Testing Two Retrieval Strategies to Enhance Eyewitness Memory: Category and Location Clustering Recall

Rui M. Paulo

School of Sciences, Bath Spa University

Emilie Jones

School of Sciences, Bath Spa University

Rebecca Mendes

School of Sciences, Bath Spa University

May 2020

Abstract

Asking eyewitnesses to provide an initial account using free recall strategies is a crucial procedure used in most investigative interviews (e.g. Cognitive Interview or PEACE model) allowing eyewitnesses to recall accurate and detailed information about the crime. Recent studies suggest clustering retrieval strategies like Category Clustering Recall (CCR) can also be effective for obtaining accurate information from eyewitnesses, and perhaps more effective than the change order mnemonic, a witness-compatible questioning, or a free recall task. This study compared how effective three retrieval strategies were (free recall, CCR, and a new retrieval strategy: Location Clustering Recall - LCR) for obtaining and initial account from eyewitnesses when used as the sole form of retrieval but combined with compatible preliminary instructions, mnemonics, and procedures that constitute best practice. We employed a between-subjects experimental design where 69 participants watched a mock robbery video and were interviewed 48 hours later with either a free recall, CCR, or LCR. Participants interviewed with CCR or LCR recalled a higher number of correct details, particularly person-related details. Participants interviewed with LCR also recalled a higher number of environmental details. Report accuracy was high, and similar, for all groups. This study provides further evidence of the ecological validity of CCR as well as initial evidence suggesting LCR might be an effective retrieval strategy as well. These retrieval strategies (CCR and LCR) might be particularly advantageous in situations where there are multiple crime-scene locations and/or the interviewer is particularly interested in obtaining information concerning environmental and person-related details.

Keywords: Category Clustering Recall, Location Clustering Recall, Cognitive Interview, Free Recall, Investigative Interviewing

Testing Two Retrieval Strategies to Enhance Eyewitness Memory: Category and Location Clustering Recall

Eyewitness testimony is often crucial for police investigations (Fisher, 1995). However, due to many factors such as communication, motivation, perception, attention, or memory, what witnesses report seldom corresponds fully with the witnessed event (Fisher, 2010). In fact, many years of research provided evidence eyewitness memory is not fully reliable as witnesses frequently omit information and commit errors (Paulo, Albuquerque, & Bull, 2013). Nonetheless, system variables (Wells, 1978) such as the type of strategies used by the police to conduct line-ups or interview crime witnesses can minimize or augment this problem (Fisher & Geiselman, 1992; Wells et al., 1998).

Enhanced Cognitive Interview (CI)

To provide police officers with adequate interviewing techniques, Fisher and Geiselman (1992) developed the enhanced cognitive interview, now commonly referred to as the cognitive interview (CI). The CI has been widely studied and used by police forces in many countries such as England, Wales, or Australia. Several studies suggest the CI can increase the number of correct units of information witnesses are able to recall while maintaining high accuracy rates (Memon, Meissner, & Fraser, 2010; Paulo et al., 2013). This has been found in the face of other factors such as witnesses' age and cognitive abilities (Wright & Holliday, 2007), witnesses' level of arousal during the crime (Ginet & Verkampt, 2007), or familiarity of the crime context (Campos & Alonso-Quecuty, 1998).

The original CI included four cognitive mnemonics that aim to enhance recall: report everything, mental reinstatement of context, change order, and change perspective. The enhanced cognitive interview also comprises several important social and communicative components such as greeting and rapport building, explaining the instructions and interview purpose to the witness (e.g. asking not to guess), witness-compatible questioning, transferring

control of the interview to the witness, and mental imagery (Fisher & Geiselman, 1992). These social and communicative components, as well as two of the original CI mnemonics (report everything and mental reinstatement of context) are known to enhance recall and are now recommended in most adequate investigative interviews (Fisher & Geiselman, 2010; Geiselman & Fisher, 2014; Griffiths & Milne, 2010, Kieckhaefer, Vallano, & Compo 2014, Milne & Bull, 1999, Paulo et al., 2013, Vallano & Schreiber Compo, 2015). However, other CI components such as the change order and change perspective mnemonics shown to be less effective for enhancing recall. For instance, Dando, Ormerod, Wilcock, and Milne (2011) found recalling in reverse order might be less effective than a second free recall attempt for increasing the number of correct units of information witnesses are able to recall. Davis, McMahon, and Greenwood (2005) also found a free recall to be more effective than the change order and the change perspective mnemonics in terms of enhancing recall, In fact, a free recall has often proved to be an effective retrieval strategy and it is currently recommended in most adequate investigative interviewing protocols (Geiselman & Fisher, 2014; Lamb, La Rooy, Malloy, & Katz, 2011; Paulo et al., 2013), namely the Cognitive Interview (Fisher & Geiselman, 1992), the PEACE and ABE guidelines (Griffiths & Milne, 2010; Paulo et al., 2013), or the NICHD protocol for interviewing children (Lamb, Orbach, Hershkowitz, Esplin, & Horowitz, 2007).

Category Clustering Recall (CCR)

To obtain as much information as possible from an eyewitness, police detectives need to have a wide array of retrieval strategies available during the interview (tool-belt approach) so they can adapt the interview protocol to each crime, witness, and investigation (Fisher and Geiselman, 2010). Recent studies suggest that a newly developed retrieval strategy, Category Clustering Recall (CCR), can be very helpful for this purpose (Paulo, Albuquerque, & Bull, 2016; Paulo, Albuquerque, Vitorino, & Bull, 2017).

CCR consists of asking witnesses to recall everything they can remember about the crime while organizing and separating their recall using broad information categories that are present in almost every crime (i.e. person details, object/ environmental details, location details, action details, conversation details, and sound details). This is, eyewitnesses first recall everything they remember about a specific category of information (*e.g.*, person details), then proceed to the next category (*e.g.*, objects at the crime scene), and so forth. Organizing a single recall attempt using category clusters seems to have several advantages over using temporal clusters (change order mnemonic), witness-compatible questioning, and possibly free recall strategies (Paulo et al., 2016; Paulo et al., 2017; Thorley, 2018).

