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Extracting Witness Evidence in "Cold Case" Investigations: What We Know and What We Need to Learn

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Abstract

Despite advances in forensic sciences, there is a significant increase in the number of cases that remain unsolved—cold cases. Cold case investigations present numerous unique challenges above and beyond those of typical (i.e., timely) investigations. In cold cases, witness memory is likely to be weakened substantially due to the historical nature of the incident (e.g., the victim of historical sexual abuse) and subject to interference from different sources (e.g., conversations with others and previous interviews). Despite the numerous and challenging barriers present within cold case investigations, researchers have not systematically explored the barriers faced by cold case investigators or the best ways of obtaining detailed and accurate information from witnesses and victims of cold cases. Solving cold cases can prevent perpetrators from committing further crimes, help bring peace to the loved ones of deceased victims, and communicate to living victims that they are not forgotten. Our goal is to generate interest in a program of rigorous experimental and applied work in this neglected field. We also aim to provide preliminary resources and practical considerations for cold case investigators based on current best practices.

Keywords Cold cases · Memory · Investigative interviewing

> *"Time is a burden and people forget things. Some other people think they remember things or they have manufactured memory. I mean sometimes you speak to a witness now and their statement seems to be much more detailed than it was from the offence date. That's because people naturally fill in the blanks. Also, people die, we lose witnesses, and people move. Some people just don't want anything to do with the investigation anymore."*
>
> *-RCMP Cpl. Kerry Shima, Cold case investigator, Alberta, Canada*

Clearance rates for violent crimes in Canada (Statistics Canada 2022), the USA (Federal Bureau of Investigation 2017), and the UK (Home Office 2021) have decreased in the past few decades, leading to an increase in "cold" cases. There has been, however, a recent increase in public interest in cold case investigations likely fueled by popular media depictions of fictional and real cold cases (e.g., investigatory podcasts such as Serial; Koenig 2014), public inquiries into historical wrongdoings (e.g., Larry Nassar in the USA, Kirby 2018; Missing and Murdered Indigenous Women and Girls in Canada 2022), and the resolution of high-profile cases due to advances in DNA technology (e.g., the Golden State Killer; St. John 2020). When DNA samples were collected and appropriately stored at the time of the original investigation, current technologies allow for comparison with databases of DNA samples, ancestry websites, or with an identified suspect. However, properly stored DNA evidence is unavailable in most cold cases (Davis et al. 2011), and investigators must rely on other investigative techniques, such as (re-) interviewing witnesses and suspects, to solve cold cases.

The primary contributor to the decision to re-open a cold case for active investigation is the discovery of new evidence—either physical or witness evidence (Davis et al. 2011, 2014). Like DNA evidence, other types of physical evidence gathered during the original investigation may be re-examined with new technologies; however, even if such evidence was collected at the time, its preservation may not meet standards for new analyses (e.g., stored inappropriately). Thus, witness evidence becomes crucial for solving

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many cold cases. Witnesses may have experienced changes in motivation, allegiance, and/or memory since the crime occurred that make re-interviewing them a potentially fruitful avenue to solving a cold case. Recent advances in interview methodologies (e.g., the development of interview strategies based on current knowledge of memory structure and function) can result in new investigative leads. Memory evidence, though fragile, can provide an important starting point from which investigators can focus their efforts. For example, witness statements have been the primary evidence in several recent high-profile historical sexual abuse cases (e.g., cases against Jeffrey Epstein, Larry Nassar, and Jerry Sandusky in the USA).

Overall, there is a lack of research specific to cold cases that need to be addressed in order to provide advice and resources to cold case investigators (but see Bänziger and Killias 2014; Yaksic 2020, for two exceptions). In the current paper, we review the extant psychological literature that might be of use in the elicitation of witness evidence in cold case investigations. We also highlight areas in which researchers could meaningfully contribute to a useful body of knowledge for investigators. We focus on two broad areas: eliciting narrative memory evidence in interviews and person identification. Our goal is to generate interest in a program of rigorous experimental and applied work in this neglected field and to highlight the critical importance of assisting investigators by sharing knowledge of potentially useful witness-engagement strategies.

