EFFECT OF DELAY ON THE RETRIEVAL AND ACCURACY OF EYEWITNESS MEMORY

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Abstract

This study aimed to evaluate the effectiveness of the Category Clustering Recall (CCR) technique in comparison to Free Recall (FR) for enhancing the quantity and accuracy of eyewitness information across two retention intervals (48 hours and one month). A sample of 158 university students, aged 18 to 46 years, was randomly assigned to one of four conditions: Free Recall after 48 hours, CCR after 48 hours, Free Recall after one month, and CCR after one month. Results indicated that CCR elicited a significantly greater amount of information overall, and in the recall of details regarding the people involved in the witnessed event, while FR produced higher accuracy, particularly in recalling objects and locations. Additionally, memory accuracy declined over time for both techniques, with higher accuracy observed after 48 hours compared to one month. Interestingly, people-related information remained stable over time, with no significant decrease in accuracy. These findings underscore the necessity of tailoring interview techniques to the type of information sought and the retention interval. CCR appears particularly useful for retrieving detailed person-related information, whereas FR may be more effective for recalling environmental details. Overall, the results highlight the importance of conducting investigative interviews promptly to maximize accuracy and recall in forensic contexts.

Keywords: Eyewitness Memory, Delay, Category Clustering Recall, Free Recall.

Resumo

O presente estudo teve como principal objetivo avaliar a eficácia da técnica de Recuperação por Categorias (RC) em comparação com o Relato Livre (RL) na melhoria da quantidade e precisão das informações fornecidas por testemunhas oculares, em dois intervalos de retenção (48 horas e um mês). Uma amostra de 158 estudantes universitários, com idades compreendidas entre 18 e 46 anos, foi aleatoriamente distribuída por quatro condições experimentais: Relato Livre após 48 horas, Recuperação por Categorias após 48 horas, RL após um mês e RC após um mês. Os resultados indicaram que a técnica de RC gerou uma quantidade significativamente maior de informações, especialmente no que diz respeito aos detalhes sobre as pessoas envolvidas no evento testemunhado, enquanto o RL produziu maior precisão, particularmente na recordação de objetos e localizações. Adicionalmente, a precisão da informação diminuiu ao longo do tempo em ambas as técnicas, com uma maior precisão observada após 48 horas em comparação com o intervalo de um mês. Curiosamente, as informações relacionadas com as pessoas mantiveram-se estáveis ao longo do tempo, sem uma redução significativa na precisão. Estes resultados reforçam a importância de adaptar as técnicas de entrevista ao tipo de informação procurada e ao intervalo de retenção. A RC demonstrou ser especialmente eficaz na recuperação de detalhes sobre pessoas, enquanto RL mostrou-se mais eficaz para a recordação de detalhes contextuais e ambientais. No geral, os resultados sublinham a necessidade de realizar entrevistas investigativas de forma célere, de modo a maximizar a precisão e a quantidade de informação em contextos forenses.

Palavras-chave: Testemunhas Oculares, Intervalo de Retenção, Memória, Recuperação por Categorias, Relato Livre.

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List of Abbreviations

CI – Cognitive Interview

ECI – Enhanced Cognitive Interview

FR – Free Recall

CCR – Category Clustering Recall

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Introduction

Interviewing victims and witnesses of crimes is a crucial procedure that significantly influences the outcomes of police investigations (Dando & Milne, 2010; Fisher & Geiselman, 1992; Paulo, Albuquerque & Bull, 2013). However, due to inherent memory limitations, the accounts provided by these individuals often fail to fully align with the actual events that were observed, resulting in omissions and errors in their testimonies (Fisher & Geiselman, 1992; Paulo et al., 2013). Scientific research has consistently demonstrated that the techniques employed during interviews greatly impact the quantity and quality of the information elicited from witnesses (e.g., Lamb, Malloy, Hershkowitz & La Rooy, 2015; Milne & Bull, 1999). Moreover, in the context of criminal investigations, victims or witnesses are seldom interviewed immediately after the incident (Goodman, Bottoms, Schwartz-Kenny & Rudy, 1991). They are frequently required to provide statements or identify suspects hours, days, or even months after the events have occurred (e.g., Behrman & Davey, 2001; Hanna, Davies, Henderson, Crothers, & Rotherham, 2010; Peixoto et al., 2017; Plotnikoff & Woolfson, 1995; Quas & Sumaroka, 2011; Saraiva, Albuquerque & Arantes, 2016). Given these challenges, the techniques used during interviews and the time elapsed between the event and the testimony collection are crucial factors that influence the reliability of eyewitness recall. These factors are pivotal in scientific research on memory retrieval, as they significantly affect the accuracy and detail of the information retrieved.

In 1984, Geiselman and colleagues developed the cognitive interview, an innovative protocol designed to enhance the accuracy of eyewitness accounts by leveraging psychological principles governing recall and information retrieval. This protocol initially incorporated four cognitive mnemonics: report everything, mental context reinstatement, “change order”, and “change perspective” (Fisher & Geiselman, 1992). Report everything involves asking the witness to describe the event in as much detail as possible, including seemingly irrelevant details. Mental context reinstatement requires the witness to mentally reconstruct the crime’s physical context and their physiological, cognitive, and emotional states during the event. “Change order” entails recalling the event in a different temporal sequence, often in reverse order. “Change perspective” guides the witness to recall the event from a different viewpoint, such as another witness’s perspective or adopting a more relaxed posture (Fisher & Geiselman, 1992; Paulo, Albuquerque & Bull, 2018).

Years later, Fisher and Geiselman (1992) enhanced the cognitive interview by integrating social and communicative components to improve the reliability of witness

accounts. This new version, known as the enhanced cognitive interview, included building rapport with the witness, tailoring questions to fit the witness's narrative, transferring control of the interview to the witness, and utilizing mental imagery. Rapport building involves establishing a positive and trusting relationship with the witness. Transferring control communicates that the witness is the primary source of information. Asking compatible questions ensures alignment with the witness's narrative and retrieval strategies. Mental imagery asks the witness to mentally recreate the crime scene, often with their eyes closed (Tulving & Thomson, 1973; Fisher & Geiselman, 2010; Paulo et al., 2013, 2018).