To test how effective this retrieval strategy was, the authors conducted two studies where CCR was incorporated in a modified CI protocol (Paulo et al., 2016; Paulo et al., 2017). In their first study, Paulo et al. (2016) replaced the change order mnemonic with CCR during the CI's second recall attempt (where the change order mnemonic is typically used). The authors found that the two groups of participants who used CCR instead of the change order mnemonic were able to recall more accurate information without a loss in report accuracy, regardless of CCR being combined with witness-compatible question and eye-closure or not. In a follow-up study, Paulo et al. (2017) tested if using a second recall with CCR to guide retrieval instead of a witness-compatible questioning would assist participants to recall more information. The authors found participants who used CCR were able to recall more information with very high report accuracy. More interestingly, Paulo et al. (2017) found participants interviewed with CCR recalled more (new) information during their second recall with CCR than during their initial free recall. Thus, Paulo et al. (2017) concluded CCR might in some situations be more effective than an initial free recall although they did not compare free recall with CCR directly at the same interview stage and suggested doing so.

Recently, Thorley (2018) tested if CCR was effective for enhancing both individual

and collaborative eyewitness memory in comparison with a free recall when both retrieval strategies were used as the sole forms of retrieval. The author found both the nominal and collaborative pairs, as well as lone individuals, recalled more information when using CCR in comparison with a free recall, particularly person-related details. However, unlike Paulo et al. (2016, 2017), Thorley (2018) used both strategies (CCR and Free Recall) without the additional preliminary instructions and mnemonics that are recommended in real investigative interviews (e.g. report everything mnemonic, mental reinstatement of context, greeting and establishing rapport, explaining the instructions and interview purpose to the witness, asking not to guess, and transferring control of the interview to the witness). Thus, although this initial comparison between these two retrieval strategies was essential to study the effectiveness of CCR as a standalone technique, the author acknowledged it would be premature to make recommendations based upon this limited evidence as both these retrieval strategies would be combined with other instructions and mnemonics in appropriate investigative interviews.

The first aim of the current study was to address this gap in the literature and test whether CCR was more effective than a free recall when: 1) these retrieval strategies are used as the sole forms of retrieval, thus controlling for possible order effects that could have occurred in Paulo et al. (2016, 2017) studies; 2) both these retrieval strategies include a range of compatible instructions that are known to enhance recall and are recommended for real police interviews, thus increasing ecological validity in comparison with Thorley's (2018) study.

Paulo et al. (2016) developed Category Clustering Recall grounded on the theory that memory traces for a given event overlap, and the activation of a memory trace can trigger other related memories (Paulo et al., 2016; Paulo et al., 2017). They hypothesized that recalling information related to one specific semantic cluster at a time might gradually trigger

memories that are closely related to this cluster and might otherwise not be recalled (Collins & Loftus, 1975). For instance, successively recalling units of information like ‘paper’, ‘desk’, or ‘pencil’, which are all related to one specific cluster (objects), might gradually trigger other related memories (e.g. ‘counter’) that might otherwise not be activated and recalled. Paulo et al. (2016) also hypothesise CCR effectiveness can be related to the fact recalling a crime event in clusters can be compatible with the witness’ mental organization of the event, as people often spontaneously organize their recall in semantic, temporal, or spatial clusters (Dalrymple-Alford & Aamiry, 1969; Manning & Kahana, 2012; Miller, Lazarus, Polyn, & Kahana, 2013; Robinson, 1966). This suggests other forms of clustering (e.g. temporal or spatial clustering) could be effective as well. The second aim of this study was to test if a new clustering retrieval strategy, which we named Location Clustering Recall (LCR), could also be effective to enhance recall.

Location Clustering Recall (LCR)

There are reasons to believe using spatial/ location clusters to guide recall can be effective. For instance, Miller (2013) found episodic memories may be organized according to their spatial attributes and people often use spatial features to guide their recall. Thus, recalling an event in spatial clusters could also be compatible with the witness’ retrieval strategy and mental organization of the event. Moreover, Paulo et al. (2016), Paulo et al. (2017) and Thorley (2018) all used broad semantic categories (e.g. persons or actions) as cues because these are present in almost every crime and would be remembered, to some extent, by all witnesses (unlike a specific cue that could be leading, e.g. the crime weapon). Similarly, all crimes occur in a spatial context and all witnesses will remember, to some extent, some sites where the crime took place. Lastly, Robin et al. (2016) found locations to be effective cues for enhancing episodic memory, particularly in comparison with person cues. Thus, with the aim of developing a new retrieval strategy interviewers can opt to use for obtaining more

information about certain types of crimes (e.g. with multiple crime-scene locations), we developed and tested a new clustering retrieval strategy we named Location Clustering Recall (LCR). LCR consisted of asking participants to recall everything they could remember about the crime by providing a single recall attempt using spatial clustering instead of semantic clustering (CCR) to guide/ organize their recall (see method section).

Current Study

In this study we compared the effectiveness of three retrieval strategies (free recall, CCR, and LCR) when each strategy was used as the sole form of retrieval but still combined with a range of compatible preliminary instructions and mnemonics that should be included in real police interviews (see method section).

We hypothesized participants interviewed with CCR and participants interviewed with LCR would recall more correct units of information than participants interviewed with a free recall, based on the premise that clustering retrieval strategies have proven to be effective for increasing the amount of information eyewitnesses are able to recall (Paulo et al., 2016; Paulo et al., 2017, Thorley, 2018). We also expected CCR to be particularly effective for increasing the recall of person-related details in comparison with a free recall, as reported in previous studies (Paulo et al, 2017; Thorley, 2018), and LCR to be particularly effective in increasing the recall of environmental details (object and location-related details). Although there is no previous research studying LCR, the clusters used in this clustering retrieval strategy (crime scene locations) are intrinsically related to environment details. Thus, we hypothesized that asking participants to focus on specific locations of the crime scene might promote the recall of environment details related to each site (i.e. objects and their locations) in comparison with the two other retrieval strategies.