What We Know (So Far) About Cold Cases

Though lacking a consistent definition, a cold case is typically defined as one that is currently unresolved, in which no fresh leads exist, and a substantial amount of time has passed (often at least 1–3 years, depending on jurisdiction; Davis et al. 2011). Cold cases involve a wide range of (potentially) criminal events including missing people, murder, sexual assault, and arson. There is tremendous variability in the reasons why a case remains unsolved, but a common underlying challenge is a lack of new leads. Solving cold cases can prevent perpetrators from committing additional crimes, help bring peace to victims and their loved ones, communicate that victims are not forgotten, and promote trust in the police particularly in under-represented or marginalized communities.

Cold cases introduce substantial challenges beyond those experienced in timely investigations; some elements typically present in fresh cases are absent from, or less salient in, cold case investigations. For example, witness memory is more likely to be substantially weakened and subject to greater interference from numerous sources in cold cases (cf. timely cases), by virtue of time passing. In some cases, previous confessions and witness testimony obtained by questionable methods have been proven false by advances in forensic evidence. Further complicating the issue, cold case investigators often receive no special training for their unique and difficult role. Rather, they must apply their training and experience from timely investigations to the complex context of cold cases.

In an exploration of factors that contribute to re-opening a cold case investigation, Davis and colleagues (2011) found the leading factor was new witnesses, which were present in 90% of re-opened cold cases. A witness' willingness to cooperate with the police will likely shift over time (e.g., changing allegiances, general trust in police; Bolger and Walters 2019; Mazerolle et al. 2013); witnesses that originally were reluctant to come forward may now be willing to provide information. Thus, the ability to effectively interview new witnesses following a substantial delay is a critical investigative skill, and one that investigators have recognized a need for; Keel (2011) conducted a survey of 55 busy police departments, and investigators overwhelmingly indicated that the greatest asset for a cold case detective is good interviewing skills.

There is a wealth of research on best interviewing practices for investigating recent crimes. For example, there are well-established and well-communicated recommendations for interviewing adult witnesses (Cognitive Interview, Fisher and Geiselman 1992; Memon et al. 2010), children (National Institute of Child Health and Human Development, Lamb et al. 2018), and suspects (the Méndez Principles on Effective Interviewing for Investigations and Information Gathering; Association for the Prevention of Torture 2019), and for collecting eyewitness identification evidence (e.g., Wells et al. 2020). Yet, there is consistent evidence that investigators around the world receive little formal training in evidence-based interviewing techniques (e.g., Dando et al. 2008; Fisher and Schreiber 2007; Mueller et al. 2015; Schreiber-Compo et al. 2012; Snook et al. 2012), let alone techniques that may be beneficial for cold cases. The lack of formal interview training is a significant barrier to advancing cold cases; if witness memory is the central evidence in a case, formal interviewing skills are required to retrieve that evidence. Despite an appetite for innovative and effective investigative techniques among cold case investigators (e.g., Bennett 2020), researchers have not responded with a body of knowledge on best practices for interviewing in cold case investigations. Thus, it is unclear whether current interviewing techniques are suitable for the unique nature of cold case investigations. A key aim of the current paper is to provide a review of current interviewing techniques that may be suitable for use in cold cases.

Overall, cold cases introduce substantial challenges beyond those experienced in timely investigations; some elements typically present in fresh cases are absent from, or less salient in,

cold cases. While some of these differences may have predictable effects (e.g., the effect of the passage of time on memory strength), there are other differences for which the effects are less clear (e.g., the impact of an initial poorly conducted interview). We begin our discussion of how to elicit memory evidence with a brief review of some memory features that are particularly relevant to interviewing "cold witnesses".