Various studies have demonstrated that the cognitive interview can significantly increase the amount of information retrieved while maintaining high accuracy rates (Memon, Weissner & Fraser, 2010; Paulo et al., 2013). These results have been observed even when considering variables such as the age and cognitive abilities of the witnesses (Wright & Holliday, 2007), the level of excitement during the crime (Ginet & Verkampt, 2007), or familiarity with the crime context (Campos & Alonso-Quecuty, 1998). The cognitive interview has proven effective with different groups of witnesses, including children, adults, and the elderly (Verkampt & Ginet, 2009; Wright & Holliday, 2007), and for various types of episodes, such as crimes, accidents, and phone recordings (Campos & Alonso-Quecuty, 2008). It has also shown efficacy across different retention intervals, ranging from a few minutes to several weeks (Larsson, Granhag, & Spjut, 2002). Consequently, this protocol is widely used by police forces in various countries, including England, Wales, and New Zealand, and has demonstrated effectiveness in countries such as the United States of America, England, Australia, Brazil, and Portugal (Paulo, Albuquerque, Saraiva & Bull, 2015; Stein & Memon, 2006).

The cognitive interview's effectiveness stems from the combination of various mnemonics and instructions, particularly the social and communicative components of the enhanced cognitive interview, as well as free recall and mental context reinstatement (Fisher & Geiselman, 2010; Geiselman & Fisher, 2014; Griffiths & Milne, 2010; Kieckhaefer, Vallano, & Compo, 2014; Milne & Bull, 1999; Paulo et al., 2013; Vallano & Compo, 2015). However, certain mnemonics, such as "change order" and "change perspective", have proven less effective individually compared to free recall and mental context reinstatement. For instance, Dando, Ormerod, Wilcock, and Milne (2011) found that recalling information in reverse order was less effective than a second recall attempt using free recall. Similarly, Davis, McMahon, and Greenwood (2005) showed that free recall outperformed both changing the order and changing perspective in enhancing memory retrieval.

Building on these findings, Paulo, Albuquerque and Bull (2016) introduced the category clustering recall technique as an alternative to these less effective mnemonics. Developed to replace "change order" and "change perspective", the category clustering recall technique is based on the theory that activating one memory trace can trigger the recall of related memories (Collins & Loftus, 1975; Paulo et al., 2016, 2017). It organizes recall into broad semantic categories – such as people, objects, locations, actions, conversations, and sounds – allowing witnesses to exhaust each category before moving to the next. This structured approach offers several advantages over traditional mnemonics, providing a more effective method of enhancing memory retrieval in investigative interviews (Paulo et al., 2016, 2017; Thorley, 2018).

In follow-up studies, Paulo and colleagues (2017) incorporated the category clustering recall technique into the enhanced cognitive interview. They found that eyewitnesses recalled significantly more information during a second recall attempt compared to studies using the "change order" mnemonic under similar conditions. Importantly, this increase in recall did not come at the expense of accuracy. Additionally, participants interviewed using category clustering recall during the second recall attempt provided substantially more new information compared to their first attempt using free recall.

Building on this work, Thorley (2018) directly compared the category clustering recall technique to free recall. Unlike the earlier studies by Paulo et al. (2016, 2017), Thorley (2018) did not include the preliminary instructions and mnemonics recommended by Fisher and Geiselman (1992) for interviews with victims or eyewitnesses. Even without these elements, Thorley found that category clustering recall consistently led to the recall of more information than free recall in all experimental conditions. This supports the view put forward by Paulo and colleagues that category clustering recall effectiveness stems from its alignment with the witnesses' natural mental organization of memories, which tends to structure recollections into semantic, temporal, or spatial categories (Dalrymple-Alford & Aamiry, 1969; Manning & Kahana, 2012; Miller, Lazarus, Polyn, & Kahana, 2013; Robinson, 1966). While these findings suggest that category clustering recall can be more effective than free recall under certain conditions, these studies did not directly compare category clustering recall and free recall across different retention intervals. A direct comparison of category clustering recall and free recall across different retention intervals leaves an important gap in understanding how memory retrieval strategies perform over time.

Over the years, researchers have developed various retrieval strategies using a "toolbox" approach, allowing interviewers to adapt the protocol to specific investigative needs (Fisher, 2010). The category clustering recall technique shows promise within this flexible framework, as supported by Paulo et al. (2016, 2017). One of the main objectives of the current study was to test the efficacy of category clustering recall compared to free recall, with the latter serving as a control condition due to its proven effectiveness in diverse contexts and populations. Free recall is a well-established retrieval strategy, widely recommended in investigative protocols such as the cognitive interview (Fisher & Geiselman, 1992), the P.E.A.C.E. model, the Achieving Best Evidence guidelines (Home Office, 2023), and Revised National Institute of Child Health and Human Development (NICHD), protocol for interviewing children (Lamb, Brown, Hershkowitz, Orbach & Esplin, 2018), among others. By employing both category clustering recall and free recall at two different delays, this study also aimed to address potential interaction effects noted in earlier studies. Moreover, incorporating key social and communicational elements from the Enhanced Cognitive Interview added ecological validity, further refining Thorley's (2018) findings. Ultimately, this study seeks to provide a comprehensive evaluation of category clustering recall effectiveness, with the potential to enhance the reliability of eyewitness testimonies and deepen our understanding of memory retrieval in forensic settings.

In most studies involving eyewitnesses, the retention intervals between the witnessed event and the interview vary significantly. These intervals often range from immediate recall, occurring within hours or days after the event, to more extended periods lasting several weeks or even months. Research has shown that the cognitive interview and enhanced cognitive interview consistently enhance recall accuracy across different time frames. For instance, short-term studies, with retention intervals of a few hours to days, demonstrate that the cognitive interview and enhanced cognitive interview significantly improve the quantity and accuracy of information recalled compared to traditional interviewing techniques (Fisher & Geiselman, 1992; Memon, Halley, Work, Bull & Köhnken, 1997). When the interval is extended to one or two weeks, the cognitive interview and the enhanced cognitive interview continue to outperform standard interviews, maintaining higher accuracy and detail retention (Geiselman, Fisher, MacKinnon & Hollan, 1985; Milne & Bull, 2002). Even in studies with long-term retention intervals of several months, these techniques prove effective in mitigating memory decay and retrieving more accurate information (Memon, Meissner & Fraser, 2010; Larsson, Granhag & Spjut, 2002). Delayed interviews using cognitive interview techniques, even after

substantial time gaps, show better recall results compared to standard methods (Wright & Holliday, 2006; Davis, MacMahon & Greenwood, 2005). Additionally, studies involving repeated interviews demonstrate that cognitive interview retains its efficacy when applied across multiple sessions, further reinforcing its robustness as a memory-enhancement tool (Iannuzzi et al., 2010; Köhnken, Milne, Memon & Bull, 1999).

