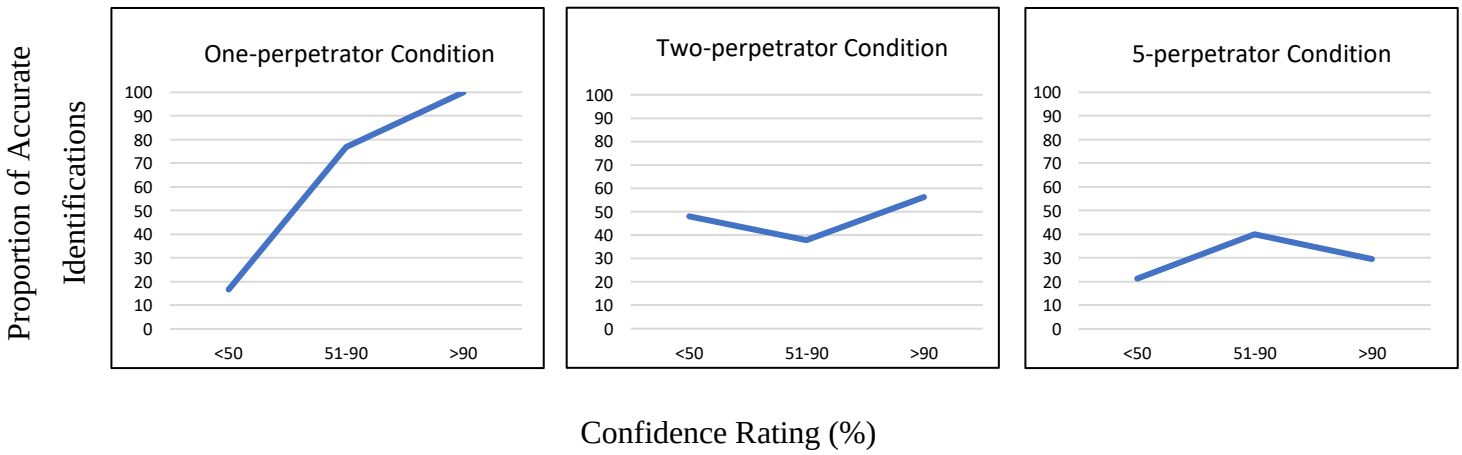
Figure 6 below shows the relationship between confidence and accuracy when participants viewed either one, two or five perpetrators at encoding. In this figure, participants' confidence ratings were split into three bands: <50%, 51-90%, and >90% (using three bands such as these is not unusual; for example see Wixted & Wells, 2017). Participants' line-up decisions were grouped into one of these three confidence bands, depending on what confidence rating they gave for each identification. For example, a participant who provided a rating of 67% would be grouped in the second confidence band

for that specific line-up decision. Thereafter, the proportion of accurate identifications in each confidence band was calculated. The graphs show that there was a positive relationship between confidence and accuracy for the one-perpetrator group. However, for the two-and five-perpetrator groups there was no relationship between confidence in line-up decision and the proportion of accurate identifications. Graphs showing the relationship between confidence and accuracy for each perpetrator are presented in Appendix I.

In addition, correlations between confidence ratings and identification accuracy were conducted. There was a moderate correlation for the one-perpetrator condition, r = .56, 95% CI [.19, .79], $t(21) = 3.08$, p = .006 and a weak correlation for the five-perpetrator condition, r = .15, 95% CI [.30, .04], $t(171) = 2.94$, p = .043. However, there was no correlation between confidence and accuracy for the two-perpetrator condition, r = .07, 95% CI [-.15, .29], $t(76) = 0.62$, p = .540.

Figure 6

The Relationship Between Identification Confidence and Accuracy Per Condition



Role Recollection Accuracy

Regardless of their experimental condition, all participants in the two-and five-perpetrator groups were required to recall the role played by each perpetrator. Participants generated one role per perpetrator. Consequently, the number of role descriptions required was equivalent to the number of perpetrators at encoding. Participants were assigned a single binary measure of accuracy (1 or 0) depending on whether they had correctly described each perpetrator's role. To do this a coding scheme which compared participants' responses with the modal descriptions listed in Table 2 was used. Firstly, the researcher compared each participant's role description against those described in Table 2 and assigned a score of either

0 or 1. Secondly, an independent rater repeated this process. There was strong agreement between the two raters, Cohen's $\kappa = .952$, 95% CI [.93, .97], $p < .001$. If there was disagreement over the accuracy of a particular role recollection, a third rater was used and their score of either 0 or 1 was used for the analysis. A summary of participants' role recollections are show in Table 11. Closer inspection shows that participants generated fewer accurate role descriptions as the number of perpetrators increased from two to five.

Table 11

Descriptive Statistics for Role Recollection Accuracy

Number of Perpetrators	*n*	Total Number of Roles Generated	Role Recollection Accuracy	
			Correct	Incorrect
Two	96	192	67.71% (130)	32.29% (62)
Five	96	480	48.12% (231)	51.88% (249)

Note. 'Total Number of Roles Generated' was calculated by multiplying the number of participants in each group (*n*) by the number of perpetrators they viewed. The percentages of correct and incorrect role recollections are calculated row wise to allow for comparison of accuracy between the rows. The frequency of correct or incorrect descriptions is presented in parentheses.

Absolute Role Recollection Accuracy

An overall, absolute role recollection accuracy was calculated for each participant. Participants were only considered to be absolutely accurate if they correctly recalled *all* of the roles played by the perpetrators. 54.17% of participants in the two-perpetrator condition were absolutely accurate. In the five-perpetrator condition, only 7.29% of participants could accurately recall all five roles.

Mixed Linear Model for Role Recollection

Two generalised mixed linear models were run to ascertain how accurate participants were at describing the perpetrators' roles. Experimental group was the fixed effect and performance on role recollection tasks, which was nested within participants was the random effect. This was to account for the repeated measures design. Initially, a null model was constructed, which predicted role recollection accuracy by the intercept and random intercepts for participants. Thereafter, a second model was constructed that incorporated

experimental group (fixed effect) and the random effect (participant). A chi-square test was used to determine whether there was a significant difference between the deviance scores of each model. The characteristics of, and comparison between, both models are presented in Table 12.

Table 12

Characteristics of the Two Models Predicting Role Recollection Accuracy

Model Name	Model Details	df	AIC	BIC	Loglikelihood	Deviance	ΔX_2
Null Model	Binary_Accuracy ~ 1 + (1 | p_number)		920.28	929.30	-458.14		
Model 2	Binary_Accuracy ~ 1 + Group + (1 | p_number)	1	904.28	917.81	-449.14	898.28	18**

Note. ** indicates a significant p-value. $\Delta\chi^2$ denotes the change in deviance between the two models. 'Model Details' indicates the syntax for each model. The tilde symbol (~) denotes prediction. The number '1' denotes the intercept and '1|' denotes the random effects (i.e., intercepts) grouped by the subsequent term.

The comparison indicated that Model 2 was a significantly better fit for the data, $\chi^2(1) = 18$, $p < .001$. Compared to the null model, Model 2 explained between 4.3% and 17% of the variance in the identification accuracy data ($R^2_{marginal} = .043$, $R^2_{conditional} = .170$). Consequently, Model 2 was used for the rest of the analysis.

Overall, the analysis indicated that there was a significant effect of experimental group, in other words the number of perpetrators, on role recollection accuracy. Specifically, the results suggest that participants who viewed two perpetrators generated a significantly higher number of accurate role recollections (67.71%) than those in the five-perpetrator conditions (48.12%), $z = 0.22$, $p < .001$.

Perpetrator-Role Pairing

All participants in the two-and five-perpetrator groups were required to link each perpetrator to their unique role in the crime. These pairings were scored as either correct or incorrect. Both a positive perpetrator identification and an accurate role description are a pre-requisite for a correct pairing, thus not all participants would be scored along this measure. Instead, participants had a different number of pairing opportunities depending on whether they were given perpetrators' identities and roles, or whether they had to rely on their

memory to retrieve this information. Participants who were provided with both images of the perpetrators and researcher-defined roles were only required to match these two pieces of information, resulting in one pairing per perpetrator. Thus, participants in this group had as many pairing opportunities as the number of offenders they viewed. This was the easiest task as participants were only required to match two pieces of information given to them by the experimenter. For participants who were given images of the perpetrators, but had to generate their own role descriptions, their potential number of pairings was limited by the accuracy of their descriptions. Thus, their number of pairing opportunities was equal to the number of accurate role descriptions they generated. Conversely, for participants who were required to identify perpetrators, but received descriptions of the roles, their potential number of pairings was limited by the accuracy of their identifications. Thus, their number of pairing opportunities was equal to the number of positive identifications they made. Finally, for participants who were required to make line-up identifications, as well as generate role descriptions, their data was manipulated in the following way: firstly, participants who did not make any positive identifications were excluded; then, participants who did not generate at least one accurate role description were excluded. Of the remaining participants, only those who generated at least as many accurate role descriptions as positive identifications were included in the sample. This was the most difficult task because participants had to be accurate in both their identifications and their role recollections so there was a higher chance of making errors.