Cold Witness Challenges

Challenges Due to Passing of Time (Delay)

It is critical to first understand some basic memory processes that contribute to what information witnesses may be able to provide to investigators following a significant delay. Excellent reviews of memory processes applied to the legal system are beyond the scope of the current paper and are available elsewhere (e.g., Conway and Jobson 2012; Howe et al. 2018). Briefly, memory retrieval is a subjective, reconstructive process, rather than a stored record of prior events (see Howe et al. 2018). What an individual will remember about an event will be a function of what they attended to, their prior and current emotional and mental state, how often they thought about the event since it happened, and any conversations or other information they have encountered since the event, among many other factors. Because of its imperfect nature, there are many opportunities for memory to decay or become contaminated.

As the period between an event occurring and attempting to recall that event increases, the amount of information recalled generally decreases—that is, we simply forget over time (Ebbinghaus 1913; Rubin and Wenzel 1996). This forgetting is due, in part, to the weakening of the memory trace over time, leading to items of information in memory becoming less accessible (see Anderson 1983). Memory can also become more "gist-like" or general in nature over time, as fine-grained information is forgotten more rapidly than coarse-grain information (Goldsmith et al. 2005). Depending on the memory in question, this may mean that central or more general features of an event are recollected while more fine-grain details are lost. This pattern of decay for fine-grained information has also been found in eyewitness reports of crime events. For example, Fisher (1996) found that reports provided after 40 days were less detailed than those provided immediately after the event. Importantly, however, despite the natural forgetting process and weakening of memory, some memory mechanisms (e.g., rehearsal) can offer protection against memory weakening. Thus, while consideration of memory weakness is critical, it is also clear that many details will be retained in memory and remain available for retrieval.

Memories are also subject to interference from both internal and external sources during encoding (i.e., experiencing the event and attending to details), storage (i.e., holding details in memory), and retrieval (i.e., recalling the details of a prior event). The simple presence of a delay provides opportunities for interference and contamination, with long delays increasing the likelihood of exposure to information that may influence what is remembered (e.g., Ridley et al. 2013). Weaker memories (due to forgetting over time) are also more vulnerable to interference than stronger memories, and research has shown that witnesses are particularly prone to interference effects following a delay, as people are less likely to notice discrepancies between their original memories for the event and any post-event information encountered (e.g., Frenda et al. 2011; Loftus 2005). Thus, given the delays inherent in cold cases, memory evidence in such cases is likely to be particularly subject to interference.

A robust body of research has shown that people sometimes have difficulty discriminating whether they experienced an event first-hand or encountered information from another source (and later adopted it as a first-hand experience). Source monitoring refers to discriminating the source of our memories, or simply, our ability to keep track of where information originated (see Johnson et al. 1992; Johnson 1997). Knowing the origin of memories is paramount in cold case investigations where witness evidence may be the main contributor to reopening a cold case or providing new leads. Unfortunately, people are prone to making source monitoring errors, especially when they lack the motivation and/or capacity to consider the veracity of the "memory" that comes to mind. Thus, interviewing techniques for cold cases must take into consideration potential protections against source monitoring errors such as critically appraising memory (Lane et al. 2007), providing warnings about potential exposure to misinformation (Blank and Launay 2014), and avoiding suggestive questions and suggestive interviewing practices (Memon et al. 2010; Shapiro and Purdy 2005).

Finally, crimes are often witnessed by more than one person and co-witnesses tend to "debrief" together (i.e., co-witness discussion). This informal debriefing can lead to the integration of co-witness details into a witness' own report, which is known as the co-witness suggestibility effect (Ito et al. 2019). Witnesses are especially vulnerable to co-witness influences when memory is weak (e.g., older), when the co-witness fills memory gaps (this can enhance accuracy if the co-witness report is accurate), when the other witness seems confident or appears to have a more reliable memory (e.g., Allan et al. 2012), and when the co-witness is familiar (e.g., Hope et al. 2008). Importantly, there are also benefits to a co-witness discussion, including error-pruning (e.g., "Oh, you're right, it was blue!"). These patterns have been observed frequently in interviews conducted after a short delay (e.g., days to weeks), but they also represent some of

the conditions—amplified in magnitude—that are likely to be present in the delay period for cold witnesses. Thus, it is likely that the extant literature underestimates co-witness influences on recall occurring after a long delay (e.g., months to years). However, potential co-witness effects following a significant delay have not been established empirically.