Although these studies highlight the long-term efficacy of the cognitive interview and the enhanced cognitive interview techniques across varying retention intervals, research has not yet explored how the category clustering recall technique performs over extended delays. Previous research on category clustering recall has primarily focused on short-term retention intervals, leaving a significant gap in understanding its effectiveness when a longer delay is introduced. This gap is particularly relevant given the realities of criminal investigations, where victims and witnesses are rarely interviewed immediately after the event (Goodman et al., 1991). Retention intervals between the crime and courtroom testimony can often span from 11 days to more than 24 months, depending on the legal context (e.g., Hanna et al., 2010; Peixoto et al., 2017; Plotnikoff & Woolfson, 1995; Quas & Sumaroka, 2011). Therefore, investigating the effects of delayed recall on eyewitness memory is crucial to understanding how well techniques such as category clustering recall perform in real-world settings. The inclusion of longer delays in memory research is essential for determining whether these retrieval strategies can sustain their effectiveness over extended periods, a variable that has yet to be systematically studied in the context of category clustering recall.

The Present Study

The primary objective of the present study was to evaluate the innovative Category Clustering Recall (CCR) technique in comparison to the well-established Free Recall (FR) technique in terms of their effectiveness in enhancing the quantity and accuracy of information recalled by adult eyewitnesses. A key aspect of this research lies in its novel examination of how these techniques perform over varying delays, specifically comparing their efficacy after a shorter retention interval of 48 hours versus a longer retention interval of one month. This approach addresses a significant gap in the literature, as no previous studies have systematically investigated the long-term efficacy of CCR in forensic contexts. The findings from this study have the potential to inform law enforcement practices by identifying more effective interview protocols that can enhance the reliability of eyewitness testimony, ultimately contributing to the accuracy and fairness of the criminal justice process.

As previously highlighted, although the Enhanced Cognitive Interview (ECI) and its associated mnemonics have demonstrated considerable effectiveness, certain mnemonics – such as changing the order and changing perspective – have shown limitations in enhancing recall. The CCR technique, developed by Paulo et al. (2016), was designed to address these limitations by organizing recall into semantic categories (e.g., people, objects, actions, locations, conversations, and sounds), which may better align with the natural structure of memory. While previous research by Paulo and colleagues (2017) has shown that CCR can elicit more information without compromising accuracy compared to traditional recall techniques, the effectiveness of CCR over extended delays has not yet been systematically studied. This study sought to build on those findings, providing a more comprehensive understanding of CCR's performance over time.

In addition to examining overall recall performance, this study also investigated recall quantity and accuracy within specific categories of information. By analysing the recall of people, actions, objects and locations, and conversations and sounds, the study aimed to offer a more detailed exploration of how these distinct types of information are affected by both recall technique and delay. This nuanced analysis allowed for deeper insights into the strengths and limitations of each technique, contributing to the practical application of these methods in real-world investigative settings.

In the current study we specifically aimed:

1. To evaluate the effect of Interview Technique (CCR versus FR) and Delay (48 hours versus one month) on the overall quantity of information recalled.
2. To investigate the influence of Interview Technique and Delay on the quantity of information recalled across specific categories of information (people, actions, objects and locations, conversations and sounds).
3. To assess the effect of Interview Technique and Delay on the overall accuracy of information recalled.
4. To examine the impact of Interview Technique and Delay on the accuracy of information recalled within specific categories of information (people, actions, objects and locations, conversations and sounds).

Based on previous research, we formulated several hypotheses. First, we hypothesized that the CCR technique would result in a significantly greater amount of information recalled compared to the FR technique across both retention intervals (48 hours and one month). This

hypothesis is supported by previous studies that demonstrate CCR's potential to elicit more detailed recall than traditional techniques (Paulo et al., 2016, 2017). Second, we anticipated that both the CCR and FR techniques would produce similar levels of accuracy in the information recalled after both delays. Previous research suggests that while CCR improves the quantity of recall, it does not compromise accuracy (Paulo et al., 2017; Thorley, 2018), making it likely that accuracy levels would be comparable between the two techniques. Third, we expected that participants would recall significantly more information after 48-hour compared to after one-month, regardless of the recall technique used. This hypothesis is based on well-established findings in the memory literature, which show that memory retention declines as the delay between encoding and retrieval increases (Geiselman et al., 1985; Milne & Bull, 2002; Memon et al., 2010). Fourth, we hypothesized that the accuracy of information recalled would also be higher after 48-hour compared to after one-month, for both techniques. This hypothesis aligns with research indicating that as retention intervals lengthen, the accuracy of recalled information tends to decline (Almeida et al., 2019a, 2019b; Larsson et al., 2003; Memon et al., 1997).

Regarding differences in recall across specific categories of information (people, actions, objects and locations, conversations and sounds), the literature does not provide sufficient evidence to formulate a specific hypothesis. Thus, this aspect of the study is exploratory. While we anticipate that the structured approach of CCR could benefit some categories of recall more than others due to its organization by semantic category (Paulo et al., 2016), no specific predictions are made. This exploratory analysis aims to determine whether certain categories might be better recalled under one technique or retention interval than another.

Method

Participants

A priori power analysis using G*Power 3.1 (Faul et al., 2009), for the use of mixed 2 × 2 ANOVA, indicated that a sample size of 144 participants would be required to achieve a statistical power of .80, with an alpha level of .05 and a medium effect size of .30. To account for potential exclusions following data collection, we initially recruited 166 participants. Eight participants were excluded for non-compliance with instructions or failure to attend the interview sessions.

The final sample consisted of 158 participants, 143 female and 15 males (M = 1.09; SD = .29), aged between 18 and 46 years (M = 21.58; SD = 4.73). Participants were university students recruited through an institutional platform that offers credits for participation in experiments. Participation was voluntary, and participants were instructed to refrain from enrolling if they had a history of psychological or psychiatric disorders or any condition affecting their memory.

Participants were randomly assigned to one of four experimental conditions: Free Recall after 48 hours (N = 40), Category Clustering Recall after 48 hours (N = 40), Free Recall after one month (N = 39), and Category Clustering Recall after one month (N = 39). This ensured a minimum of 36 participants per condition, exceeding the minimum number established by the power analysis using G*Power (Faul et al., 2009).