A high (and similar) report accuracy was expected for all groups (Paulo et al., 2016; Paulo et al., 2017, Thorley, 2018) because all retrieval strategies included adequate

instructions (e.g. instruction not to guess; rapport building; transfer of control) known to enhance report accuracy (Fisher & Geiselman, 2010; Griffiths & Milne, 2010; Paulo et al., 2013). Lastly, as reported in previous studies (Paulo, Albuquerque, & Bull, 2015a; Paulo, Albuquerque, & Bull, 2019), we hypothesized participants would be able to identify less accurate information by spontaneously verbalizing low confidence utterances (see method section), regardless of the retrieval strategy used.

Method

Participants

An *a priori* power analysis was conducted using G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) to calculate the minimum sample size necessary to test the difference between the three groups using analysis of variance. An alpha of .05 and an estimate of a large effect size (f = .40) was used considering the effect sizes reported in previous CCR studies (Paulo et al., 2016; Paulo et al., 2017, Thorley, 2018). Results showed that 22 participants per group would be required to achieve a power of .80. To account for participants who might later need to be excluded from the analysis, a total of 69 students from a British University, 60 female and nine male participants, with an age range from 18 to 27 years (M = 20.67, SD = 1.47) voluntarily participated in this study. Participants were randomly assigned to one of three interview groups with 23 participants in each group. The first group was interviewed with a free recall. This group had 20 female participants and three male participants with an age range from 19 to 22 years (M = 20.35, SD = .78). The second group of participants was interviewed with Category Clustering Recall (CCR). This group had 21 female participants and two male participants with an age range from 19 to 27 years (M = 21, SD = 2.05). The third group was interviewed with Location Clustering Recall (LCR). This group had 19 female participants and four male participants with an age range from 18 to 24 years (M = 20.65, SD = 1.30).

Design

A between-subjects design was used with interview condition manipulated between-subjects (Free Recall, Category Clustering Recall, or Location Clustering Recall). The dependent variables were: 1) recall quantity, i.e. the number of correct units of information recalled operationalized according to information category in five measures (person, action, object, location, and auditory details); and 2) report accuracy, i.e. the ratio between the number of correct units of information recalled over the total number of units of information recalled.

Materials

All participants watched a two minutes and 30 seconds non-violent video clip of a bank robbery from the movie 'The Stickup' (Herrington, 2002) on a 13-inch LCD screen. This video clip was chosen as it contained varied and substantial information regarding the different forensically relevant categories of information described in the 'coding' section, as well as been previously used in other eyewitness memory studies (Luna & Migueles, 2009). Participants were asked if they had previously watched this video clip or the full movie. All participants responded negatively to this question. In this video clip, a security van parks in front of a bank and two guards exit the van holding white bags while proceeding to enter the bank and drop the bags in a vault room. An armed robber with a clown mask then arrives in a car, gets out and enters the bank. He physically and verbally interacts with the customers and employees before leaving with a bag that an employee had filled with money.

Procedure

Ethics committee approval was granted. After being informed about the study and having signed a consent form, participants took part in two sessions. At the first session participants were randomly allocated to one of the three interview conditions and shown the video clip. Participants were asked to pay as much attention as possible to this video clip

because they would later be interviewed about it. A second session took place approximately 48 hours later and each participant was interviewed with a single retrieval strategy (either FR, CCR, or LCR) according to the randomly assigned groups. All interviews were audio recorded.

Interview Protocols

A full description of the interview protocols is included as a supplemental material. All interviews started with the following initial instructions and communicative components from Fisher and Geiselman (1992): greeting, establishing rapport, explaining the instructions and interview purpose to the witness, asking not to guess, and transferring control of the interview to the witness. The report everything instruction was also given to all participants. Mental reinstatement of context (with eye-closure) was then applied and maintained throughout retrieval. These initial instructions, mnemonics, and communicative components were identical for all participants as these are nowadays considered best practice for interviewing cooperative witnesses and should be included at the beginning of appropriate investigative interviews regardless of the retrieval strategy used afterwards (Fisher & Geiselman, 1992; Paulo et al., 2015a ; Paulo, Albuquerque, Saraiva, & Bull, 2015b). Fisher and Geilseman (1992) guidelines for applying these instructions and mnemonics were followed.

Participants were then asked to orally report everything they could remember about the crime using a single retrieval strategy according to the interview group (free recall, CCR, or LCR).

Participants in the free recall (FR) group were asked to recall everything they could remember about the crime in any order and at the pace they desired.

Participants in the CCR group were asked to use Category Clustering Recall instead. This retrieval strategy consisted of asking participants to recall everything they could

remember about the crime but, instead of choosing the strategy they wished to use to recall the event (free recall), participants were asked to organize their single recall attempt into four information categories: person details, action details, object/environmental details, and auditory information (conversations and sounds). Although Paulo et al. (2016) and Paulo et al. (2017) used CCR with more information categories (person details, person-location details, object details, , action details, object-location details conversation details, and sound details), Thorley (2018) used CCR with only three broader categories (person details, action details, and environment details) finding similar results, i.e. CCR effectiveness prevailed regardless of the number of categories used. In this study, we used four information categories to be able to match the number of categories used in CCR with the number of locations used in LCR.

Participants in the LCR group were asked to recall the event using Location Clustering Recall. This retrieval strategy consisted of asking participants to organize their single recall attempt by addressing each of the four crime scene locations separately. These locations were the outside area (e.g. near the main road and side streets), the bank entrance (e.g. near the bank's front door), the main customer area (e.g. near the counters), and the back area of the bank (e.g. the vault room and its surroundings). These broad locations were chosen because they covered the whole crime scene and were noticeably shown more than once in the video clip. Thus, it was highly unlikely a participant would not remember one of these locations.

Being the aim of this study to test these three retrieval strategies when used as sole forms of retrieval, participants (in all interview groups) were not asked to respond to witness-compatible questions (e.g. open-ended or closed-ended questions) or perform any additional retrieval attempts. Further, this had been previously addressed in other studies (Paulo et al., 2016; Paulo et al., 2017). All interviews were audio-recorded.

Interviewers, Training and Coding

Two trained researchers conducted and coded all the interviews. Each researcher conducted half of the interviews for each condition (free recall, CCR, and LCR). An expert in investigative interviewing who had taken several qualified courses on investigative interview strategies consisting of more than 50 lecture hours, practice, role-playing exercises, and feedback/ evaluation trained both interviewers. This expert also trained both interviewers regarding the use of the scoring technique from Paulo et al. (2016), described below. To assure interviewer performance was adequate and consistent across all interview conditions, pilot interviews were conducted and evaluated by the expert who concluded interviews were adequately conducted and followed the interview scripts. Interview scripts were followed and read verbatim when possible with minor adjustments when adapting the script to the participant.