Table 13 summarises participants' perpetrator-role pairing accuracy. The sample sizes could not be kept consistent across conditions because a participant's ability to score along this measure was restricted by their accuracy during the experiment. Consequently, although the initial sample size for each group was equal (n = 24), there were as few as 13 participants in certain conditions (i.e., only 13 participants who made at least one accurate identification or role description). This is most notable for experimental conditions in which participants were required to make identifications, as less than 63% of the original sample was included in the perpetrator-role pairing data. This is problematic as the accuracy pairing scores for certain experimental groups was inflated as all the inaccurate participants had already been excluded from the sample. Accordingly, the data could not be further analysed as the under-representation of inaccurate participants prevented a meaningful analysis.

However, an inspection of Table 13 shows that participants in the two-perpetrator conditions made more correct pairings than those who viewed five perpetrators. In addition, participants who were given researcher-defined roles, instead of generating their own, were

able to pair more perpetrators to their roles. Furthermore, the data indicates that participants who were required to make line-up identifications, instead of being given images, were more accurate in their perpetrator-role pairings.

Table 13

Descriptive Statistics for Perpetrator-Role Pairing Accuracy

Experimental Condition	Number of Perpetrators	*n*	Total Number of Pairing Opportunities	Correct	Incorrect
Viewed Line-ups					
Participant-defined roles	Two	13 (54.17%)	16	87.50%	12.50%
Researcher-defined roles	Two	13 (54.17%)	17	94.12%	30.77%
Participant-defined roles	Five	15 (62.50%)	22	27.27%	72.73%
Researcher-defined roles	Five	14 (58.33%)	21	47.62%	52.38%
Given Images of Perpetrators					
Participant-defined roles	Two	20 (83.33%)	34	82.37%	17.65%
Researcher-defined roles	Two	24 (100%)	48	87.50%	12.50%
Participant-defined roles	Five	23 (95.83%)	59	25.42%	74.58%
Researcher-defined roles	Five	24 (100%)	120	43.33%	56.67%

Note. Total Number of Pairing Opportunities was calculated using how many accurate identifications or role recollections were made, according to participants' experimental condition. *n* denotes the number of participants in each experimental condition, with their proportion of the original sample size ($n = 24$) in parentheses.

Absolute Accuracy for Perpetrator-Role Pairings

To further inspect the data in Table 13, an overall perpetrator-role pairing accuracy was calculated for each participant in the two-and five-perpetrator conditions. Consequently, this measure applied to all participants in these groups, regardless of whether they are represented in Table 13. Participants were only considered to be absolutely accurate if they correctly paired *all* of the perpetrators to their correct roles. The findings suggest that participants had a higher level of absolute accuracy when they viewed two perpetrators

instead of five. In addition, there was a higher number of participants considered absolutely accurate in groups that were provided with line-ups rather than being given images. Furthermore, participants who were given researcher-defined roles, instead of providing their own, achieved higher absolute accuracy scores. Of note is that, out of all participants in the study, only three were able to correctly link all five perpetrators to their roles. These three participants were all given both the images of, and roles for, all five perpetrators.

Confidence Rating Per Perpetrator-Role Pairing

After making each pairing, participants were required to use a scale, from 0-100, to rate how confident they were in their decision. A single confidence score was calculated for each participant by averaging their confidence ratings across their number of pairing opportunities. Thus, only participants represented in Table 14, all of whom had the potential to make one pairing, were used for this calculation. These individual confidence scores were further averaged across the number of participants in that experimental group.

As with the perpetrator-role pairing accuracy data, no further analyses could be conducted on participants' confidence ratings. However, Table 14 suggests a trend where participants who viewed two perpetrators were more confident than those who viewed five. However, there was inconsistency regarding whether participants who received role descriptions and perpetrators' images were more confident than those who provided this information themselves.

Table 14

Average Perpetrator-Role Pairing Confidence Ratings Across the Number of Perpetrators

Experimental Condition	Number of Perpetrators	*n*	Total Number of Pairing Opportunities	Average Confidence in Perpetrator-role Pairing *M (SD)*
Viewed Line-ups				
Participant-defined roles	Two	13 (54.17%)	16	95.06% (10.16)
Researcher-defined roles	Two	13 (54.17%)	17	77.65% (29.69)
Participant-defined roles	Five	15 (62.50%)	22	59.95% (25.43)
Researcher-defined roles	Five	14 (58.33%)	21	73.57% (22.67)
Given Images of Perpetrators				
Participant-defined roles	Two	20 (83.33%)	34	84.09% (25.55)
Researcher-defined roles	Two	24 (100%)	48	82.60% (29.20)
Participant-defined roles	Five	23 (95.83%)	59	58.90% (4.31)
Researcher-defined roles	Five	24 (100%)	120	50.32% (33.08)

Note. Means are presented with standard deviations in parentheses. *Total Number of Pairing Opportunities* was calculated using how many accurate identifications or role recollections were made, according to participants' experimental condition. *n* denotes the number of participants in each experimental condition, with their proportion of the original sample size (n = 24) in parentheses.

Discussion

Multi-perpetrator eyewitness testimonies are comprised of three components: (a) perpetrator identification (b) role recollection and (c) perpetrator-role pairing. The current research aimed to investigate factors affecting the accuracy of these components by testing four hypotheses. In this section, the findings relevant to each hypothesis will be reviewed and discussed in relation to existing literature. Thereafter, the limitations of the study and recommendations for future research will be addressed.

The Accuracy of Perpetrator Identification

The first aim of the study was to determine the effect of the number of perpetrators at encoding on identification accuracy. It was hypothesised that identification accuracy would

decrease as the number of perpetrators at encoding increased from one to two to five. The results provided evidence for this hypothesis and suggested that participants who viewed two perpetrators made more correct identifications than those who viewed five. However, there was no significant difference in performance between participants who viewed one or two perpetrators.

In the current research, 16.67% of participants in the two-perpetrator condition were able to identify both perpetrators, which is higher than in other research. For example, Shepherd (1983) and Wells and Pozzulo (2006) reported that, for participants who could identify both perpetrators, accuracy levels were 2.40% and 10.60% respectively in their two-perpetrator conditions. Furthermore, Nortje (2018) found that 15% of participants who encoded a two-perpetrator crime, and then viewed perpetrator-present line-ups, were able to correctly identify both perpetrators. It is possible that participants in the current study performed better than those in research reported by Nortje (2018), Shepherd (1983), and Wells and Pozzulo (2006) because the materials at encoding were easier. Alternatively, the line-ups could have been biased towards certain perpetrators. This could be because different perpetrators had distinguishing features, for example a hairstyle that was difficult to match with other photographs from the database. In addition, although Megreya and Bindemann (2011) only tested memory for the main assailant, they found that participants who viewed two perpetrators were significantly less accurate than those who viewed one. It is possible that the current study did not observe this "double-perpetrator disadvantage" (Megreya & Bindemann, 2011) because accuracy levels were higher than those found in previous research thereby reducing the difference between the one-and two-perpetrator conditions. This suggests that the results of the current study did follow the trend in other research, namely that increasing the number of perpetrators does adversely affect eyewitness memory.

Furthermore, in this study only 2.08% of participants in the five-perpetrator condition were able to identify all five perpetrators, which is consistent with other research. For example, Nortje (2018) found that 2.50% of participants in the five-perpetrator condition were able to identify all five perpetrators. Nortje (2018) asserted that a drop-off in identification accuracy was especially evident when five perpetrators were present at encoding. Similarly, findings from Clifford and Hollin (1981), who studied one, three and five perpetrators at encoding, also support that there is a decrease in identification accuracy when five or more perpetrators commit a crime. Specifically, they noted that participants performed below chance level (chance = .10) when viewing five perpetrators.

The theories of perceptual overload and working memory could explain the decrease in identification accuracy observed in the multiple-perpetrator conditions. The presence of multiple perpetrators would result in complex stimuli at encoding, creating a perceptual load that would overwhelm working memory, thereby disrupting the encoding process (Cartwright-Finch & Lavie, 2007). Consequently, participants would not have been able to encode certain details or would have had a weaker memory trace of the crime (Cartwright-Finch & Lavie, 2007). This would create confusion and errors at the recognition stage, especially when comparing line-up members with similar facial features (Cartwright-Finch & Lavie, 2007; Megreya & Bindemann, 2011). However, this is speculation as it is not clear whether different elements of the crime are comparable to the discrete pieces of information, for example numbers, that are used to measure the working memory span. In other words, it cannot be guaranteed that components of a multiple-perpetrator crime, for example perpetrators' faces, can be considered equal to the units of information that are usually referred to when discussing the working memory span.

Although it was not one of the hypotheses, in addition to participants' identification accuracy, their confidence in each line-up decision was also measured. The relationship between eyewitness confidence and identification accuracy has been long studied, although the results are equivocal (Berkowitz et al., 2020; Wixted & Wells, 2017). However, there has been little research into identification confidence for multi-perpetrator eyewitnesses. The current results suggest that, confidence in line-up decisions could also predict identification accuracy. Specifically, as the number of perpetrators increases, participants' confidence in their decision decreases. However, there were only significant differences between the two- and five-perpetrator conditions.

The Accuracy of Role Recollection

The second aim of the study was to determine the effect of the number of perpetrators at encoding on role recollection accuracy. It was hypothesised that accuracy would decrease as the number of perpetrators at encoding increased from two to five. To test this hypothesis, each role description generated by participants in the multi-perpetrator groups was scored before the role assignment process. The results provided evidence for this hypothesis and suggested that participants who viewed two perpetrators generated more correct role descriptions than those who viewed five perpetrators.