Design

The present study employed a between-subjects experimental design. The main independent variables were interview technique: (Free Recall (FR) and Category Clustering Recall (CCR) and delay: 48 hours and one month. The dependent variables were the number of units of information recalled and recall accuracy – proportion of correct information, that is, the number of correct units of information a participant recalled divided by the total number of units of information she/he recalled. We conducted a mixed 2 × 2 ANOVA to see if interview technique and delay had an effect on the number of correct units of information recalled.

Materials and Procedure

The present study received ethical approval and was conducted over two sessions, each lasting approximately 20 to 30 minutes (M = 37.10; SD = 12.45). Prior to involvement, all participants read and signed an informed consent, which provided general information about the study, including assurances of anonymity and confidentiality. It was emphasized that participants could withdraw from the study at any time, and it was noted that the interviews would be audio-recorded for later transcription and coding.

In the first session, participants watched a video of a non-violent crime. In subsequent sessions, either 48 hours or one month later, participants were interviewed about the video using one of two interview techniques: FR or CCR.

The interviews were conducted by the author of this dissertation and a research assistant, both trained in the interview techniques under assessment by the CCR original author and co-supervisor of the present study, Prof. Dr. Rui Paulo. The training aimed to ensure a

proper understanding and application of the interview techniques, including familiarizing interviewers with the protocols, intensive practice, constructive feedback, and ongoing assessments to ensure consistency and effectiveness. Interviewers maintained a standardized approach in all interactions with participants to promote uniformity and minimize potential biases.

Session 1: Event to be Recalled

Participants watched a two-minute and thirty-six-second video of a non-violent crime on a 17-inch screen. Before the video presentation, they were instructed to focus their attention as they would be interviewed about its content later. The video, adapted from the film "Sorte Nula", featured a detailed scene with three protagonists involved in a non-violent crime, providing extensive information across several relevant categories: people, objects, actions, locations, and conversations or sounds.

Specifically, the video began in a junkyard with three abandoned cars. Initially, the scene showed one of the protagonists rummaging through bags and papers in the back seat of one of the cars. After grabbing a black plastic bag, he moved to the trunk, where an unconscious male was lying, and covered his head. He then called his accomplice to help carry the body. Nearby, another individual in a white shirt and dark pants was sitting next to an electricity pole. After removing the body from the trunk, they moved into a forest, discussing what to do with the body, even considering buying it. Lacking the necessary tools, they transported the body to another car parked in the forest, placing it in the trunk along with a gun retrieved by the protagonist from his waistband. After that, the assailants agreed to meet at school the next day and left in opposite directions. One of the crime protagonists wore a black beanie, cream-colored pants, a blue jacket, and a denim jacket around his waist, while the other wore dark clothes and a dark vest. The victim was dressed in green boxers, a white tank top, black socks up to the shins, and had knee injuries. The sound of birds was audible throughout the video. This detailed description demonstrates the video's suitability as an event to be recalled for the study's objectives.

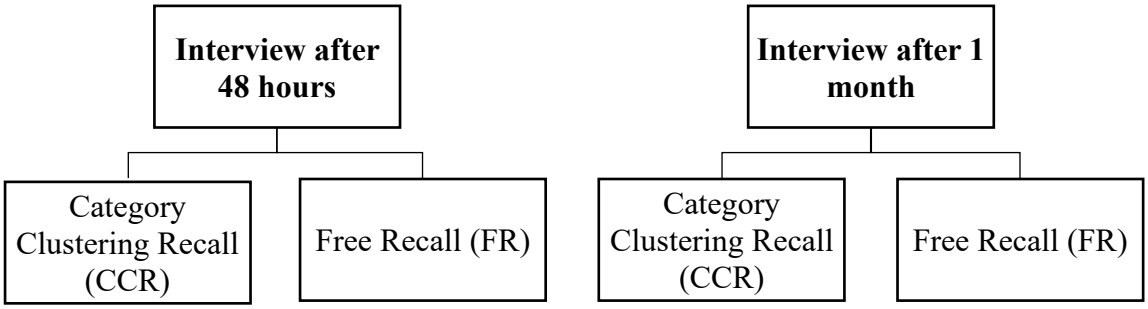
After watching the video, participants completed two distractor tasks (Uno and Sudoku) for 20 minutes in a counterbalanced manner to prevent intentional memorization of the video's content. They were instructed not to discuss the video's content with anyone. All participants confirmed they were unfamiliar with the video.

Session 2: Interview

The second session took place either approximately 48 hours (M = 41.11; SD = 1.33) or one month (M = 32.99; SD = 1.32) after participants had seen the video. All participants confirmed that they had not discussed the video's content with anyone. During this session, participants were interviewed using either the FR or the CCR, based on their randomly assigned group. Figure 1 illustrates the organization of the experimental and control groups in the study, showing the distribution of participants based on the interview techniques and retention intervals.

Figure 1

Illustrative Example of the Organization of Experimental and Control Groups



Preliminary Instructions. All interviews began with the instructions proposed by Fisher and colleagues (1992), including greeting, establishing rapport, explaining the purpose of the interview, requesting participants not to make assumptions, and finally, transferring control of the interview to the participant. These preliminary instructions are recognized as best practices for interviewing adult eyewitnesses (e.g., Fisher et al., 1992; Paulo et al., 2015) and were provided to all participants regardless of the retrieval strategy used.

Participants were then asked to verbally report the information they could recall about the event using the assigned retrieval technique. In both interview protocols (FR and CCR), only one attempt at information retrieval was requested; participants were not asked to respond to additional open or closed questions.

Free Recall. Participants in the FR condition were instructed to recall all details of the crime without restrictions on the order or type of information reported. The following instructions were given:

> Our goal is to help you remember as much information as possible about the video you watched two days ago. I would like you to tell me everything you remember about the video, with as much detail as possible. Please tell me everything you remember, even the details that might seem irrelevant or that you only partially remember. Some people omit information they believe is not important for the interview. However, I am interested in everything that comes to your mind.

Category Clustering Recall. Participants in the CCR condition were instructed to recall all details of the crime by organizing their recall into categories of information provided by the interviewer. The categories included details related to people, objects, locations, actions, and conversations or sounds (Paulo et al., 2016). The following instructions were provided:

> I'm going to ask you to tell me everything you remember about the video, but addressing one type or category of information at a time, that is, separately. This means I'll ask you to first relate all the details about the people present in the video and their descriptions; then all the details about the objects and crime scenes; next all the details about the actions or behaviours of the characters; and finally about the conversations or sounds you heard. These are the categories: people, objects, locations, actions, and conversations or sounds. You should report all the details about each one, separately and in any order. Don't worry, as I will remind you of the categories if needed. Any questions? When you are ready, you can start recalling everything you remember, beginning with the category of your choice.