Participants' recall (audio-recorded) was scored and coded using the template scoring technique from Paulo et al. (2016). Before data collection, a comprehensive list of details in the video recording was first compiled, discussed and agreed upon by all authors. In this list, correct units of information in the video were identified and also categorized according to categories of information that can have different investigative relevance (Memon et al., 2010): (i) person details; (ii) action details; (iii) object details ; (iv) location details; or (v) auditory information: conversation or sound. This list of details identifies 402 correct units of information.

The participant's verbal recall (captured using an audio-recorder) was divided into units of information and registered in a written format. If a unit of information (correct or not) was recalled more than once, this information was scored only the first time it was mentioned (Prescott, Milne, & Clark, 2011). Information that did not concern the witnessed event (*e.g.*, 'I was excited') and subjective statements (*e.g.*, 'The robber was cool') were disregarded. The remaining units of information were checked against the list of details and classified as either

correct, incorrect (*e.g.*, saying the bag was black when it was identified as beige in the previously compiled list) or confabulation (mentioning a detail or event that was not present or did not happen), as well as according to the category of information assigned in the list of details.

As suggested by Paulo, Albuquerque, and Bull (2015b, 2019), units of information were also categorized according to the confidence level participants qualitatively assigned to these as either: (i) information recalled with no confidence utterances (regular recall) – when participants recalled information which had no adjacent verbal expression of uncertainty (e.g. 'He had a jacket'); or (ii) information recalled with low confidence (uncertainties) - when participants spontaneously verbalized uncertainty (e.g. I think; Maybe; I believe, I am not sure, Possibly, etc.) to communicate to the interviewer they were unsure about the accuracy of this particular unit of information (e.g. 'I believe he had a jacket'). As addressed below, inter-rater reliability was calculated to assess whether different researchers agreed on how to categorize units of information.

Inter-rater Reliability

To assess inter-rater reliability, 17 interviews (25%) were randomly selected and scored independently by another researcher. Intraclass correlation coefficients (ICC) were calculated for all relevant recall measures. High inter-rater reliability was found for all measures: total recall (.986), correct recall (.988), and incorrect recall (.934). High inter-rater reliability was also found for verbal expressions of uncertainty that determined the confidence level (described above) assigned to each unit of information (.939).

Results

Bonferroni corrections were applied when multiple statistical tests were conducted on a single data set to avoid type 1 error. Otherwise, an alpha level of .05 was used for all statistical tests (Field, 2009).

Recall Quantity

First, a one-way ANOVA was conducted to see if interview condition had an effect on the overall number of correct units of information recalled. A main interview condition effect for participants' number of correct units of information recalled was found, F (2, 66) = 9.16, p < .001, η_p^2 = .22. Planned contrasts revealed that participants interviewed with a free recall recalled fewer correct details (M = 33.48, SD = 9.44) than participants who were interviewed with CCR (M = 43.30, SD = 16.63) or LCR (M = 50.96, SD = 14.57), t (63.24) = 4.50, p < .001. Planned contrasts also revealed no difference between the CCR and the LCR groups regarding the number of correct details recalled, t (43.26) = 1.66, p = .104. Thus, participants in the CCR and LCR conditions recalled more correct units of information than participants in the free recall condition (see Table 1).

Insert Table 1

Next, we conducted a multivariate ANOVA to see if interview condition had an effect on the number of correct units of information recalled operationalized according to information category in five measures (person, action, object, location, and auditory details). This found a significant difference in the number of correct units of information recalled according to interview condition, F (10, 124) = 4.96, p < .001, *Wilk's* Λ = .51, η_p^2 = .29. An interview condition effect was found for the number of correctly recalled person-related details, F (2, 66) = 6.09, p = .004, η_p^2 = .16, object-related details, F (2, 66) = 10.66, p < .001, η_p^2 = .24, and location-related details, F (2, 66) = 14.66, p < .001, η_p^2 = .31 (see Table 1). No interview condition effect was found for the number of correctly recalled action-related

details, F (2, 66) = 1.45, p = .242, η_p^2 = .04, nor auditory details, F (2, 66) = 1.55, p = .221, η_p^2 = .05.

For person-related details, Tukey HSD pairwise comparisons revealed participants in the free recall group recalled less correct units of information (M = 9.61, SD = 4.22) than participants in the CCR group (M = 15.74, SD = 8.23), p = .011, 95% CI [1.22, 11.04], and participants in the LCR group (M = 15.87, SD = 7.71), p = .009, 95% CI [1.35, 11.18]. No differences between the LCR and CCR groups were found. Thus, participants in the LCR and CCR conditions recalled more correct units of information related to persons than participants in the free recall group.

For object-related details, Tukey HSD pairwise comparisons revealed participants in the LCR group recalled more correct units of information (M = 14.13, SD = 5.40) than participants in the CCR group (M = 9.61, SD = 4.89), p = .004, 95% CI [1.24, 7.80], and participants in the free recall group (M = 8.04, SD = 3.42), p < 001, 95% CI [2.80, 9.37]. No differences between the free recall and CCR groups were found. Thus, participants in the LCR condition recalled more correct units of information related to objects than participants in the free recall and CCR conditions.

For location-related details, Tukey HSD pairwise comparisons revealed participants in the LCR group also recalled more correct units of information (M = 4.09, SD = 1.68) than participants in the CCR group (M = 2.48, SD = 1.68), p = .002, 95% CI [.51, 2.71], and participants in the free recall group (M = 1.65, SD = 1.27), p < 001, 95% CI [1.34, 3.53]. No differences between the free recall and CCR groups were found. Thus, participants in the LCR condition recalled more correct units of information related to locations than participants in the free recall and CCR conditions.

In sum, we found participants in the CCR and LCR groups recalled more correct units of information related to persons in comparison with participants in the free recall group.

Moreover, the LCR group recalled more correct units of information related to locations and objects in comparison with the other two groups (CCR and free recall).