There is sparse research into the role recall process within the multi-perpetrator eyewitness literature. The few studies that have tested for role assignment often do not report the accuracy of role recollections as a separate dependent variable before the pairing process

(e.g., Hobson et al., 2012; Nortje, 2018; Wells & Pozzulo, 2006). Conversely, the current study scored role descriptions as correct if they corresponded to the actions played by *any* of the perpetrators before these roles were assigned to a specific perpetrator.

The theory of source monitoring could explain why the role recollection process was more vulnerable to error as the number of perpetrators increased. Multi-perpetrator crimes are complex by nature, meaning that there are many details to be encoded that stem from a shared context (Hobson et al., 2012). As such, participants could have made source monitoring errors by confusing the origin of the role details they were able to recall by attributing them to the incorrect perpetrators (Hobson et al., 2012). There is evidence for this as there were very few participants who confabulated when describing the different roles. Instead, they often confused elements of different roles in their descriptions. For example, a participant would report that the perpetrator carried a box *and* a tyre, when in fact they had only stolen the former object. Thus, the poor recall rate in the multi-perpetrator conditions could have been because the roles overlapped, especially when perpetrators engaged in conversations with one another. As such, source monitoring errors could account for the poor role recall in the multi-perpetrator groups, especially when recalling the components of roles that were shared by two perpetrators.

The Accuracy of Perpetrator-Role Pairings

There is sparse research into the role assignment process within the multi-perpetrator eyewitness literature. Of the studies reviewed, only three tested role assignment (Hobson et al., 2012; Nortje, 2018; Wells & Pozzulo, 2006). Conversely, other studies assigned a main perpetrator and accomplice/s (e.g., Megreya & Bindemann, 2011).

Although it was not an aim of the study, the effect that the number of perpetrators at encoding has on perpetrator-role pairing accuracy was also investigated. Of the studies that tested role assignment, all required participants to make identifications from line-ups and generate their own role descriptions. Thus, in order to contrast results with previous findings, only participants from the current study who were also required to complete those tasks could be included in the comparison. Hobson et al. (2012) and Wells and Pozzulo (2006) found that participants were able to make accurate perpetrator-role pairings. Specifically, Wells and Pozzulo (2006) stated that there was no evidence of "role transference" (p. 417) as only one participant could not recall the role the accomplice played in the crime. However, Nortje (2018) reported that 73.33% and 53.33% of participants in the two-and five-perpetrator groups who made a positive identification also assigned the correct role to each offender. In comparison, the current study found that accuracy rates were 87.50% and 27.27% for the

two-and five-perpetrator groups respectively. This discrepancy could be attributed to the complexity and distinctiveness of the roles played in the various mock crime videos. For example, the roles played by perpetrators in the two-perpetrator condition in the current research may have been more distinctive than those in the crime video from Nortje (2018). Thus, participants in this study would be better able to assign a unique role to each offender. Furthermore, the converse could be true for the roles in the five-perpetrator condition. As such, participants in the current research could have been more vulnerable to source monitoring errors, which would explain why their accuracy levels were lower than those reported in Nortje (2018).

The third aim of the current research was to determine whether accurate perpetrator-role pairings were more likely under conditions of reduced recognition load. Specifically, it was hypothesised that being provided with photographs of the offenders, rather than making a line-up identification, would aid in the role assignment process. The findings did not support this hypothesis. This could be explained by the fact that the process of comparing line-up members could have provided participants with an opportunity to make relative judgements (Wixted & Mickes, 2014). This could have aided in role assignment as research has shown that the process of making relative judgements between line-up members has helped in activating a network of memories associated with the criminal event (Wixted & Mickes, 2014). Another possibility is that accuracy levels were inflated for participants in this condition as those who were not able to provide accurate identifications or role recollections were already excluded from the analysis.

The fourth aim of the current research was to determine whether being required to generate role descriptions for each perpetrator or being given experimenter-defined roles yielded more accurate perpetrator-role pairings. It was hypothesised that being provided with descriptions of each role would aid in the role assignment process. The results supported this hypothesis. Furthermore, being provided with experimenter-defined roles could have eliminated source monitoring errors. Instead, these accurate role descriptions could have functioned as triggers for other memories related to the specific perpetrators, namely their role in the crime (Gillund & Shiffrin, 1984).

Participants who were provided with both photographs of the perpetrators and descriptions of their roles performed the best at the perpetrator-role pairing task. This is expected as these participants were not vulnerable to errors during the line-up and/or role recollection tasks. However, role assignment accuracy for these participants was still relatively low for the five-perpetrator condition (43.33%). A possible explanation for this

finding is that the encoding of the mock crime video was already impaired and being provided with photographs and role descriptions at the pairing stage could not compensate for impoverished eyewitness memory.

Limitations and Recommendations for Further Research

The current experiment had methodological limitations attributable to adjustments to the original procedure necessitated by the COVID-19 pandemic, which prohibited face-to-face data collection in a laboratory. In a laboratory setting, the researcher would be able to control for extraneous variables such as the environment in which participants completed the experiment, the device used, video quality, and adherence to instructions. However, because in-person data collection was not possible, these factors could not be controlled for. Future research could overcome these methodological issues by conducting data collection in an environment in which researchers could standardise the device used to administer the experiment and ensure that participants follow instructions.

The current experiment had limitations attributable to the relatively small number of participants included in the perpetrator-role pairing analysis. Future research could address this by increasing the sample size. However, it is not possible to directly increase the group of participants who made correct identifications. Accordingly, the number of participants making perpetrator-role pairings could still remain relatively low.

In the current study, both identification and perpetrator-accuracy pairing confidence were measured. However, participants were not required to rate how confident they were in their role recollections. Future studies could include role recollection confidence as this would give further insight into witnesses' ability to delineate the actions constituting the crime, which is an integral part of multi-perpetrator eyewitness testimonies. In addition, future research could test whether role recollections can be accurately paired with photographs at the recollection stage. This would isolate the effect of role recollection on pairing, without the possible interference that perpetrator identification could have on this process.

In addition, the current research only used a series of simultaneous line-ups, with one line-up per perpetrator. However, research has shown that line-ups with more than one perpetrator are also used in real-life scenarios. Thus, future research could include a condition in which all perpetrators were in the same line-up to see whether this line-up format affected the results.

Furthermore, the results from this study indicate that identification accuracy was different for the various actors. For example, more positive identifications were made for

Perpetrator Four than Perpetrator Three from the second version of the crime (8 versus 3). A possible reason for this is that Perpetrator Four was more distinctive. He had a prominent fringe making it difficult to match his hairstyle with other photographs from the database. As a result, the line-up could have been biased towards him as his appearance was less comparable to the other line-up members. To address this, future research could use actors that were more similar in appearance. Alternatively, the effect of perceptual differences on identification accuracy could be included as a factor in the experimental design.

A further limitation was that there was only a 25-minute delay between the encoding and recognition stages of the experiment. This does not mimic real-life situations, in which there may be days or even months between witnesses viewing a crime and being required to view a line-up/s. Thus, future research could include a delay in the experimental procedure to test whether this affects multi-perpetrator eyewitness accuracy.

A Theoretical Approach to Understanding the Unreliability of Multi-perpetrator Eyewitness Testimonies

In the current research, theories of perceptual overload, working memory, associative memory and source monitoring have been proposed as possible explanations as to why multi-perpetrator eyewitness testimonies are vulnerable to error. The results of this study have suggested that participants were especially inaccurate when linking each perpetrator to their specific role in the crime. This finding is best explained by the associative memory and source monitoring theories that purport that information relating to the same event is encoded together in a way that results in overlapping memory traces that form a network of associated memories. As a result, eyewitnesses may confuse details that have been encoded into this network as they share the same origin. The consequence of this is that eyewitnesses may be unable to trace a memory that they were able to recall to its unique origin, as opposed to the general criminal event. Such source monitoring errors were prevalent in this research as participants could recall accurate roles, but were not able to link them to the correct perpetrator.

However, these theories are only applicable if eyewitnesses encoded sufficient details to form a network in the first place. Thus, the working memory and perceptual overload theories are fundamental in understanding multi-perpetrator eyewitnesses' inaccuracy. These theories also explain why both perpetrator identification and role recollection accuracy also decreased as the number of perpetrators increased.