Challenges Related to a Poor Initial (Original) Interview

The science of investigative interviewing has evolved considerably over the past 30 years. As such, many witnesses in cold cases may have been initially interviewed using what researchers and practitioners now know to be problematic interviewing practices (e.g., leading questions). Thus, the challenge to consider is the potential impact of an initial poor-quality interview on subsequent recall. There is evidence that a high-quality initial interview can enhance the amount of information provided at a delayed recall (Hashtroudi et al. 1993; Hope et al. 2014; Marsh et al. 2005), but few studies have explored the long-term impact of a poor interview on a later high-quality interview (but see Goldfarb et al. (2019) who found that an initial suggestive interview did not substantively impact accuracy for sexual contact in an interview 20 years later).

Witnesses cannot be expected to recall events from the past in full, but the way in which witnesses are questioned is likely to have a substantive influence on their ability to recall past events. Investigators who are reviewing witness evidence originally collected many years ago should consider the context in which that evidence was collected and the potential impact on the reliability of a witness' statement. For instance, a witness who previously produced little narrative description may be able to recall additional detail with new memory retrieval techniques. Alternatively, a witness who was interviewed suggestively may still retain suggested details in their memory. We now turn to practical memory retrieval strategies that may be useful in cold case interviews—strategies developed from our understanding of memory that may provide the greatest likelihood of success while minimizing potential contamination.

Practical Interviewing Techniques for Cold Case Investigations

A critical question is the extent to which existing tools and techniques will satisfy the needs of cold case investigators. Despite a sizeable evidence base on appropriate interviewing practices, we know much less about which interviewing strategies might be particularly useful after a significant delay (e.g., years). Many aspects of interviewing cold witnesses will be the same as best practices in timely interviews. For example, it is important to build rapport, clearly outline the interview rules, encourage interviewees to avoid guessing and instead report only what they are certain they remember, and promote elaborate and effortful retrieval (Memon et al. 2010; Vallano and Compo 2011). Interviewers must also avoid interrupting, over-talking, and excessive closed or yes/no or suggestive questions to reduce interference in the retrieval of a potentially weakened memory.

There are, however, several critical considerations that may limit the ability of researchers to directly apply findings from the literature that has focused on timely interviews. When there is a long delay between the event and memory retrieval, a primary process in the retention interval is forgetting (Kelley 2014). However, there are processes that may act against forgetting—salience, vividness, comprehension, emotion, integration with other memories, rehearsal, filling gaps with prior and intervening experiences, environmental cues, conversations, interviewer questions, and expectations. The degree to which a memory is subject to interference during the retention interval is at least in part a function of the strength of the encoded memory—weaker memories are more vulnerable to external influences (see Howe et al. 2018). In a cold case in which memories are anticipated to be weaker due to the passage of time, there are many cognitive, social, community, and environmental pressures and changes that take place over the course of what is often many years; these processes have longer and more varied conditions under which to act.

Finally, a key limitation in the extant literature is that delays present in cold case investigations are much longer than those studied in most laboratory studies. Establishing base truth for an autobiographical event that occurred many years ago with a sample of participants large enough from which researchers can draw conclusions about the relative effectiveness of a variety of memory retrieval techniques is a substantial challenge. Such work is unlikely to take place, and be replicated, in the near future. In the interim, cold case investigations proceed in the real world, and it is incumbent upon researchers to communicate what we know that could be useful to them.

Next, we review interview techniques that may be particularly promising for use in cold case investigations. Though many of these techniques have not been tested after a lengthy delay, their theoretical approach to memory retrieval provides promising avenues for interviews with cold witnesses. Importantly, the techniques reviewed here are consistent with best-practice memory retrieval strategies. Thus, although direct evidence of their success after a long delay has not always been established, the techniques hold theoretical promise and run a very low risk of contaminating memory.