Report Accuracy

Report accuracy was measured in correct recall proportion: the ratio between the number of correct units of information recalled over all units of information recalled. As suggested by Paulo et al. (2015a, 2019), the confidence level participants qualitatively assigned to the information was considered in the accuracy analysis as an independent variable manipulated within-subjects (see method section).

For this purpose, a 3 (interview group: free recall, CCR, or LCR – between-subjects) × 2 (confidence level: see below – within-subjects) ANOVA was conducted to see if interview condition had an effect on report accuracy. Two confidence levels were used in this analysis: uncertainties (units of information which had an adjacent verbal expression of uncertainty: e.g. I think he had a jacket), and regular recall (units of information which had no adjacent uncertainty utterance: e.g. He had a gun).

We found no interview condition main effect, F (2, 60) = .51, p = .604, η_p^2 = .02, or interaction effect, F (2, 60) = .15, p = .858, η_p^2 = .01, on accuracy. However, we did find a confidence level main effect on accuracy, F (1, 60) = 42.03, p < .001, η_p^2 = .41. Regular recall (no verbal expressions of uncertainty) was more accurate than uncertainties (see Table 2), p < 001, 95% CI [.12, .27].

In sum, high accuracy values were found for participants' full report regardless of the interview condition (see Table 2).

Insert Table 2

Discussion

This study compared three retrieval strategies (free recall, CCR, and LCR) when used as the sole forms of retrieval but combined with preliminary mnemonics and instructions that are recommended in real investigative interviews (Fisher & Geiselman, 2010; Geiselman & Fisher, 2014; Griffiths & Milne, 2010, Kieckhaefer, Vallano, & Compo 2014, Milne & Bull, 1999, Paulo et al., 2013). As predicted, participants interviewed with CCR and participants interviewed with LCR recalled a higher number of correct details in comparison with participants interviewed with a free recall. As we also hypothesized, report accuracy was high, and similar, for all groups.

Paulo et al. (2016) found CCR enhances recall in comparison with the change order mnemonic and a witness-compatible questioning (Paulo et al., 2017) when these retrieval strategies are included in a Cognitive Interview protocol. Paulo et al. (2017) also provided initial evidence CCR might be superior to a free recall, although the authors did not directly compare these procedures. More recently, Thorley (2018) did a clean comparison between CCR and free recall by isolating such procedures, .i.e., using both as single retrieval strategies without any additional instructions or mnemonics. The author found CCR to be effective for enhancing both individual and collaborative memory in comparison with a free recall. Nonetheless, Thorley (2018) did not study these retrieval strategies when combined with preliminary instructions (greeting, establishing rapport, explaining the instructions and interview purpose, transferring control, and asking not to guess) and mnemonics (report everything and mental reinstatement of context) that are known to enhance recall (Fisher & Geiselman, 1992; Griffiths & Milne, 2010; Paulo et al., 2013).

Our study addresses this gap in the literature and extends current knowledge by suggesting CCR can be effective when combined with such preliminary instructions and mnemonics that now constitute best practice (Fisher & Geiselman, 1992; Griffiths & Milne, 2010; Paulo et al., 2013). As hypothesized, participants interviewed with CCR were able to

recall a higher number of correct units of information about the crime in comparison with participants interviewed with a free recall. Thus, this study provides further evidence of the ecological validity of CCR's superiority against a free recall (Thorley 2018). Our study also supports previous literature suggesting CCR might be particularly effective for increasing the number of person-related details eyewitnesses are able to recall (Paulo et al., 2017, Thorley, 2018).

There are relevant theoretical explanations for why CCR increased the number of information participants recalled in comparison with a free recall. The spreading activation theory of semantic processing suggests memories might be interconnected and semantically associated (Collins & Loftus, 1975). Accordingly, Paulo et al. (2016) hypothesize asking witnesses to focus on one category of information at a time might increase recall of associated memories. This is, recalling information about one specific semantic cluster at a time might gradually trigger memories that are closely related (Collins & Loftus, 1975). For instance, recalling units of information that are all related to one specific cluster (e.g. objects: 'paper', 'desk', or 'pencil') might gradually trigger other related memories (e.g. 'counter') that might otherwise not be activated and recalled. Furthermore, people often spontaneously encode and retrieve information in semantic, temporal, or spatial clusters (Dalrymple-Alford & Aamiry, 1969; Manning & Kahana, 2012; Miller, 2013; Robinson, 1966). Thus, focusing on a specific category of information at a time during retrieval might be more congruent with how participants encode and recall information in comparison with a free recall, as participants often do not know what retrieval strategies are helpful or compatible with the way information is encoded, stored, and retrieved (Paulo et al., 2016; Paulo et al., 2017).

Based on the premise that clustering retrieval strategies have proven to be effective in investigative interviews (Paulo et al., 2016; Paulo et al., 2017, Thorley, 2018), this study also extends current knowledge by developing and testing if a new retrieval strategy (Location

Clustering Recall) can be used to obtain more information regarding crimes involving multiple crime-scene locations. Our results supported our hypothesis as participants interviewed with LCR recalled a higher number of correct units of information about the crime in comparison with participants interviewed with a free recall. Moreover, as expected, participants interviewed with LCR recalled a higher number of units of information related to objects and locations than the free recall and the CCR groups. We argue LCR might be particularly helpful in increasing the recall of environment details related to objects and their locations because this information is intrinsically related to the clusters used with this retrieval strategy (crime scene locations). For instance, the crime scene location 'vault room' contained several objects located at different sites. Thus, it is possible that asking participants to focus on a specific location of the crime scene at a time helped participants to recall details about this site that might otherwise not have been activated and recalled (Paulo et al., 2017). In sum, this study supports our hypothesis that LCR can be an effective retrieval strategy to enhance eyewitnesses' memory. These results are compatible with the premise that recalling an event in clusters might be more compatible with the witness' mental organization of the event and consequently improve recall (Dalrymple-Alford & Aamiry, 1969; Manning & Kahana, 2012; Miller, 2013; Robinson, 1966). This is, LCR might be more compatible with how participants encode and recall information in comparison with a free recall, particularly because episodic memories can sometimes be organized according to their spatial attributes (Miller, 2013). Furthermore, LCR allowed participants to use spatial features to guide their recall and previous studies suggest locations can be particularly effective cues for enhancing episodic memory (Robin et al., 2016).