Conclusion

Multi-perpetrator eyewitness testimonies are treated as convincing evidence in determining an accused's innocence or guilt. However, research has shown that these testimonies can be inaccurate, and may have devastating consequences. In crimes committed by a single perpetrator, eyewitnesses are only required to identify the one perpetrator from a line-up. However, multi-perpetrator eyewitnesses face a unique challenge as they are tasked with providing three forms of evidence. Specifically, they are required to describe the roles played in the crime, identify the perpetrators from line-ups, and assign each of these roles to a specific perpetrator. However, there has been little research on the topic. As such, the current research aimed to investigate the effect of the number of perpetrators at encoding on both perpetrator identification and role recollection accuracy. Furthermore, it aimed to ascertain whether being provided with perpetrators' identities and descriptions of what they did in the crime would aid in the role assignment process. The results suggested that, as the number of perpetrators increased, the accuracy of role recollections and perpetrator identifications decreased. Although participants' identification performance was worse when viewing five perpetrators compared to one perpetrator, there was no difference between the two multiple-perpetrator groups. The perpetrator-role pairing data suggested that being provided with perpetrators' role descriptions aided in the role assignment process. However, being required to make line-up identifications yielded more accurate pairings. Overall, the results of the current study suggest that eyewitness memory is fallible at the identification, role recollection and role assignment phases. Insight into eyewitness memory during each of these processes is needed to aid law enforcement in determining the most effective way of eliciting testimonies from eyewitnesses of multi-perpetrator crimes. In addition, the findings have theoretical implications as they suggest that, even when the identities and actions of perpetrators are known, there is a difficulty in linking these two streams of evidence. This means that the complexity of multi-perpetrator crimes may disrupt encoding to such an extent that removing the identification and recognition stages cannot compensate for this. Future research is needed into multi-perpetrator eyewitness testimonies, especially into perpetrator-role pairings as this is the process most vulnerable to error. Such additional understanding into the role assignment process, which is largely neglected in the literature, is necessary to prevent devastating miscarriages of justice that stem from incorrect perpetrator-role pairings.

References

Baddeley, A. D., & Hitch, G. (1974). Working memory. In K. D. Federmeier, & E. R. Schotter (Eds.), *The psychology of learning and motivation, volume 73* (pp. 47-89). Elsevier Academic Press.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*(1), 1-48. https://doi.org/10.18637/jss.v067.i01

Berkowitz, S. R., Garrett, B. L., Fenn, K. M., & Loftus, E. F. (2020). Convicting with confidence? Why we should not over-rely on eyewitness confidence. M*emory*, 1-6. https://doi.org/10.1080/09658211.2020.1849308

Bindemann, M., Burton, M. A., & Jenkins, R. (2005). Capacity limits for face processing. *Cognition, 98*(2), 177-197. https://doi.org/10.1016/j.cognition.2004.11.004

Bindemann, M., Jenkins, R., & Burton, M. A. (2007). A bottleneck in face identification. *Experimental Psychology, 54*(3), 192-201. https://doi.org/10.1027/1618-3169.54.3.192

Carlson, C. A., Dias, J. L., Weatherford, D. R., & Carlson, M. A. (2017). An investigation of the weapon focus effect and the confidence–accuracy relationship for eyewitness identification. *Journal of Applied Research of Memory and Cognition, (6)*(1), 82-92. https://doi.org/10.1016/j.jarmac.2016.04.001

Cartwright-Finch, U., & Lavie, N. (2007). The role of perceptual load in inattentional blindness. *Cognition, 102*(3), 321-340. https://doi.org/10.1016/j.cognition.2006.01.002

Clifford, B. R., & Hollin, C. R. (1981). Effects of the type of incident and the number of perpetrators on eyewitness memory. *Journal of Applied Psychology, 66*(3), 364-370. https://doi.org/10.1037/0021-9010.66.3.364

Cowan, N. (2010). The magical mystery four: How is working memory capacity limited, and why? *Current Directions in Psychological Science, 19*(1), 51–57. https://doi.org/10.1177/0963721409359277

Du Toit, E., De Jager, F. J., Paizes, A., Skeen, A. S. Q., & Van der Merwe, S. E. (2011). *Commentary on the criminal procedure act (Vol. 1).* Juta.

Egan, D., Pittner, M., & Goldstein, A. G. (1977). Eyewitness identification: Photographs vs. live models. *Law and Human Behaviour, 1*(2), 199-206. https://doi.org/10.1007/bf01053439

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power and analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behaviour Research Methods, 41*(4), 1149-1160. doi:10.3758/BRM.41.4.1149

Gillund, G., & Shiffrin, R. M. (1984). A retrieval model for both recognition and recall. *Psychological Review, 91*(1), 1-67. https://doi.org/10.1037/0033-295x.91.1.1

Greene, C. M., Murphy, G., & Januszewski, J. (2017). Under high perceptual load, observers look but do not see. *Applied Cognitive Psychology, 31*(4), 431–437. https://doi.org/10.1002/acp.3335

Hobson, Z. J., & Wilcock, R. (2011). Eyewitness identification of multiple perpetrators. *International Journal of Police Science and Management, 13*(4), 286-296. https://doi.org/10.1350/ijps.2011.13.4.253

Hobson, Z. J., Wilcock, R., & Valentine, T. (2012). Multiple suspect showing: A survey of police identification officers. *Policing, 7*(1), 79 – 87. https://doi.org/10.1093/police/pas021

Hollingworth, A., & Henderson, J. M. (2002). Accurate visual memory for previously attended objects in natural scenes. *Journal of Experimental Psychology: Human Perception and Performance, 28*(1), 113-136. https://doi.org/10.1037/0096-1523.28.1.113

Hope, L., Mullis, R., & Gabbert, F. (2013). Who? What? When? Using a timeline technique to facilitate recall of a complex event. *Journal of Applied Research in Memory and Cognition, 2*(1), 20-24. https://doi.org/10.1016/j.jarmac.2013.01.002

Horvath, M. A., & Kelly, L. (2009). Multiple perpetrator rape: Naming an offence and initial research findings. *Journal of Sexual Aggression, 15*(1), 83-96. https://doi.org/10.1080/13552600802653818

Innocence Project (2020). *Eyewitness misidentifications.* http://www.innocenceproject.org/understand/Eyewitness-Misidentification

Jacob, P. (1994). *The feasibility of using multiple-suspect sequential lineups.* [Unpublished Honour's thesis]. Queen's University, Canada.

Jenkins, R., Lavie, N., & Driver, J. (2003). Ignoring famous faces: Category-specific dilution of distractor interference. *Perception & Psychophysics, 65*(2), 298-309. https://doi.org/10.3758/bf03194801

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114*(1), 3-28. https://doi.org/10.1037/0033-2909.114.1.3

Kask, K. (2020). Identification accuracy of a single culprit in a multiple-perpetrator

mock crime. *European Review of Applied Psychology, 70*(6), 1-9. https://doi.org/10.1016/j.erap.2020.100606

Laldin, S. (1997). *Contextual effects on lineup identification of multiple perpetrators.* [Unpublished Honour's thesis]. Queen's University, Canada.

Lamont, A. C., Stewart-Williams, S., & Podd, J. (2005). Face recognition and aging: Effects of target age and memory load. *Memory & Cognition, 33*(6), 1017-1024. https://doi.org/10.3758/bf03193209

Loftus, E. F. (2018). Eyewitness science and the legal system. *Annual Review of Law and Science, 14*(1), 1-10. https://doi.org/10.1146/annurev-lawsocsci-101317-030850

Malpass, R. S., Tredoux, C. G., & McQuiston-Surrett, D. (2007). Lineup construction and lineup fairness. In R. C. L. Lindsay, D. F. Ross, J. D. Read, & M. P. Toglia (Eds.), *The handbook of eyewitness psychology, Vol. 2. Memory for people* (pp. 155–178). Lawrence Erlbaum Associates Publishers.

Maw, A. (2013). *The psychological impact of rape: A longitudinal study of adult female survivors in the Western Cape, South Africa.*[Unpublished doctoral dissertation]. University of Cape Town, South Africa.

Megreya, A. M., & Bindemann, M. (2011). Identification accuracy for singe- and double-perpetrator crimes: Does accomplice gender matter? *British Journal of Psychology, 103*(4), 439-453. https://doi.org/10.1111/j.2044-8295.2011.02084.x

Mestry, N., Menneer, T., Cave, K. R., Godwin, H. J., & Donnelly, N. (2017). Dual-target cost in visual search for multiple unfamiliar faces. *Journal of Experimental Psychology: Human Perception and Performance, 48*(8), 1504-1519. https://doi.org/10.1037/xhp0000388

Metzger, M. (2002). Stimulus load and age effects in face recognition: A comparison of children and adults. *North American Journal of Psychology, 4*(1), 51-62. https://doi.org/10.1037/e413792005-476

Mulligan, N. W. (1998). The role of attention during encoding in implicit and explicit memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*(1), 27-47. https://doi.org/10.1037/0278-7393.24.1.27

Mthethwa and Another v The State. [2020] ZAFSHC 200 (2020).

Nortje, A. (2018). *The butcher, the baker, the candlestick maker: Investigating facial recognition for multiple-perpetrator crimes.* [Unpublished doctoral dissertation]. University of Cape Town, South Africa.

Police and Criminal Evidence Act (PACE) (1984). Codes of Practice (Code D). (2011).

http://police.homeoffice.gov.uk/operational-policing/powers-pace-codes/pace-codeintro/

RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/.

Shepherd, J. W. (1983). Identification after long delays. In S. M. A. Lloyd-Bostock & B.R. Clifford (Eds.), *Evaluating witness evidence: Recent psychological research and new perspectives* (pp. 173 – 187). John Wiley & Sons Ltd.