The Cognitive Interview

The Cognitive Interview (CI) is a comprehensive and well-established protocol with clearly outlined evidence-based procedures that can successfully elicit rich

narrative descriptions about experienced events (Fisher and Geiselman 1992; Memon et al. 2010). The CI has been tested extensively in more than 100 laboratory and field experiments over the past 30 years, consisting of thousands of interviews. The convergence of evidence has shown that the CI performs better than a standard free-recall interview as it helps generate more information and more precise responses (Memon et al. 2010). Crucially, the benefits of the CI have been demonstrated after delays of up to 21 months (Dodier et al. 2021), and even up to 35 years (Fisher et al. 2000). There are indications that some CI mnemonics, including mental reinstatement of context and sketching, may be particularly useful when conducting delayed interviews.

Mental Reinstatement of Context

The mental reinstatement of context (MRC) mnemonic involves reinstating the encoding context of the target event. MRC has been found to increase the amount and accuracy of witness recall and is one of the most effective recall strategies for adult witnesses. MRC typically includes strategies such as focusing on sounds, smells, feelings, and people from a time and place of interest, which is then thought to trigger memories for other related details of the event. The effectiveness of MRC in eliciting more complete and accurate recall has been observed at delays of weeks to months (Dietze et al. 2012; Drohan-Jennings et al. 2010; Emmett et al. 2003; Hershkowitz et al. 2001). The MRC technique is primarily used for eliciting episodic memories related to specific events or experiences. Thus, interviewers of cold witnesses may want to provide witnesses with a range of temporal and contextual cues to assist in their retrieval of older, weaker memories.

In addition, context reinstatement can be achieved physically by returning to the place of an event. In cold case investigations, where the memories are expected to be weaker and perhaps less recently rehearsed, there may be utility in expending the time and energy to engage a particularly promising witness in physical context reinstatement. Taking the witness back to the scene of a crime after a period of time spent not thinking about it might reinstate the encoding context and thus, facilitate retrieval of event details (e.g., Wong and Read 2011; but note the potential negative emotional impact for some witnesses). An important caveat is that cold cases come with the inevitable likelihood that environments will have changed since the crime occurred, even beyond expected changes, like seasons and weather. Researchers do not yet know enough about which features of the revisited physical context are most effective for enhancing recall—this difficult determination will almost certainly be a function of many factors unique to each experience.

Sketching

Sketching involves an interviewee drawing details of a witnessed event (e.g., locations, movements, people) and then using their sketch as a reference when providing a verbal account of what they witnessed (Dando et al. 2011). Similar to MRC, sketching is also grounded in encoding specificity theory (Tulving and Thomson 1973), whereby the sketch is believed to help an interviewee recreate the spatial cues present during encoding of the event that facilitate recall. Sketching may also reduce cognitive load through external storage (i.e., committing cues to paper to avoid taxing working memory; Middendorf and Macan 2002; Rickards and Friedman 1978). Several studies have shown that sketching increases the amount of detailed and accurate information obtained from both child and (older) adult interviewees (e.g., Dando 2013; Dando et al. 2009, 2020; Eastwood et al. 2018, 2019; Mattison et al. 2015, 2018), as well as aiding information receivers' to better understand the information they receive from witnesses (e.g., interviewers; Luther et al. 2022). Overall, reducing the working memory load might provide additional support needed to assist cold witnesses in providing their accounts.

Other Memory Cueing

Hierarchical models of autobiographical memory, such as the Self Memory System (Conway and Pleydell-Pearce 2000), suggested that memories that are more relevant to a person's self-concept (or ones that are personally significant/emotionally charged) are typically more accessible and enduring over time (cf. memories less connected to one's self-concept). Thus, the use of memory-cueing strategies may prove useful for accessing distant events. In the next section, we outline a number of existing strategies and techniques that use memory-cueing to promote access to witness details.