Coding Scheme

Participants verbal recall was recorded and transcribed. These transcriptions were then coded using the technique proposed by Paulo and colleagues (2016). The authors created a comprehensive list of 323 information units from the video, categorized into six categories: people (e.g., "perpetrator"), actions (e.g., "walked"); objects (e.g., "car"), locations (e.g., "inside the trunk"), conversations (e.g., "come on"), or sounds (e.g., "heavy breathing"). The information units reported by participants were compared to this list to classify them as correct (e.g., "he had a black hat" when he indeed had one), incorrect (e.g., "he had a red hat" instead of black), or confabulations (e.g., "he had a hat" when he did not) and assigned to the corresponding detail categories (i.e., people, objects, actions, locations, conversations, or sounds).

Due to the low number of confabulated information units (M = .15; SD = .98), these were combined with incorrect information for analysis. For the same reason, we merged the category locations (M = 6.41; SD = 2.99) with the category objects, and the category sounds (M = 2.41; SD = 2.11) with the category conversations.

For coding purposes, each detail was counted only once, the first time it appeared in the narrative (following the approach of Prescott, Milne & Clark, 2011). Subjective opinions were not considered in the analysis (e.g., "they were nice"; Paulo et al., 2016, 2017). Table 1 shows an illustrative example of the coding scheme employed in this study.

Table 1

Illustrative Example of the Coding Scheme

				Categories					
Information	Corr.	Incorr.	Conf.	Peop.	Act.	Obj.	Loc.	Conv.	Soun.
Agressor 1 (female)		1		1					
Agressor 1 (jacket – white letters – white – on the back)	1			1		1			
Agressor 2 (*"Não está ninguém")*	1							1	
Agressor 2 (beside car 3)	1						1		
Agressor 2 (goes in front of ther's no-one-there)	1				1				
Car 1 (red)		1				1			

Reliability

To analyse the reliability of the coding, we calculated the Intraclass Correlation Coefficient (ICC). A random sample of 32 interviews, representing 20% of the total interviews, was independently coded by a second investigator (the aforementioned research assistant). The ICC's were calculated for all relevant recall measures. A high agreement index was observed for all measures, namely, total recall (.97), correct recall (.97), and incorrect recall (.94).

Results

Analytical Plan

The research questions were addressed using a series of analyses of variance (ANOVA) to examine differences between groups in the dependent variables: the quantity and accuracy of information recalled by the participants. We conducted separate analyses for the quantity and accuracy of the information.

All variables included in the parametric analyses exhibited normal distribution, and all assumptions for ANOVA were verified. When the assumption of sphericity was violated, as indicated by Mauchly's test, the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity. Effect sizes were reported using partial eta-squared (η^2_p). Simple effect analyses, with Bonferroni corrections, were used to explore significant interactions. These corrections were applied to avoid Type I errors when multiple statistical tests were conducted on a single data set. We used an alpha level of .05 for all statistical tests (Field, 2009).

Effects of Delay and Interview Technique on Recall Quantity

Firstly, we conducted a series of Analyses of Variance (ANOVA) to examine the effects of Interview Technique (Category Clustering Recall versus Free Recall) and Delay (48 hours versus one month) on the amount of information recalled. Separate ANOVA's were performed for overall recall and for each category of information: people, actions, objects and locations, and conversations and sounds. Table 2 shows the means and standard deviations for the amount of information recalled by participants, by interview technique and delay.

Table 2

Means and Standard Deviations for the Amount of Information Recalled, by Interview Technique and Delay

	Interview Technique and Delay															
	Total				CCR						FR					
	48H		1M		48H		1M		Total		48H		1M		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall Recall	41.11	11.94	32.99	11.65	42.43	11.67	35.72	12.06	39.11	12.26	39.80	12.20	30.26	10.69	35.09	12.38
People	14.76	6.85	12.35	5.82	15.80	6.40	13.97	5.58	14.90	6.04	13.72	7.20	10.72	5.66	12.24	6.62
Actions	16.65	7.33	12.73	5.79	16.08	7.98	12.54	5.60	14.33	7.09	17.23	6.66	12.93	6.05	15.10	6.69
Objects and Locations	6.91	2.78	5.88	3.14	7.05	2.16	6.46	3.55	6.76	2.93	6.78	3.31	5.31	2.59	6.05	3.05
Conversation and sound	2.78	2.27	2.04	1.89	3.48	2.55	2.74	2.07	3.11	2.34	2.08	1.70	1.33	1.38	1.71	2.12

Notes. CCR: Category Clustering Recall; FR: Free Recall; 48H: 48-hour interview; 1M: 1-month interview.

Overall Recall

For overall recall, including correct and incorrect information, results indicated there was a significant main effect of Interview Technique, $F(1, 154) = 4.74$, $p = .031$, $\eta^2 = .03$, with more information being recalled using CCR ($M = 39.11$; $SD = 12.26$) compared to FR ($M = 35.09$; $SD = 12.38$). Additionally, there was a significant main effect of Delay, $F(1, 154) = 19.13$, $p < .001$, $\eta^2 = .11$, with participants recalling more information after 48 hours ($M = 41.11$; $SD = 11.94$) than after one month ($M = 32.99$; $SD = 11.65$). However, there was no significant Delay x Interview Technique interaction, $F(1, 154) = .58$, $p = .446$, $\eta^2 = .004$.

People

There was a significant main effect of Interview Technique, $F(1, 154) = 7.18$, $p = .008$, $\eta^2 = .05$. Participants recalled more information about people when interviewed with CCR ($M = 14.90$; $SD = 6.04$) than with FR ($M = 12.24$; $SD = 6.62$). There was also a significant main effect of Delay, $F(1, 154) = 5.89$, $p = .016$, $\eta^2 = .04$. Participants recalled more information about people after 48 hours ($M = 14.76$; $SD = 6.85$), than after one month ($M = 12.35$; $SD = 5.82$). There was no significant Delay x Interview Technique interaction, $F(1, 154) = .35$, $p = .554$, $\eta^2 = .002$.