Sourcebook of Criminal Justice Statistics. (2011, May 21). Estimated percent distribution of violent victimizations by multiple offenders by type of crime and perceived race of offenders. https://www.albany.edu/sourcebook/pdf/t3312008.pdf

South African Police Service. (2015, 29 September). Crime Situation in South Africa. https://www.saps.gov.za/services/crimestats_archive.php

Swart, L., Gilchrist, A., Butchart, A., Seedat, M., & Martin, L. (2000). Rape surveillance through district surgeon offices in Johannesburg, 1996-1998: Findings, evaluation and prevention implications. *South African Journal of Psychology, 30*(2), 1-10. https://doi.org/10.1177/008124630003000201

Tredoux, C. G., Meissner, C. A., Malpass, R. S., & Zimmerman, L. A. (2004). Eyewitness identification. In C. Spielberger's (Ed.), *Encyclopedia of applied psychology* (pp. 875-887). Academic Press.

Tupper, N., Sauerland, M., Sauer, J. D., & Hope, L. (2019). Eyewitness identification procedures for multiple perpetrator crimes: A survey of police in Sweden, Belgium, and the Netherlands. *Psychology, Crime & Law*, *25*(10), 992-1007. https://doi.org/10.1080/1068316x.2019.1611828

Vanderwal, A. (1996). *The effects of the sequential presentation of lineups with multiple perpetrators on eyewitness identification.* [Unpublished Honour's thesis]. Queen's University, Canada.

Vuilleumier, P. (2000). Faces call for attention: Evidence from patients with visual extinction. *Neuropsychologica, 38(*5), 693-700. https://doi.org/10.1016/s0028-3932(99)00107-4

Wells, G. L. (1978). Applied eyewitness-testimony research: System variables and estimator variables. *Journal of Personality and Social Psychology*, *36*(12), 1546-1557. https://doi.org/10.1037/0022-3514.36.12.1546

Wells, G. L., Kovera, M. B., Douglass, A. B., Brewer, N., Meissner, C. A., & Wixted, J. T.

(2020). Policy and procedure recommendations for the collection and preservation of eyewitness identification evidence. *Law and Human Behavior, 44*(1), 3–36. https://doi.org/10.1037/lhb0000359

Wells, E. C., & Pozzulo, J. D. (2006). Accuracy of eyewitnesses with a two-culprit crime: Testing a new identification procedure. *Psychology, Crime & Law, 12*(4), 417-427. https://doi.org/10.1080/10683160500050666

Wixted, J. T., & Mickes, L. (2014). A signal-detection-based diagnostic-feature-detection model of eyewitness identification. *Psychological Review, 121*(2), 262-276. https://doi.org/10.1037/a0035940

Wixted, J. T., & Wells, G. L. (2017). The relationship between eyewitness confidence and identification accuracy: A new synthesis. *Psychological Science in the Public Interest, 18*(1), 10-65. https://doi.org/10.1177/1529100616686966

Appendix A

Dear students,

We would like to invite you to participate in an online study on theft prevention at UCT. If you choose to partake in this 45-minute study you will be required to view a short video clip depicting a crime and complete various activities based on what you watched. At the end of the experiment you will be fully debriefed so that you can learn more about this interesting field of research.

There are no exclusion criteria! In return for your participation, you will be entered into a raffle to win a R250 Takealot vouchers. One winner will be raffled for every 50 students who complete the study.

We would prefer you to complete the experiment on a laptop or desktop computer. However, you can use another device (e.g. smartphone or tablet) but please indicate this at the beginning of the experiment.

Use this link to begin:
https://toulousepsychology.eu.qualtrics.com/jfe/form/SV_1XJ64hEj1lYDa0l

Please contact Carrie Allen (allcar007@myuct.ac.za) if you have questions regarding participation in the study.

Appendix B

CPS Safety Tips to Prevent Theft on Campus

Theft is the most common crime on campus. The best means of prevention is to reduce or remove the opportunity:

- Whenever you leave your office, laboratory or residence, lock the door and close all the windows, even if you are leaving for only a short time.
- Never leave access doors propped open.
- Lock your purse or wallet in a drawer or filing cabinet while you are in the office.
- Don't leave your bag or backpack unsupervised in public places.
- Never leave items on display inside your car while it is parked.
- Invest in a steering, wheel or gear lock for your car.
- Engrave your property, preferably with your driver's licence number.
- Keep a record of the serial numbers and descriptions of your valuables.

Definitions

Theft

Simple theft (also known as larceny) is a type of crime that involves unlawfully taking or using property that belongs to another person or entity. There are many different flavors of theft charges in most jurisdictions, ranging from misdemeanor shoplifting to grand theft. Typically, they all have the same basic elements (i.e., unlawfully taking property that belongs to another person or entity), but have a subtle variation, such as whether it was taken from a retail store (shoplifting), the value of what was stolen (petty or grand theft), the type of property stolen (grand theft auto), etc.

Fraud

Stealing that involves deceiving someone to give up their property willingly but under false pretenses rather than using violence or simply walking away with the property is often referred to as fraud. Just as with simple theft, fraud can have many varieties based on the nature of the deception involved. For example, if someone takes property with which they were entrusted for other purposes they have committed embezzlement. If someone creates a fake currency, check, or other negotiable instrument, they may be charged with counterfeiting. If they mislead the government regarding their income, they may be guilty of tax fraud or evasion.

Fraud is often referred to as a "white collar" crime, as it usually involves no violence and is conducted through business dealings. Despite the use of deception rather than physical force, fraud can be extremely serious and have a devastating effect on the finances of the victim (consider those who lose their life savings in fraudulent investment schemes). Acts of fraud can result in enormous amounts of monetary and property theft, since there are often dozens, if not hundreds, of victims. As a result, sentences can vary widely, as well, from simple fines and probation to serious prison time in federal penitentiaries.

Theft Prevention Questionnaire

1. What is the most common crime on campus?

2. According to CPS guidelines, how can you protect yourself from theft on campus?

3. What do you think was the most useful theft prevention tip from the article you read?

4. Where do you think most thefts on campus take place?

5. What forms of punishment do you think would best reduce theft of campus?

6. What do CPS suggest in order to prevent car theft?

7. What time of year do you think most theft on campus takes place? Explain your answer

8. What does CPS suggest you do when you leave your office to prevent theft?

9. What does “theft” mean?

10. What does “fraud” mean?

11. How is “theft” different to “fraud”?

12. Do you think there should be different punishments for theft and fraud? Explain your answer

Appendix C

Photographing faces : the Schaupp-Tredoux entente

Where to get key and camera?

1 Physical-spatial preparation

a) Place **chair**, **camera** and **flash units** in the designated places. If they are already setup, check their position.

b) Set flash units to the following heights; Lower flash unit = 78 cm; Higher flash unit = 128 cm.

Refer to Drawing A.

2 Setup of flash heads

a) Check that switch on wall is on.

b) Power both flash units on, including modeling lights (to II, higher power setting).

c) Each flash unit to have flash intensity set to maximum.

d) Discharge each flash unit twice to dissipate pre-charge.

Refer to Drawing B.

3 Setup of camera

a) Mount camera on tripod, in portrait orientation; ensure camera is level and straight.

b) Connect flash sync lead to camera and to lower flash head.

c) Set mode to M(anual) on mode selection wheel.

d) Reset camera settings to default (?)

e) Set image quality to large, smooth.

f) Set white balance option to color temperature (K) on small LCD screen.

g) Set color temperature to 5000 K (via menu).

h) Set aperture to 8.0, shutter speed to 60 (i.e. f = 8.0, s = $1/60^{th}$).

4 Photo subjects

I Preliminaries

a) Explain release form to subject and get signature.

b) Ask subject to remove jewellery, headgear, glasses. If they wear heavy make up, continue, but ask them at the end of the session if they can return later without make up.

c) Ask subject to sit down in chair.

d) Adjust height of tripod so the camera lens is at eye level of subject.

e) Adjust angles of the umbrellas and flash units to be 45 degrees to subject's line of sight. (see Drawing A)

f) Adjust angles of the flash units according to qualitative impression – lower unit umbrella must reflect downward, higher unit must reflect upward.

g) Take photograph of MacBeth colour chart for first subject of the day/session. Subject to hold chart so that it is centred in frame, parallel plane to camera. Tell the subject to hold colour chart on the edges without touching any of the colour swats on the chart.

II Photographs

h) Only one subject in the room at a time. Subject to sit down, upright, not against back of chair. In frontal view should fill 2/3 of frame horizontally, ½ of the frame vertically

i) Tell subject that you are taking four shots

j) Take casual shot; check for this and all other shots that results are acceptable i.e. no shut eyes, in frame, in focus (test focus with zoomview option in review mode of camera)

k) Take frontal shot, but VERY IMPORTANTLY ensure

i) Vertical orientation angle to be checked ("lift chin", "drop chin"; lead by example)

ii) Horizontal orientation angle to be checked ("swivel your head to the left", lead by example)

iii) Pupil eyeline angle to be checked ("tilt your head to the left/right" etc, lead by example)

NOTE that these are dynamic and changes in one can undo changes in another! Check and re-check.

l) Take ¾ shot. Ask subject to change seating position, not just head angle, and to look to back of umbrella. Adjust vertical ("drop chin") and horizontal orientation ("swivel left"). A correctly composed shot will just show a hint of the far cheek and eye.