Self-Generated Cues

A self-generated cue (SGC) is a memory cue generated according to an individual's idiosyncratic representations of a target memory (Wheeler and Gabbert 2017). Such cues are therefore salient details that are unique to each individual, rather than cues generated by an interviewer (e.g., pre-defined generic instructions used in MRC). SGCs prompt witnesses to consider key aspects of the target event themselves, thus optimizing cue saliency, distinctiveness, and potentially greater activation of the relevant memory networks—all of which predict the likelihood of successful memory retrieval (see Kontogianni et al. 2018; Wheeler and Gabbert 2017; Nairne 2002 for a more comprehensive discussion of SGCs). An example of using SGCs in an interview context would be to ask a witness to note down

the first six things that come to mind when thinking about the target event and then using those things or "cues" to facilitate more focused retrieval (Gabbert et al. 2014). Research has demonstrated that SGCs are beneficial for facilitating the retrieval of a target memory (Kontogianni et al. 2018) and effective for retrieving autobiographical memories (Harris and O'Connor, 2023; Uzer and Brown 2017). While the efficacy of the SGCs has not yet been tested following a long delay, theoretically, this mnemonic approach holds promise, not least, because as the cues are self-generated by the interviewee, there is little opportunity for contamination via interviewer-generated cues.

The Timeline Technique

The Timeline Technique (Hope et al. 2013) is a self-administered reporting format that uses a visual "timeline" to provide a structure for remembering. The technique was developed for use in information-gathering contexts involving complex or extended events, where the interviewee likely has a large amount of information to impart, the full scope of which may not be entirely known to the interviewer. The Timeline Technique draws on memory theory (e.g., temporal–spatial memory associations and clusters; Polyn et al. 2009; Tulving 1983) and effective techniques used in social survey methodologies (e.g., event history calendars) to facilitate retrospective retrieval of autobiographical events (e.g., Belli et al. 2009; Glasner and Van Der Vaart 2009). The Timeline Technique dispatches with the conventional idea that witnesses should provide an account in a linear narrative, starting "at the beginning"; witnesses instead report and structure information as they remember it and to best reflect what actually happened. Importantly, this technique enables interviewees to provide detailed information about complex events involving multiple people and/or repeat incidents. In brief, when using the Timeline Technique, witnesses are provided a physical timeline to represent the temporal space of the target event(s) and then instructed to add detail about that target event using individual cards or post-it notes to describe both persons and actions. Instructions also emphasize linking specific people to specific actions. Importantly, witnesses can start their account at any point on the timeline (i.e., within the relevant temporal space) and are free to re-order and revise to improve accuracy as more detail comes to mind (see Gabbert and Hope 2023; Hope et al. 2013, 2023 for more information).

Hope et al. (2013) found that mock witnesses who provided accounts about a multi-perpetrator event using a timeline technique provided more information overall, including more (i) person descriptions, (ii) person actions, and (iii) sequence details than those who provided a free report, and at no cost to accuracy. More recent research suggests that the Timeline Technique also facilitates the recall of criminal conversations (Hope et al. 2019a) and repeated events (Kontogianni et al. 2021) and that it can be used effectively with SGCs (Kontogianni et al. 2018). Given the complexity of recalling events from long ago, such a directed memory retrieval task with flexibility for the witness to report the strongest memories at will has promise for carefully cueing and retrieving old memories. Again, as this technique is self-administered by the interviewee, the risk of memory contamination via leading or suggestive questioning or assumptions by the interviewer is reduced.

The Self-Administered Interview

The Self-Administered Interview (SAI; Gabbert et al. 2009) was developed for situations in which witnesses cannot be individually interviewed soon after an event. The SAI involves a standard protocol with instructions and a set of questions that allows the witness to retrieve their memory without the need for an investigator to conduct an interview. A recent meta-analysis of the SAI (Horry et al. 2021) indicated that, compared to alternative recall methods (e.g., cued or free recall), there was a large increase in the number of correct details reported, along with a small increase in the number of incorrect details reported, with overall accuracy slightly lower. Of particular interest for cold cases, the authors also explored the impact of early SAI completion on later memory reports. Results clearly indicated that completing the SAI (compared to no initial retrieval attempt) improved the accuracy and completeness of subsequent reports after delays of longer than 1 week (three studies) or 1 week or less (16 studies).