Actions

There was a significant main effect of Delay, $F(1, 154) = 13.74$, $p < .001$, $\eta^2 = .082$, with participants recalling more information about the actions that were performed during the

video after 48 hours (M = 16.65; SD = 7.33) than after one month (M = 12.73; SD = 5.79). However, there was no significant main effect of Interview Technique, $F(1, 154) = .53$, $p = .469$, $\eta^2 = .003$, and no significant Delay x Interview Technique interaction, $F(1, 154) = .13$, $p = .718$, $\eta^2 = .001$.

Objects and Locations

There was a significant main effect of Delay, $F(1, 154) = 4.79$, $p = .030$, $\eta^2 = .030$, with participants recalling more information about object and locations after 48 hours (M = 6.91; SD = 2.78), than after one month (M = 5.88; SD = 3.14). However, there was no significant main effect of Interview Technique, $F(1, 154) = 2.31$, $p = .130$, $\eta^2 = .015$, and no significant Delay x Interview Technique interaction, $F(1, 154) = .88$, $p = .351$, $\eta^2 = .006$.

Conversations and Sounds

There was a significant main effect of Interview Technique, $F(1, 154) = 19.92$, $p < .001$, $\eta^2 = .115$. Participants recalled significantly more information about conversations and sounds when interviewed with CCR (M = 3.11; SD = 2.34), compared to FR (M = 1.71; SD = 2.12). There was also a significant main effect of Delay, $F(1, 154) = 5.473$, $p = .021$, $\eta^2 = .034$. Participants recalled significantly more information about conversations and sounds after 48 hours (M = 2.78; SD = 2.27), than after one month (M = 2.04; SD = 1.89). There was no significant Delay x Interview Technique interaction, $F(1, 154) = .00$, $p = .987$, $\eta^2 = .000$.

Effects of delay and Interview Technique on Recall Accuracy

Subsequently, we conducted a series of Analyses of Variance (ANOVA) to examine the effects of Interview Technique and Delay on the accuracy of the information recalled by participants. Separate ANOVA's were performed for overall recall accuracy and for the accuracy of each category of information: people, actions, objects and locations, and conversations and sounds. The accuracy of participants' reports was measured by dividing the number of correct details reported by the total number of details recalled. Table 3 shows the percentage of recall accuracy, by interview technique and delay.

Table 3

Percentage Accuracy of Information Recalled, by Interview Technique and Delay

	Interview Technique and Delay															
	Total				CCR						FR					
	48H		1M		48H		1M		Total		48H		1M		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall Recall	.88	.08	.82	.11	.87	.09	.83	.11	.85	.10	.89	.06	.81	.10	.85	.09
People	.91	.09	.89	.11	.89	.11	.87	.12	.88	.11	.93	.08	.91	.11	.92	.09
Actions	.85	.15	.75	.22	.84	.15	.78	.23	.81	.20	.85	.15	.73	.21	.79	.19
Objects and Locations	.93	.11	.87	.16	.92	.12	.84	.16	.88	.14	.95	.11	.89	.16	.92	.14
Conversation and sound	.91	.17	.81	.36	.86	.20	.83	.34	.85	.27	.98	.06	.79	.38	.89	.28

Notes. CCR: Category Clustering Recall; FR: Free Recall; 48H: 48-hour interview; 1M: 1-month interview.

Overall Recall

There was no significant main effect of Interview Technique, $F(1, 154) = .21$, $p = .644$, $\eta^2 = .001$. There was a significant main effect of Delay, $F(1, 154) = 16.29$, $p < .001$, $\eta^2 = .096$. Participants' overall recall was significantly more accurate 48 hours after the event ($M = .88$; $SD = .08$), than one month after the event ($M = .82$; $SD = .11$). However, there was no significant Delay x Interview Technique interaction, $F(1, 154) = 2.56$, $p = .112$, $\eta^2 = .016$.

People

There was a significant main effect of Interview Technique, $F(1, 154) = 6.06$, $p = .015$, $\eta^2 = .038$. Participants' recall regarding people was significantly more accurate when interviewed with FR ($M = .92$; $SD = .09$) than when interviewed with CCR ($M = .88$; $SD = .11$). However, there was no significant main effect of Delay, $F(1, 154) = 1.49$, $p = .224$, $\eta^2 = .010$, and no significant Delay x Interview Technique interaction, $F(1, 154) = .08$, $p = .782$, $\eta^2 = .000$.

Actions

There was a significant main effect of Delay, $F(1, 153) = 10.14$, $p = .002$, $\eta^2 = .062$. Participants' recall regarding actions was significantly more accurate after 48 hours ($M = .85$; $SD = .15$), than after one month ($M = .75$; $SD = .22$). However, there was no significant main effect of Interview Technique, $F(1, 153) = .58$, $p = .448$, $\eta^2 = .004$, and no significant Delay x Interview Technique interaction, $F(1, 153) = .86$, $p = .356$, $\eta^2 = .006$.

Objects and Locations

There was a significant main effect of Interview Technique, $F(1, 154) = 3.89$, $p = .050$, $\eta^2 = .025$. Participants' recall regarding objects and locations was significantly more accurate when interviewed with FR ($M = .92$; $SD = .14$), than when interviewed with CCR ($M = .88$; $SD = .14$). There was also a significant main effect of Delay, $F(1, 154) = 7.75$, $p = .006$, $\eta^2 = .048$. Participants' recall regarding objects and locations was significantly more accurate after 48 hours ($M = .93$; $SD = .11$), than after one month ($M = .87$; $SD = .16$). However, there was no significant Delay x Interview Technique interaction, $F(1, 154) = .36$, $p = .551$, $\eta^2 = .002$.

Conversations and Sounds

There was a significant main effect of Delay, $F(1, 125) = 5.39$, $p = .022$, $\eta^2 = .041$. Participants' recall regarding conversations and sounds was significantly more accurate after 48 hours ($M = .91$; $SD = .17$), than after one month ($M = .81$; $SD = .36$). However, there was no significant main effect of Interview Technique, $F(1, 125) = 0.699$, $p = .405$, $\eta^2 = .006$, and no significant Delay x Interview Technique interaction, $F(1, 125) = 3.075$, $p = .082$, $\eta^2 = .024$.