Report accuracy was high for all interview groups. High accuracy was expected for all interview conditions because all retrieval strategies (Free Recall, CCR, and LCR) contained adequate instructions (e.g. instruction not to guess; rapport building; transfer of control)

which are known to increase report accuracy (Fisher & Geiselman, 2010; Griffiths & Milne, 2010; Paulo et al., 2013). Furthermore, these high accuracy values are compatible with previous research where clustering retrieval enhanced the amount of accurate information provided by participants without compromising report accuracy (Paulo et al., 2016; Paulo et al., 2017, Thorley, 2017). Lastly, although it is beyond the scope of this study to address the confidence-accuracy (CA) relationship (Luna & Martín-Luengo, 2010; Sarwar, Allwood, & Innes-Ker, 2014), our study supports Paulo et al. (2015a, 2019) findings suggesting spontaneous verbal judgments of uncertainty can be relevant when looking at report accuracy. Participants were able to identify less accurate information by spontaneously verbalizing low confidence utterances. Information recalled with low confidence utterances (uncertainties: e.g. I think the robber had a jacket) was less accurate than information recalled with no confidence utterances (regular recall: e.g. the robber had a jacket). This finding is consistent with previous literature suggesting unlike other types of confidence judgments, spontaneous verbal judgments of uncertainty are linked to report accuracy (Paulo et al., 2015a, 2019).

Limitations and Future Research

As with the majority of laboratory mock witness research, the present study contained methodological limitations such as the use of a mock non-emotional video portraying a robbery committed by an unknown offender. However, police investigations might focus on a range of violent and non-violent crimes (e.g. sexual abuse, fraud, murder, etc.) that involve different eyewitnesses (e.g. children, adults, or elderly adults) and offenders (e.g. known offenders). In this primary study, we were mainly concerned with testing these retrieval strategies ability to enhance episodic memory for a non-violent event, thus choosing a non-violent video previously used in other eyewitness memory studies (Luna & Migueles, 2009) and containing varied and substantial information. Nonetheless, applied research considering these (and other) factors should be conducted to evaluate the use of these strategies in

different investigations. It is also important to disclose that although the second session of this experiment took place approximately 48 hours after the first session, there was a short period (approximately two hours) in which this session could be booked if necessary to accommodate for participants' schedules. Thus, there might have been small variations in the retention interval that were not considered for analysis but instead controlled by randomly assigning participants to groups.

The mock crime used in this study purposely contained multiple crime scene locations. Nonetheless, LCR might not be appropriate for situations where the witness sees the event from/ at a single location. In such occasions, retrieval strategies like CCR or a free recall might be more appropriate. Further, this experiment addressed LCR's effectiveness in a scenario where there was a known crime-scene and the interviewer was able to use cues to help the witness identifying the different crime-scene locations, thus limiting the generalizability of our findings. The cues provided were carefully selected and kept to a minimum. These cues were as broad as possible, likely to be remembered, and similar to the cues used with all participants for applying mental reinstatement of context. Nonetheless, LCR (and CCR to a lesser degree) differ from free recall in the sense that, similarly to mnemonics like mental reinstatement of context, require cues to be provided to the interviewee. Building on this limitation and the recent research on self-generated cues (Wheeler & Gabbert, 2017), we believe it is important to test the effectiveness of these clustering retrieval strategies (CCR and LCR) when cues are self-generated by the interviewee. Self-generated location cues might not only enhance recall (Kontogianni, Hope, Taylor, Vrij, & Gabber, 2018) but also allow retrieval strategies like LCR to be used even when the police do not have prior information about the different crime-scene locations. Nonetheless, this study provides initial evidence LCR can successfully enhance episodic memory when used in a specific type of investigation (i.e. non-violent crime committed by an

unknown offender in a known crime-scene with multiple locations). It is important to acknowledge investigative interviewing protocols are designed to be flexible and dynamic and the effectiveness of the different interview components depends on the investigation, crime, and witness (Fisher & Geiselman, 2010; Paulo et al., 2013).

All retrieval strategies (i.e. free recall, CCR, and LCR) were combined with the same preliminary instructions and mnemonics recommended in real investigative interviews. This decision was made to provide further evidence of the ecological validity of CCR as Thorley (2018) already compared these mnemonics without the combined use of such components. Nonetheless, it is important to acknowledge these instructions and mnemonics might interact differently with these retrieval strategies. However, it was beyond the scope of this study to test how each of these preliminary procedures might be influencing recall. Future research could focus on studying these interaction effects. Lastly, previous studies (Paulo et al., 2016; Paulo et al., 2017) already tested and included CCR in an investigative interview with witness-compatible questioning. We aimed to test these three retrieval strategies when used as sole forms of retrieval. Thus, these were not included in a dynamic and flexible interview protocol where free recall might be combined with witness-compatible questioning and other retrieval strategies. Consequently, studying LCR effectiveness when included in a full investigative interviewing protocol is still valuable.

Conclusions and Contributions to Public Policy

Obtaining detailed information from eyewitnesses can be crucial for police investigations (Fisher, 2010). Having dynamic and flexible interview protocols where the interviewer can choose from a wide array of retrieval strategies depending on the crime, witness, and investigation (tool-belt approach) can contribute towards this goal (Fisher and Geiselman, 2010). This experiment is the first to provide initial evidence that a new interviewing technique, Location Clustering Recall (LCR), might be another helpful

clustering retrieval strategy that merits further testing and can enhance eyewitness memory in certain situations (e.g. when there are multiple crime-scene locations). This study also supports an emerging number of research suggesting clustering retrieval strategies, namely CCR, can increase the amount of information eyewitnesses are able to recall (Paulo et al., 2016; Paulo et al., 2017; Thorley, 2018). Further, it provides evidence of the ecological validity of CCR when combined with compatible preliminary instructions, mnemonics, and procedures that constitute best practice. Although an initial free recall is a key procedure for obtaining accurate information and is currently recommended in most adequate investigative interviewing protocols and guidelines (e.g. CI, PEACE, ABE, NICHD), this study provides initial evidence there are alternative retrieval strategies (CCR and LCR) that deserve further testing and might be useful for enhancing eyewitness memory, particularly when the interviewer is interested in certain types of information (e.g. person-related details).