The SAI may be useful for cold case investigators who wish to make a broad call for witnesses in cases in which particular witnesses with information might not be known or readily available. Although the original purpose of the SAI was the preservation of memory evidence, it also demonstrated the ability of witnesses to provide written narrative accounts that effectively triggered thorough recall of an experienced event and has proven useful for missing person investigations (Gabbert et al. 2020). Cold case investigators may not have the resources to interview the residents of an entire small town, but accessing a motivated group of community members who are willing to take the time to engage in a targeted memory retrieval task may bear investigative fruit, or at the very least facilitate the prioritization of witnesses for interview and optimize use of investigative resources.

Reporting Information About Networks and Groups (RING) Task

The RING task (Hope et al. 2019b) was developed to improve the recall and reporting of information about people and their associates, whether friends, family, colleagues, or in a forensic context, members of organized crime gangs, criminal networks, or terrorist cells. The RING task draws on the associative nature of memory and the concept of "keeping memory in view". The

RING task is based on the notion that visually representing the links between people will (i) facilitate recall of individuals who associate with that particular group or network and (ii) prompt recall of additional individuals who might otherwise go unmentioned. First, memory for a network member should serve as a cue for other relevant individuals and prompt a more comprehensive retrieval of information. Second, a visual representation of the network capitalizes on how memory is organized and should prompt additional recall as a result. Similar to the aforementioned strategies, the RING task offers a non-suggestive introduction of directed categories of information (in this case, people) and capitalizes on associations to related information (i.e., other people) to elicit recall of information brought to mind by the task. For example, witnesses may be instructed to think about the people present and how they are linked with each other. As such, the RING task is a reporting format designed to elicit as much information as possible about individuals involved in a group or network, the links (i.e., relationships) between those individuals, and the strength, direction, and proximity of those relationships. At the most basic level, this instruction can be used to prompt an interviewee to work on a paper-and-pen diagram of the network. This format and strategy provide ample potential for probing what may be relatively unrehearsed semantic information known to a cold witness and of relevance to cold case investigators.

Interview Techniques Summary

The most important recommendation when eliciting witness evidence following a long delay is to use evidence-based best practices, as in timely investigations. Adhering to good practices may be even more critical after a delay because an investigator can expect memories to be relatively weaker after a long (cf. short) delay, which leaves witnesses more vulnerable to external influences during memory retrieval. Thus, interviewer skill in delayed cases is just as critical, and perhaps more, as in timely investigations.

Next, we turn to person-specific evidence. This type of evidence should be considered distinctly from narrative recall because it will often involve a combination of recognition memory (i.e., person identification) and recall memory (i.e., memory of people's actions and behaviors).

Person Identification

While extracting descriptions of prior events will sometimes result in the disclosure of information about people, there are also many instances in which investigators will be interested in targeting person-specific evidence. The large body of eyewitness identification research indicates that making an accurate identification of a previously seen person (e.g., from a photographic, live, or video lineup) is often very difficult (see Wells et al. 2020), even after a short delay of minutes or hours. While individuals' "people recognition" ability for unfamiliar others may not be the most promising avenue for generating leads in cold cases, there are circumstances under which person-specific information may be particularly useful after a long delay.

Investigators interested in identifying a person who played a role in a cold case have essentially three options for presenting images of the person of interest to a potential witness or to the public:

1. A dated image of the target (i.e., dating from around the time of the incident)
2. An updated image (if available) of the target
3. An age-progressed image of the target

Which of the above strategies an investigator chooses will depend on the nature of the case. If investigators have a *suspect in a cold case* and wish to create a lineup for eyewitness identification, they must decide between constructing a lineup with a dated suspect image (and accompanying dated filler images) or an updated suspect image (and accompanying updated filler images). Identification research has not yet directly answered the question of which is likely to be the most effective strategy. However, research on the match between the witness' encoded memory and the image used to attempt retrieval suggests that the closer the match, the more likely a witness is to retrieve an associated memory (i.e., encoding specificity; Tulving and Thomson 1973), thus indicating that presenting a dated image is likely to be most effective. Most research on lineup identifications has focused on very short delays to recall (minutes to days), thus leaving the question of much longer delays largely unanswered (Dysart and Lindsay 2007).