Discussion

The present study aimed to evaluate the effectiveness of the Category Clustering Recall (CCR) technique in comparison to Free Recall (FR) across varying retention intervals, focusing on the amount and accuracy of information recalled by eyewitnesses. In addition, the study sought to explore differences in recall across specific categories of information, such as people, actions, objects, locations, conversations, and sounds. By incorporating two distinct retention intervals (48 hours and one month), this research provides valuable insights into how memory retrieval techniques perform over time, addressing a notable gap in the literature on the long-term efficacy of CCR. Given the widespread use of FR in investigative interviews with adult witnesses, understanding the comparative performance of these techniques is essential for improving investigative interview protocols and ensuring the reliability of eyewitness testimony in real-world criminal investigations. The findings have important implications for the field of forensic psychology, particularly regarding the practical application of memory retrieval strategies under different temporal conditions. In this section, we discuss the implications of the results, situating them within the broader context of eyewitness memory literature, and explore the practical significance of the CCR technique for investigative interviewing. Additionally, we consider the limitations of the current study and propose directions for future research.

The first objective of the present study was to evaluate the effect of interview technique and delay on the overall quantity of information recalled. We hypothesized that CCR would elicit significantly more information than FR, irrespective of the delay, a hypothesis confirmed by the results. These findings align with earlier research by Paulo et al. (2016, 2017), which demonstrated that the structured, category-based retrieval strategy of CCR enables witnesses to access more memory traces, leading to a more exhaustive recall of event details. In contrast, FR relies on the witness's spontaneous retrieval, which may result in less organized and therefore less complete overall recall. This advantage of CCR is further supported by theories of semantic memory organization, suggesting that prompting individuals to retrieve information based on specific categories can trigger associated memories more effectively (Collins & Loftus, 1975; Anderson, 1983; Paulo et al., 2017). However, it's crucial to acknowledge that these advantages of CCR are primarily demonstrated in controlled lab settings and may not fully extend to field situations where emotional stress or cognitive load can affect memory recall differently (Deffenbacher, Bornstein, Penrod & McGorty, 2004).

Moreover, the study confirmed the impact of delay on the quantity of information recalled, with participants recalling significantly more details after 48 hours than after one month. This finding is consistent with research on memory decay, which shows that memory retention declines rapidly over time, especially without the presence of rehearsal or cues (Ebbinghaus, 1885; Memon et al., 2010). Recent studies have similarly emphasized how memory is subject to significant deterioration shortly after encoding, particularly under conditions where interference occurs (Wixted, 2010; Roediger & Butler, 2011). These results underscore the importance of conducting interviews promptly to maximize recall and minimize memory decay, a crucial point in forensic investigations (Wixted & Wells, 2017).

The second objective of the study was to explore the influence of Interview Technique and Delay on the quantity of information recalled within specific categories of information, such as people, actions, objects and locations, and conversations and sounds. While this aspect of the study was exploratory due to the lack of specific hypotheses in the literature, the findings suggest that CCR is particularly effective in increasing the recall of details related to conversations and sounds. These results mirror previous findings by Thorley (2018), who reported that category-based recall strategies help witnesses organize their memories in a way that facilitates more detailed reporting, especially in categories where details might otherwise be overlooked. However, it's important to recognize that factors such as stress, cognitive load, and individual differences – including age and cognitive impairments – can significantly affect

memory recall (Deffenbacher et al., 2004). For instance, vulnerable populations like children or the elderly may not experience the same benefits from CCR due to differences in cognitive processing and memory capacity (Milne, Bull, Köhnken, & Memon, 1995). Therefore, while CCR shows promise in enhancing recall within certain categories, its generalizability across different demographics and settings requires cautious interpretation and further investigation.

While this study is the first to examine the CCR technique over a longer retention period, the findings indicate that CCR has potential to improve the quantity of information recalled, consistent with earlier research by Paulo et al. (2016, 2017) and Thorley (2018). Specifically, participants interviewed with CCR recalled more narrative details than those interviewed with free recall. However, the difference in the number of errors between the two techniques was minimal, suggesting that while CCR may enhance the quantity of information retrieved, its effect on accuracy remains comparable to free recall. These results support the idea that organizing recall into semantic categories, as proposed by Paulo et al. (2016, 2017), may help activate related memory traces, potentially leading to more comprehensive recall. Nonetheless, further research is needed to confirm whether these benefits are consistently observed across different populations and real-world contexts, especially considering the potential limitations posed by factors such as stress and cognitive load during interviews.

The third and fourth objectives of the present study aimed to evaluate the effect of Interview Technique and Delay on the overall accuracy of information recalled and on accuracy across specific categories of information. We hypothesized that both techniques would produce similar levels of accuracy, and that accuracy would be higher after the 48-hour retention interval compared to one month. The results are in line with the initial hypothesis. Specifically, FR led to higher overall accuracy, and higher accuracy for information regarding objects and locations, whereas CCR proved more effective for people-related information. These findings are consistent with previous research suggesting that both techniques yield comparable accuracy levels (Paulo et al., 2017; Thorley, 2018). FR, which is less structured, may allow participants to focus selectively on peripheral environmental details, contributing to better recall of objects and locations, while the structured nature of CCR, which organizes recall into distinct categories, may encourage participants to focus more on socially salient details, such as descriptions of individuals, potentially leading to better accuracy for person-related information. These results align with the notion that person-related information, such as physical descriptions and identifying features, may be processed differently in the brain, potentially leading to deeper encoding (Bruce & Young, 1986; Raykov & Marcoulides, 2020;

Cohen & Conway, 2007). This type of information may thus be more readily accessible when prompted with appropriate retrieval strategies (Paulo et al., 2017). In contrast, episodic details, such as objects and locations, may be more vulnerable to memory decay, and participants in the FR condition may have had more flexibility to retrieve these types of information selectively, leading to better accuracy in these areas (e.g., Roediger & Butler, 2011)

The second part of our hypothesis – that accuracy would be higher after a 48-hour retention interval compared to one month – was supported. Regardless of the recall technique used, participants were more accurate after 48 hours than after one month, consistent with well-established theories of memory decay (Memon et al., 2010). Over time, as the delay between the event and the retrieval increases, memory traces tend to fade, leading individuals to rely on reconstructive processes that introduce inaccuracies (Loftus, 2005). This finding underscores the importance of minimizing delays in investigative interviews to preserve the accuracy of eyewitness testimony.