This was the first experiment studying Location Clustering Recall and one of a few experiments studying Category Clustering Recall. Thus, we believe this experiment has important innovative value but one should be extremely careful in drawing direct implications for forensic practice and policy. Much more experimental and applied research involving different types of eyewitnesses, crimes, offenders, and legislations, needs to be carried out before these techniques can be safely incorporated into practice. Nonetheless, we believe extensive experimental research constitutes an important step towards the development and testing of interviewing procedures that led to changes in global interviewing practices and policies worldwide (e.g. CI, PEACE, ABE, NICHD). Although applied research addressing how these techniques can be used by different police forces and adapted to different legislation is still crucial, our study provides further evidence of the ecological validity of CCR and initial evidence that LCR is a technique that disserves further testing. Ultimately, we believe this line of research will inform whether clustering retrieval strategies should be

included in police interviewing guidelines, policies, and training, and constitute another valuable interviewing 'tool' in the interviewing 'tool-belt'.

Conflict of interest statement

The authors declare there are no conflicts of interest.

References

Campos, L., & Alonso-Quecuty, M. L. (1998). Knowledge of the crime context: Improving the understanding of why the cognitive interview works. *Memory, 6,* 103-112. doi: 10.1080/741941602

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82,* 407-428. doi: 10.1016/B978-1-4832-1446-7.50015-7

Dalrymple-Alford, E. C., & Aamiry, A. (1969). Language and category clustering in bilingual free recall. *Journal of Verbal Learning and Verbal Behavior, 8,* 762-768. doi: 10.1016/S0022-5371(69)80041-1

Dando, C. J., Ormerod, T. C., Wilcock, R., & Milne, R. (2011). When help becomes hindrance: Unexpected errors of omission and commission in eyewitness memory resulting from change temporal order at retrieval? *Cognition, 121,* 416-421. doi: 10.1016/j.cognition.2011.06.015

Davis, M. R., McMahon, M., & Greenwood, K. M. (2005). The efficacy of mnemonic components of the cognitive interview: Towards a shortened variant for time-critical investigations. *Applied Cognitive Psychology, 19,* 75-93. doi: 10.1002/acp.1048

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

Fisher, R. P. (1995). Interviewing victims and witnesses of crime. *Psychology, Public Policy, and Law, 1*, 732-764. doi: 10.1037/1076-8971.1.4.732.

Fisher, R. P. (2010). Interviewing cooperative witnesses. *Legal and Criminological Psychology, 15,* 25-38. doi: 10.1348/135532509X441891

Field, A. P. (2009). *Discovering statistics using SPSS*. London, UK: SAGE.

Fisher, R. P., & Geiselman, R. E. (1992). *Memory-enhancing techniques for investigative interviewing: The cognitive interview*. Springfield, IL: Charles C. Thomas.

Fisher, R. P., & Geiselman, R. E. (2010). The Cognitive Interview method of conducting police interviews: Eliciting extensive information and promoting therapeutic jurisprudence. *International Journal of Law and Psychiatry, 33,* 321–328. doi: 10.1016/j.ijlp.2010.09.004

Geiselman, R. E., & Fisher, R. P. (2014). Interviewing witnesses and victims. In M. St-Yves (Ed.). *Investigative interviewing: Handbook of best practices*. Toronto: Toronto, ON: Thomson Reuters Publishers.

Ginet, M., & Verkampt, F. (2007). The cognitive interview: Is its benefit affected by the level of witness emotion? *Memory, 15,* 450-464. doi: 10.1080/09658210601092670

Griffiths, A., & Milne, R. (2010). The application of cognitive interview techniques as part of an investigation. In C. A. Ireland & J. M. Fisher (Eds.), *Consultancy and advising in forensic practice: Empirical and practical guidelines* (pp. 71–90). Chichester, UK: BPS Blackwell.

Herrington, R. (Director). (2002). The Stickup [Motion Picture]. United States: Artisan Entertainment.

Kieckhaefer, J. M., Vallano, J. P., & Compo, N. S. (2014). Examining the positive effects of rapport building: When and why does rapport building benefit adult eyewitness memory? *Memory, 22*, 1010–1023. doi: 10.1080/09658211.2013.864313

Kontogianni, F., Hope, L., Taylor, P. J., Vrij, A., & Gabbert, F. (2018). The benefits of a self-generated cue mnemonic for timeline interviewing. *Journal of Applied Research in Memory and Cognition, 7*, 454-461. doi: 10.1016/j.jarmac.2018.03.006

Lamb, M. E., La Rooy, D. J., Malloy, L. C., & Katz, C. (2011). *Children's testimony: A handbook of psychological research and forensic practice* (2nd ed.). SXW, UK: Wiley-Blackwell. doi: 10.1002/9781119998495

Lamb, M. E., Orbach, Y., Hershkowitz, I., Esplin, P. W., & Horowitz, D. (2007). Structured forensic interview protocols improve the quality and informativeness of investigative interviews with children: A review of research using the NICHD investigative interview protocol. *Child Abuse & Neglect, 31*, 1201-1231. doi: 10.1016/j.chiabu.2007.03.021

Luna, K., & Martín-Luengo, B. (2010). New advances in the study of the confidence-accuracy relationship in the memory for events. *The European Journal Of Psychology Applied To The Legal Context*, *1*, 55-71.