m) Take 90 degree profile shot. Check vertical and horizontal angles

n) Thank subject; say goodbyes

---

4 Closure

a) Switch off camera

b) Turn flash units off, power at wall off

c) Take out sync leads from camera

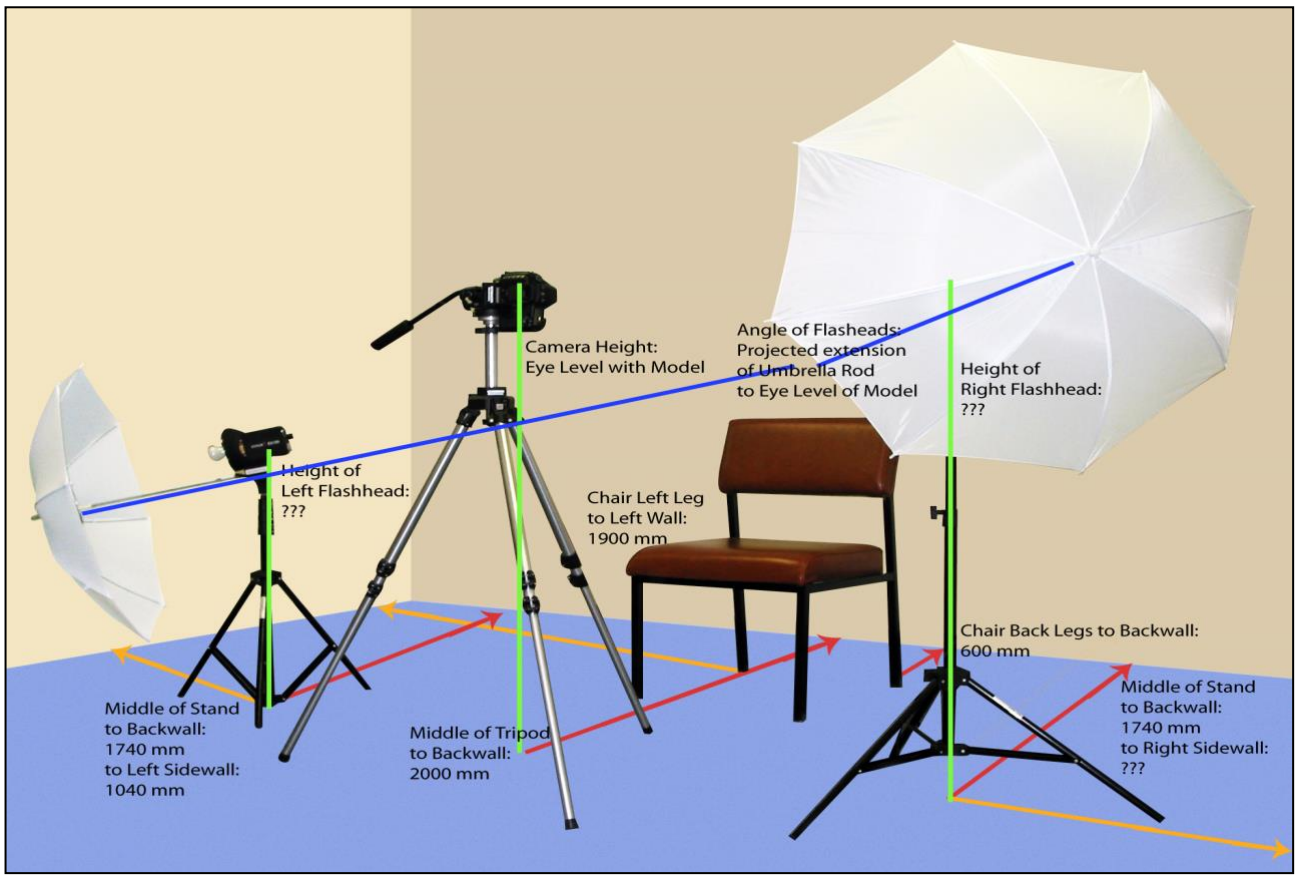
d) Dismount camera.

e) Camera to be removed from venue, door to be locked

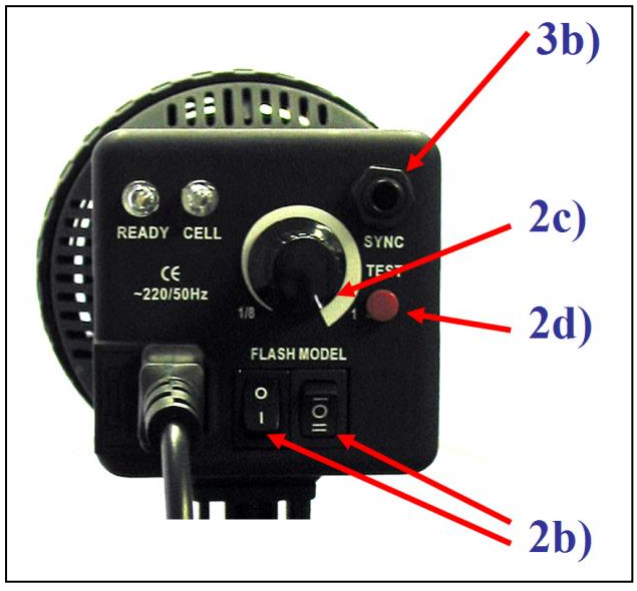
f) Memory flash card to be given to Heike. Heike to download images, to copy them to the Macintosh server, and to add them to the backup CD or DVD.

Key??

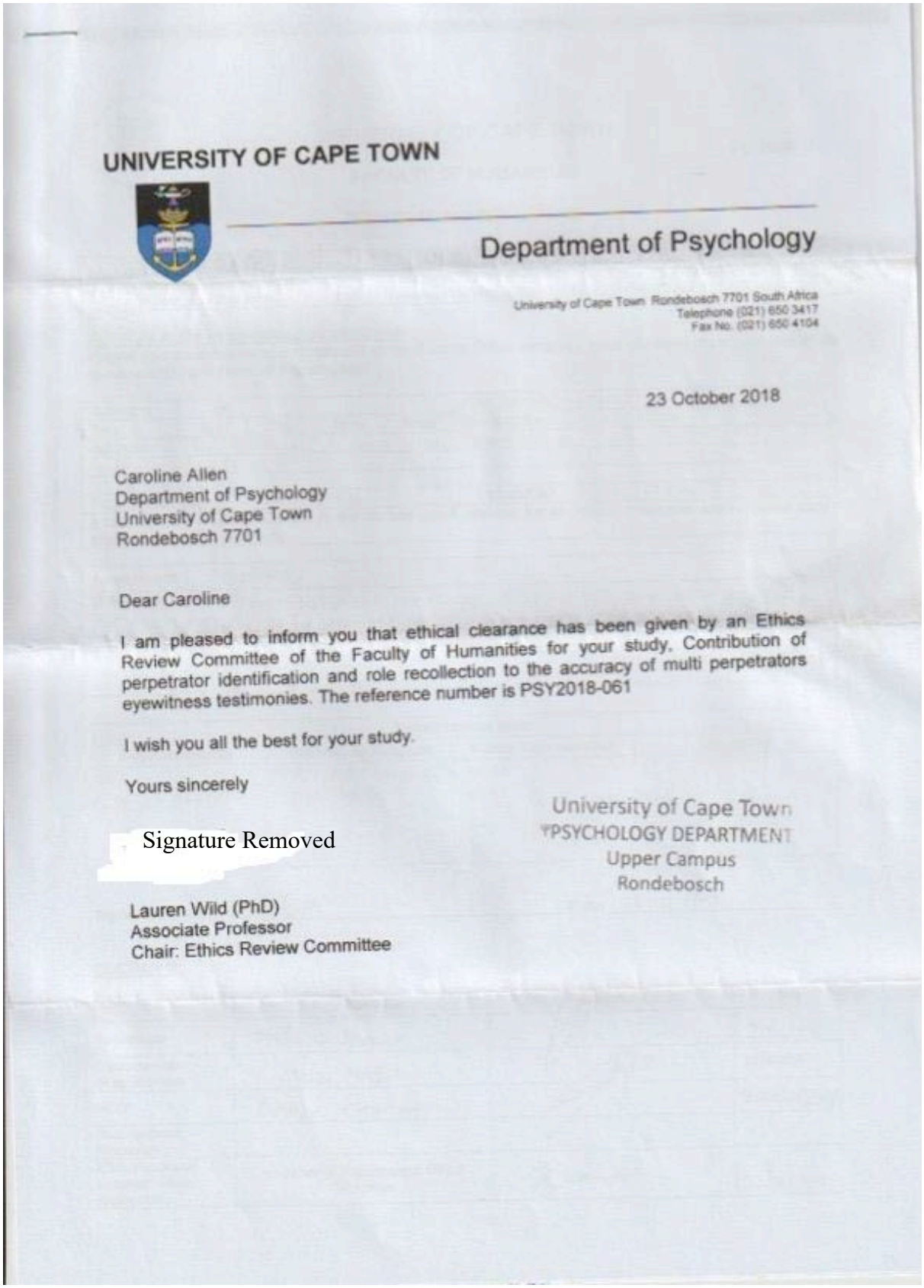
Drawing A: High Fidelity Photographic Setup for Forensic Studio in Room 4.23



Drawing B: Settings for Flash Heads



Appendix D



UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

23 October 2018

Caroline Allen
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Caroline

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your study, Contribution of perpetrator identification and role recollection to the accuracy of multi perpetrators eyewitness testimonies. The reference number is PSY2018-061

I wish you all the best for your study.