Interestingly, the effect of delay on accuracy varied across specific categories of information. While delay significantly reduced accuracy for actions, objects and locations, and conversations and sounds, people-related information remained relatively stable over time, with no significant decline in accuracy between the 48-hour and one-month delays. This finding suggests that certain types of information may be more vulnerable to memory decay over time than others. The stability of accuracy in recalling people could be related to the distinctiveness of person-related information. Socially salient information (e.g., physical appearances or identifying features) may be more resilient to memory decay, potentially due to deeper encoding processes or the emotional significance attached to these details (Jackson & Raymond, 2006). In contrast, episodic details such as actions, objects, and conversations rely more on episodic memory, which is known to degrade more rapidly, particularly when reconstructive processes are involved (Tulving, 1985).This aligns with the theory of memory schemas, which suggests that people may fill in gaps in memory with plausible details from general knowledge, particularly when recalling episodic events after a long delay (Brewer & Treyens, 1981). Thus, participants may have been more prone to reconstructing details about actions or objects inaccurately after a longer retention interval, leading to the observed decline in accuracy for these categories.

The fifth objective of the present study was to explore the effects of Interview Technique and Delay on the quantity and accuracy of recall across specific categories of information, including people, actions, objects and locations, and conversations and sounds.

This objective was designed to shed light on whether different types of information would benefit more from one technique or retention interval than another, a largely underexplored area in existing literature. It was anticipated that CCR's structured approach could yield advantages in certain categories, such as people, due to its systematic organization. Our findings revealed distinct patterns in how recall quantity and accuracy varied across categories. As previously noted, CCR proved more effective for people-related information, while FR led to higher accuracy in recalling objects and locations. Interestingly, both techniques yielded similar results for actions and conversations, although both categories were more vulnerable to memory decay over time. These findings support the notion that different types of information may benefit from different retrieval strategies (Bruce & Young, 1986).

Regarding actions and conversations, both techniques demonstrated comparable results, suggesting that these types of information may be less influenced by the structure of the retrieval technique. Dynamic events and actions are often automatically encoded during the witnessing of an event, benefiting from motor memory processes that aid retention, though this declines over time (Tulving, 1985). The consistency across techniques in recalling actions and conversations suggests that temporal factors, rather than the interview technique, are the primary drivers of memory decay for these categories (Shapiro, 2021). Nevertheless, both actions and conversations were susceptible to memory decay, with greater accuracy after 48 hours compared to one month, reinforcing the importance of prompt investigative interviews.

Overall, these findings highlight the complex dynamics of memory retrieval across different types of information and suggest that interview techniques must be tailored to the specific details investigators seek to elicit. For instance, CCR may be particularly effective for eliciting accurate person-related information, which is often critical in forensic contexts, while FR might be more advantageous when retrieving environmental details or episodic information. The distinction between categories of information also emphasizes the importance of considering temporal factors in investigative interviews, as memory decay may disproportionately affect certain types of information over others. This supports the view that forensic interviewing protocols should account for both the type of information needed and the timing of the interview, to maximize the reliability of eyewitness testimony.

The findings from this study have several important implications for forensic interviewing practices. The results demonstrate that the CCR technique can be particularly effective in enhancing the quantity of information recalled without sacrificing accuracy, especially for person-related details. This highlights the potential utility of CCR in cases where

identifying suspects or witnesses is critical, such as during investigative interviews that focus on suspect identification or witness testimonies regarding individuals present at a crime scene. Conversely, FR proved more effective for accurately recalling environmental details, such as objects and locations, which can be equally important in cases involving forensic reconstruction or when understanding the physical context of a crime is essential.

The observed effect of delay on recall accuracy reinforces the importance of conducting investigative interviews as soon as possible after a witnessed event, as shorter delays lead to greater accuracy in both recall techniques. This aligns with existing recommendations for police and investigative protocols (e.g., Lamb et al., 2018; Paterson, Ejikemans & Kemps, 2018, Hope, Gabbert, Fisher & Jamieson, 2014; Krix, Sauerland, Gabbert & Hope, 2014), suggesting that forensic interviews should be conducted within a short window to minimize memory decay. These insights could help inform training programs for law enforcement personnel, ensuring that officers use the most effective interviewing strategies depending on the type of information they seek. Furthermore, understanding that memory retention varies by category (e.g., people versus objects) allows investigators to prioritize specific types of information based on their temporal sensitivity, ultimately improving the reliability of eyewitness testimony in criminal investigations.

Limitations and Future Directions

Despite the valuable insights provided by the study, several limitations should be acknowledged. One significant limitation is the sample population, which consisted predominantly of university students. While this demographic is commonly used in memory research, it may not be representative of the broader population, particularly in forensic settings where witnesses can vary widely in age, education, and cognitive abilities (Wells, Memon & Penrod, 2020). Future research should consider testing these recall techniques across more diverse populations to ensure generalizability.

Additionally, the study's-controlled laboratory setting may not fully capture the complexities and emotional pressures that witnesses experience in real-world situations. Eyewitnesses to actual crimes often face heightened stress and emotional arousal, which can significantly influence memory encoding and retrieval (Deffenbacher et al., 2004). The absence of these factors in a lab-based setting might lead to differences in recall performance, potentially overestimating the effectiveness of these techniques when compared to real-world applications.

Another limitation relates to the limited range of retention intervals used in the study. While we examined recall at 48 hours and one month, these timeframes may not fully represent the variety of delays witnesses experience before being interviewed in real-world cases. Some witnesses may be interviewed within hours of a crime, while others might face delays of several months. Further research could explore the effects of longer and shorter delays, providing a more nuanced understanding of how memory decays over time and how retrieval strategies like CCR and FR perform under different conditions.

Future research should build upon the findings of the present study by addressing these limitations and exploring new avenues for understanding eyewitness memory. One key area for future investigation is the effectiveness of CCR and FR techniques across different age groups and cognitive profiles, such as children, the elderly, or individuals with neurodivergent conditions, such as autism spectrum disorder (Almeida, Lamb & Wiesblatt, 2019b). Understanding how these techniques perform in more diverse populations would offer valuable insights for tailoring interview protocols to different witness profiles. Moreover, future studies could examine the effects of longer retention intervals, extending beyond one month to capture how memory decays over several months or even years. This would provide a clearer picture of how CCR and FR techniques hold up in cases where witnesses are interviewed long after the event. Additionally, incorporating stress-inducing or emotionally charged scenarios into experimental designs could help simulate more realistic conditions, revealing how these factors influence the effectiveness of the recall techniques in forensic contexts (Deffenbacher et al., 2004).

Finally, research could investigate how other variables, such as interviewer behaviour, question phrasing, or post-event information, interact with CCR and FR to affect eyewitness recall. This would further refine our understanding of how to optimize interview protocols to ensure the accuracy and reliability of eyewitness testimony, particularly in the face of misleading information or suggestion. By addressing these research gaps, future studies can provide a more comprehensive and practical framework for enhancing forensic interviewing techniques.

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