Luna, K., & Migueles, M. (2009). Acceptance and confidence of central and peripheral misinformation. *The Spanish Journal of Psychology*, 12, 405-413. doi: 10.1017/S1138741600001797

Manning, J. R., & Kahana, M. J. (2012). Interpreting semantic clustering effects in free recall. *Memory, 20,* 511-517. doi: 10.1080/09658211.2012.683010

Memon, A., Meissner, C. A., & Fraser, G. (2010). The cognitive interview: A meta-analytic review and study space analysis of the past 25 years. *Psychology, Public Policy, and Law, 16*, 340-372. doi: 10.1037/a0020518

Milne, R., & Bull, R. (1999). *Investigative Interviewing: Psychology and Practice*. Chichester, WS: Wiley. doi: 10.1002/cbm.444

Miller, J., Lazarus, E., Polyn, S., and Kahana, M. (2013). Spatial clustering during memory search, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 39, 773-781. doi: 10.1037/aO029684

Paulo, R. M., Albuquerque, P. B., & Bull, R. (2013). The enhanced cognitive interview: Towards a better use and understanding of this procedure. *International Journal of Police Science & Management, 15,* 190-199. doi: 10.1350/ijps.2013.15.3.311

Paulo, R. M., Albuquerque, P. B., & Bull, R. (2015a). The Enhanced Cognitive Interview: Expressions of uncertainty, motivation and its relation with report accuracy. *Psychology, Crime & Law, 22,* 366-381. doi: 10.1080/1068316X.2015.1109089

Paulo, R. M., Albuquerque, P. B., & Bull, R. (2019). Witnesses' verbal evaluation of certainty and uncertainty during investigative interviews: Relationship with report accuracy. *Journal of Police and Criminal Psychology,* 1-10. doi: 10.1007/s11896-019-09333-6

Paulo, R. M., Albuquerque, P. B., Saraiva, M., & Bull, R. (2015b). The enhanced cognitive interview: Testing appropriateness perception, memory capacity and error estimate relation with report quality. *Applied Cognitive Psychology, 29,* 536-543. doi: 10.1002/acp.3132

Paulo, R. M., Albuquerque, P. B., & Bull, R. (2016). Improving the enhanced cognitive interview with a new interview strategy: Category clustering recall. *Applied Cognitive Psychology*. doi: 10.1002/acp.32532016

Paulo, R. M., Albuquerque, P. B., Vitorino, F., & Bull, R. (2017). Enhancing the cognitive interview with an alternative procedure to witness-compatible questioning: Category clustering recall. *Psychology, Crime & Law, 23,* 967-982. doi: 10.1080/1068316X.2017.1351966

Prescott, K., Milne, R., Clark, J. (2011). How effective is the enhanced cognitive interview when aiding recall recall of older adults including memory for conversation? *Journal of Investigative Psychology and Offender Profiling, 8,* 257-270. doi: 10.1002/jip.142

Robin, J., Wynn, J., and Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42,* 1-8. doi: 10.1037/xlm0000167

Robinson, J. A. (1966). Category clustering in free recall. *The Journal of Psychology: Interdisciplinary and Applied, 62,* 279-286. doi:10.1080/00223980.1966.10543793

Sarwar, F., Allwood, C. M., & Innes-Ker, A. (2014). Effects of different types of forensic information on eyewitness' memory and confidence accuracy. *The European Journal Of Psychology Applied To The Legal Context, 1,* 17-27. doi: 10.5093/ejpalc2014a3

Thorley, C. (2018). Enhancing individual and collaborative eyewitness memory with category clustering recall. *Memory, 26,* 1128-1139. doi: 10.1080/09658211.2018.1432058

Vallano, J. P., & Schreiber Compo, N. (2015). Rapport-building with cooperative witnesses and criminal suspects: A theoretical and empirical review. *Psychology, Public Policy, and Law*, *21*, 85–99. doi: 10.1037/law0000035.

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

Wells, G. L., Small, M., Penrod, S., Malpass, R. S., Fulero, S. M., & Brimacombe, C. A. E. (1998). Eyewitness identification procedures: Recommendations for lineups and photospreads. *Law and Human Behavior, 22,* 603-647. doi: 10.1023/A:1025750605807

Wheeler, R. L., & Gabbert F. (2017). Using self-generated cues to facilitate recall: A narrative review. *Frontiers in Psychology, 8*, 18-30. doi: 10.3389/fpsyg.2017.01830

Wright, A. M., & Holliday, R. E. (2007). Interviewing cognitively impaired older adults: How useful is a cognitive interview? *Memory, 15*, 17-33. doi: 10.1080/09658210601047351

Table 1

Mean, Standard Deviation, and 95% Confidence Intervals for the Number of Newly Recalled Correct Units of Information According to Interview Condition and Category of Information.

Category of Information	Interview Condition								
	Free Recall			Category Clustering Recall			Location Clustering Recall		
	M	*SD*	*95% CI*	*M*	*SD*	*95% CI*	*M*	*SD*	*95% CI*
Person**	9.61	4.22	[7.78, 11.43]	15.74	8.23	[12.18, 19.30]	15.87	7.71	[12.54, 19.20]
Object***	8.04	3.42	[6.57, 9.52]	9.61	4.89	[7.50, 11.72]	14.13	5.40	[11.80, 16.46]
Location***	1.65	1.27	[1.11, 2.20]	2.48	1.68	[1.75, 3.20]	4.09	1.68	[3.36, 4.81]
Action	11.43	4.44	[9.51, 13.35]	11.22	5.27	[8.94, 13.50]	13.39	4.55	[11.42, 15.36]
Auditory	2.70	2.06	[1.81, 3.58]	4.00	2.43	[2.95, 5.05]	3.39	2.98	[2.10, 4.58]
Total***	33.48	9.44	[29.40, 37.56]	43.30	16.63	[36.11, 50.50]	50.96	14.57	[44.65, 57.26]

** $p < .01$. *** $p < .001$.

Table 2

Mean, Standard Deviation, and 95% Confidence Intervals for the Proportion of Correct Information Recalled (Report Accuracy) According to Interview Condition and Confidence Level.

Interview Condition	Confidence Level								
	Uncertainties			Regular Recall			Total		
	M	*SD*	*95% CI*	*M*	*SD*	*95% CI*	*M*	*SD*	*95% CI*
Free Recall	.68	.26	[.57, .79]	.90	.05	[.88, .92]	.87	.07	[.84, .90]
Category Clustering Recall	.74	.24	[.63, .84]	.91	.06	[.89, .94]	.89	.06	[.86, .91]
Location Clustering Recall	.74	.24	[.63, .84]	.93	.06	[.90, .95]	.90	.06	[.87, .92]
Total	.72	.24	[.66, .78]	.91	.05	[.90, .93]	.88	.06	[.87, .90]