Yours sincerely

Signature Removed

University of Cape Town
PSYCHOLOGY DEPARTMENT
Upper Campus
Rondebosch

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

Appendix E

Consent to participate in a research study

Dear student,
Study Aim
You are being invited to partake in a study being done by researchers from the Department of Psychology at the University of Cape Town. The aim of this study is to learn more about crime prevention at UCT.

Study Procedures
If you choose to participate in this study you will have to watch a short video clip of a theft and complete various activities online based on what you have viewed. The study will take 1 hour in total.

Possible Risks
A risk for this study is the loss of confidentiality when filling out the consent, participant information and SRPP forms that ask for details such as names, student numbers and demographics. In addition, the video of the theft might be distressing to some; however, the crime is victimless and non-violent.

Possible Benefits
You will be entered into a raffle to win a R250 Takealot voucher. One voucher will be raffled per every 50 participants. You will only be entered into the raffle if you complete the ENTIRE experiment.

Costs
The only cost involved is the time that you will give up in order to take part in the study.

Voluntary Participation
Your participation is this study is completely your choice. You will not suffer any consequences if you decide not to take part in this experiment or if you choose not to answer a certain question. You are also free to leave the study at any time.

Confidentiality
Information that you provide during this study will be kept privately. Your identifying details, such as your name, student number and demographic information, will only appear on the consent, participant information and consent forms. These forms will be kept privately by the researchers in a secure location. Only the researchers will be able to track your performance back to you, but this information will also be kept privately and securely.

Questions
If you have any questions or comments relating to the study you should contact the following researchers:

Carrie Allen allcar007@myuct.ac.za
Alicia Nortje alicia.nortje@gmail.com
Rosalind Adams rosalind.adams@uct.ac.za

By selecting either option below you are acknowledging the following:

I have read the consent form and understood what participating in this study will involve. I am aware of the risks and benefits. I have no further questions about the study and voluntarily consent to participate.

- ○ Yes, I consent
- ○ No, I don't consent

- ○ Yes, I consent
- ○ No, I don't consent

Appendix F

It is common to ask for demographic information in empirical experiments. This is because, in comparison to other countries around the world, the South African population is extremely diverse. Therefore, researchers require the following information in order to determine whether findings from other countries are relevant to the South African population

Which race do you identify with?

- Black
- White
- Asian
- Indian
- Coloured
- Other

What gender do you identify with?

- Male
- Female
- I prefer a different description

Are you a South African citizen?

- Yes
- No

How old are you?

Appendix G

Table 3

Instruction for the Role Recollection Phase

	Instruction
Role description instructions	Now, pretend the police officer has asked you to give an account of what each perpetrator looked like. In the blocks provided below, please write your description of the perpetrators' appearance. You do not have to describe the perpetrators according to the order in which they appeared in the crime video. There should be one description per block. Include as much detail as you can remember.

Table 4

Instructions for the Perpetrator Identification Phase

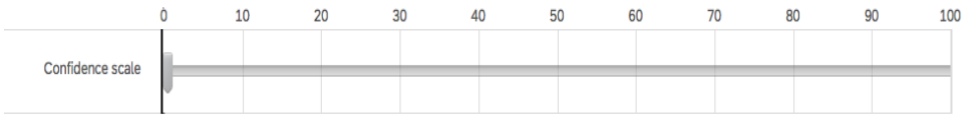
	Instruction
Perpetrator Identification required	Now, you will be presented with a line-up, which may or may not contain one of the perpetrators that committed the crime in the video. Your task is to decide who, if anyone, from the line-up is one of the perpetrators. You will be shown two line-ups in total, both of which will consist of six people. If you think the perpetrator is in the line-up, click on the image of their face. However, if you think the perpetrator is not in the line-up, select the 'Not Present' option. Select the 'Don't Know' option if you are not sure whether the perpetrator is in the line-up.
Perpetrator Identification confidence	Now, you need to rate how confident you are in your decision on the previous line-up task, regardless of whether you selected a line-up member or selected the 'Not Present' option. Your confidence will be measured on a scale of 0-100. For example, if you have no doubt that the line-up member you selected is the perpetrator, you would give a rating of 100. If you are certain that the perpetrator was not in the line-up, you would also give a rating of 100. You would give a rating of 0 if you are completely uncertain about your decision to select either a line-up member or the 'Not Present' option. 

Table 5

Instructions for the Perpetrator-Role Pairing Phase

	Instruction
Perpetrator Identification required, Role Recollection required	On the next page, you will be shown the two descriptions you provided of the different roles played by the perpetrators in the crime. Your task is to link the perpetrators to their unique role. In other words, you need to decide who did what. To do this, you will be shown an image of the perpetrator you just identified from the line-up, and will then select their role from the two descriptions that you provided.
Perpetrator Identification required, Role Recollection given	On the next page, you will be provided with descriptions of the two different roles played by the perpetrators in the crime. Your task is to link each of the perpetrators to their unique role. In other words, you need to decide who did what. To do this, you will be shown an image of the perpetrator you just identified from the line-up and will then select their role from the two descriptions provided.
Perpetrator Identification given, Role Recollection required	On the next page, you will be shown images of the two perpetrators that committed the crime in the video. In addition, you will be presented with the two descriptions you provided of the different roles played by the perpetrators. Your task is to link the perpetrators to their unique role. In other words, you need to decide who did what. To do this, you will be shown the first image on the next page and will then select this perpetrator's role from the two descriptions you provided.
Perpetrator Identification given, Role Recollection given	On the next page, you will be shown images of the two perpetrators that committed the crime in the video. In addition, you will be provided with descriptions of the two different roles played by the perpetrators. Your task is to link each perpetrator to their unique role. In other words, you need to decide who did what. To do this, you will be shown the first image on the next page and will then select this perpetrator's role from the two descriptions provided.
Perpetrator-Role pairing confidence (for all conditions)	Now, you need to rate how confident you are in your decision on the previous perpetrator-role matching task. Your confidence will be measured on a scale of 0-100. For example, if you have no doubt that the perpetrator played the role you selected, you would give a rating of 100. If you are completely uncertain about whether you matched the perpetrator to the correct role, you would give a rating of 0.

Appendix H

Thank you for giving up your time to participate in our study, it is greatly appreciated!

This research aims to understand the processes that underlie the unreliability of multi-perpetrator eyewitness testimonies, meaning the eyewitness accounts provided by witnesses of crime committed by more than one offender. Research has shown that multi-perpetrator eyewitness testimonies are extremely unreliable. This is because these witnesses have a very difficult task to do as they have to:

1) Identify all of the perpetrators from line-ups
2) Link each perpetrator to their exact role in the crime

If witnesses provide inaccurate perpetrator identifications and perpetrator-role pairings the consequences are devastating as innocent individuals could be misidentified, forcing them to spend years in jail while the guilty perpetrators remain free to offend again. In South Africa, this topic is extremely relevant as the rates of multi-perpetrator crimes are alarmingly high. Despite the importance of this topic, there has been little research into why multi-perpetrator eyewitness testimonies are so inaccurate, in fact there are fewer than 20 published on the topic! In light of this, your participation has contributed to filling a research gap that has real-life relevance.

In this study we are interested in investigating WHY multi-perpetrators are so inaccurate by asking:

1) Does the difficulty lie in identifying perpetrators from the line-up?
2) Does the difficulty lie in the being able to describe the role played by each perpetrator?
3) Does the difficulty like within having to link each perpetrator to their role played in the crime?

Having highlighted the practical nature of the multi-perpetrator eyewitness testimony problem, we would like to explain why we had to use deception in order to answer the research aims we are trying to address:

In our SRPP announcement we advertised that our study was about crime prevention at UCT instead of explicitly stating that it was about the accuracy of multi-perpetrator eyewitness testimonies. This was necessary to create conditions in the experiment that most mimic real-life situations. In reality, eyewitnesses are not notified prior to viewing a crime as such events are unexpected which is why remembering relevant details is so difficult. In order to investigate for the kind of spontaneity that eyewitnesses would experience, we did not tell you what tasks you would be completing after watching the video. If we had told you, you would have been able to focus on what each perpetrator looked like and what they were doing and this could have made the identification tasks easier. Also, you were asked to complete the comprehension as a way to distract you from rehearsing what you saw in the video. This was necessary as witnesses who view real crimes have to hold to details of the event until they are asked to give a police report or make an identification. Overall, we believe that the risk of deception outweighed the benefits that could come from this research and its potential influence on the criminal justice system.

You may have noticed that other participants watched videos and completed tasks that you did not. This is because each participant was randomly assigned to various groups in order to test identification and perpetrator-role pairing accuracy under different conditions. We hope that your participation in the study has given you some insight into the complex and interesting nature of experimental designs.

We have also tried to keep the video you watched as least distressing as possible by depicting a victimless and non-violent crime. All of the individuals in the video were actors and the theft was staged.

In addition, all of the forms containing any of your identifying details will be kept privately and safely by the researchers.

We hope that by participating in this study you have gained some insight into multi-perpetrator eyewitness research. The following interesting article highlights the importance of the research to which you have just contributed:

Hobson, Z. J., & Wilcock, R. (2011). Eyewitness identification of multiple perpetrators. *International Journal of Police Science and Management, 13*(4), 286-296. doi: 10.1350/ijps.2011.13.4.253

If you have any questions, comments or complaints regarding your experience of study, do not hesitate to contact us:

alicia.nortje@gmail.com

allcar007@myuct.ac.za
rosalind.adams@uct.ac.za

Below we have listed the contact details of the Student Wellness Service in case you would like to seek help for any distress that may have been caused by this study. In addition, we have listed the details of CPS in the event that you feel unsafe on campus or witness any criminal event.

The Student Wellness Service
Ivan Toms Building
28 Rhodes Ave
Mowbray 7700
Tel: 021 650 1020 / 1017

CPS Management
Tel: 021 650 4654 or 021 650 4525

CPS Crime Prevention
Tel: 021 650 2222

Appendix I

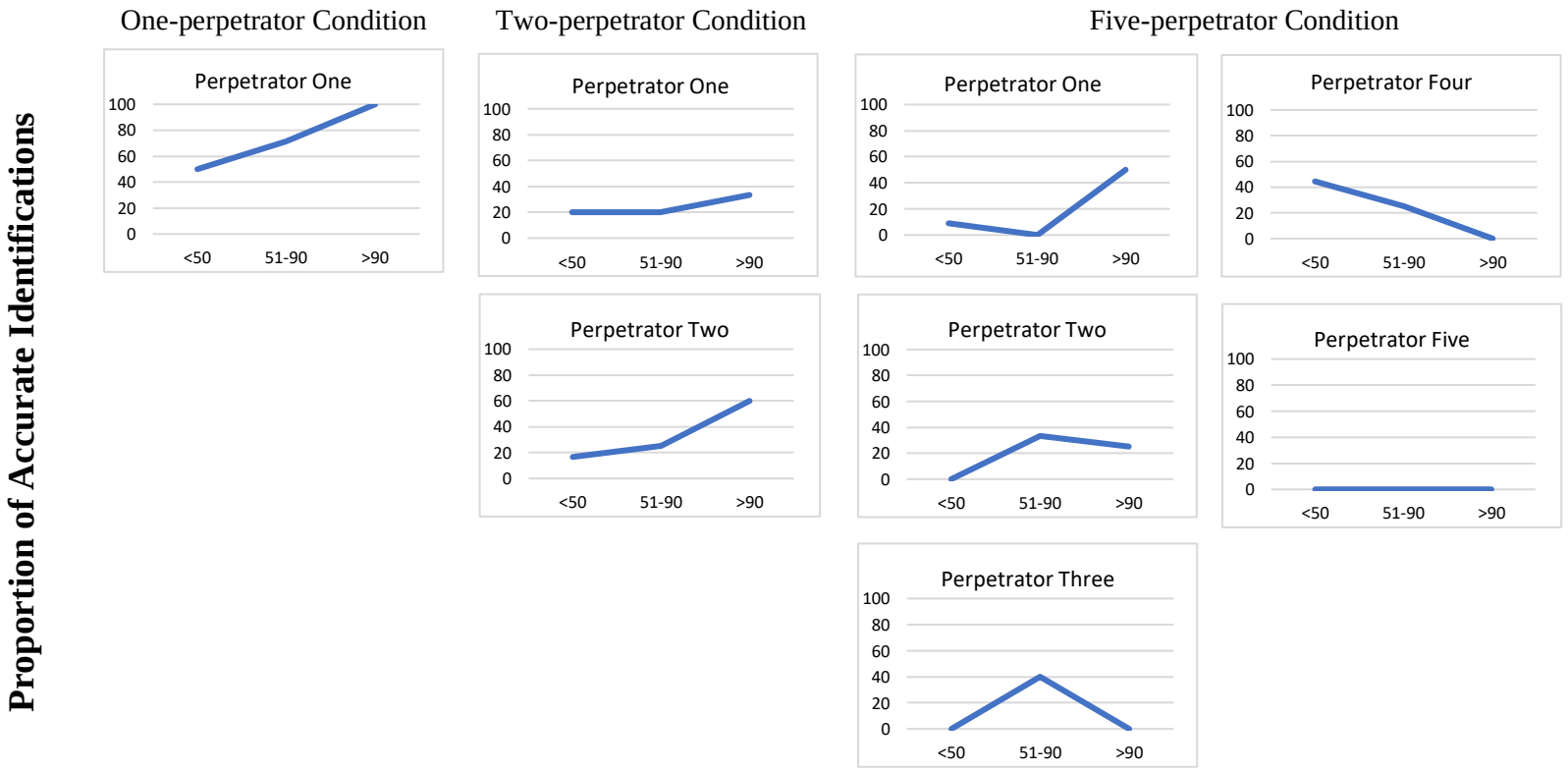
Table 6

Measures of Accuracy

Dependent Variables	Factors		
	Number of Perpetrators	Perpetrator Identification	Role Recollection
Accuracy of perpetrator identification	One perpetrator Two perpetrators Five perpetrators	Identification required	Role required Role provided
Accuracy of role recollection	Two perpetrators Five perpetrators	Identification required Identification provided	Role required
Accuracy of perpetrator-role pairing	Two perpetrators Five perpetrators	Identification required Identification provided	Role required Role provided

Figure 7

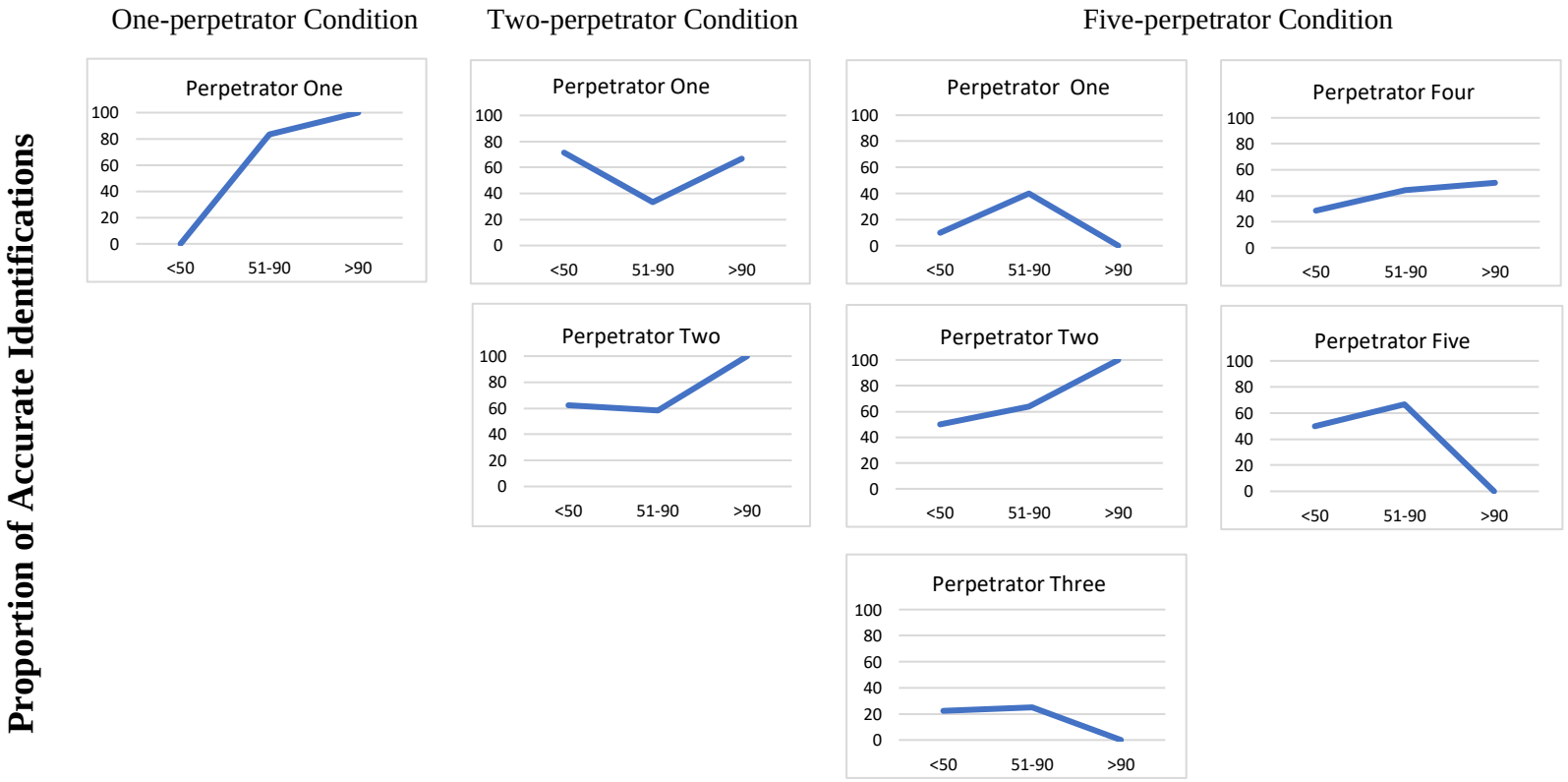
The Relationship Between Identification Confidence and Accuracy Per Perpetrator



Note. The confidence-accuracy relationship per each perpetrator in each condition is represented on a separate graph. The perpetrators represented in the graphs were present in the first version of the mock crime films.

Figure 8

The Relationship Between Identification Confidence and Accuracy Per Perpetrator



Note. The confidence-accuracy relationship per each perpetrator in each condition is represented on a separate graph. The perpetrators represented in the graphs were present in the second version of the mock crime films.