If investigators have identified, but not located, a *suspect in a cold case* and decide to make a public appeal to locate this suspect, most potential witnesses will not have the originally encoded memory (i.e., they will not have encountered the suspect at the time of the crime). In this scenario, an updated suspect image is likely to be the best choice because it will match the suspect's current appearance. Conversely, if investigators seek to locate a person who has been *missing for a long time*, they must decide if public appeals would be most effective with a dated or updated "progressed" image. Investigators may choose to have an image created that approximates what the missing person might look like now had they aged since their disappearance. In this case, although the person may have been familiar to many potential witnesses at the time (e.g., the disappearance of a child well-known in the community), the age-progressed image is an unfamiliar representation of the now-older person. To

assess which of these strategies is more likely to be successful, one must first consider the utility of age-progressed images, an often-used technique in cold case investigations.

Age-Progressed Images

Age progression is a set of techniques that can include computer simulation (e.g., altering a dated photo), or hand drawings by a forensic artist (Yang et al. 2019). Age progressions consider typical growth patterns given demographic norms, often supplemented with images of parents or other relatives. The accuracy of such images will depend on the person's adherence to average growth as well as lifestyle factors (e.g., sun exposure, weight, health problems/diseases); thus, there is substantial interpersonal variability in the effects of aging on appearance. To be useful in an investigation, age-progressed images should produce more accurate identifications than simply relying on dated photos, without a commensurate cost. Thus, an important first question is *how accurate are age-progressed images*? Lampinen et al. (2015) explored match and agreement among age-progressed images produced by eight trained forensic artists and found that age progressions were rated as more similar to real images than description-matched foils. However, the overall similarity of age progressions to real images was only moderate, and there was large variability between artists in how close the match was (see also Erickson et al. 2017). In a series of studies exploring the added value of age-progressed images to public appeals, Lampinen and colleagues (2012a, b) found that although identification with age-progressed images was sometimes better than chance, recognition accuracy was not better than dated images alone (and, in one case, worse; Lampinen et al. 2012b, Exp. 4). Thus, accuracy appears quite variable, modest, and not superior to dated images.

In Lampinen's series of studies, age-progressed images did not increase the accuracy of recognition, but they also did not impede the ability to recognize a target. Thus, any additional benefits of using age-progressed images (e.g., generating interest in the case) might justify their use. However, Charman and Carol (2012) found that adding an age-progressed image to a dated image may impede the ability to identify a target person by changing observers' decision strategies so that they considered a larger range of images to be plausible (but see Lampinen et al. (2012a); Exp. 1 and 2 who found a more liberal response bias for dated images than for dated + age-progressed images).

If age-progressed images can interfere with the ability to accurately recognize a person when a dated image is available, a final critical question is *how well can people be recognized from dated images*? That is, if there is a low baseline of recognition from dated images, the cost of introducing an age-progressed image may be worth the risk, given other case-related advantages of releasing new information. The extant evidence suggests that people are reasonably accurate in their recognition of people who have aged since a photo was taken (Charman and Carol 2012; Lampinen et al. 2012a).

There is clearly substantial variability in the accuracy of age-progressed images; much more work needs to be done to assess this cost-benefit balance. Researchers should work to articulate the conditions under which the utility of age progressions exceeds the value of dated photos. For instance, Erickson et al. (2017) observed that variability in age progressions created by different artists was greatest when the age gap between a dated image and the projected age-progressed image was the longest. Though this finding is intuitive, locating the boundaries of reliable image creation will take considerable time before researchers can translate this work into the circumstances under which it would be best to use age-progressed images versus dated images.

Avoiding Pitfalls in Cold Case Investigations

We cannot discuss evidence-based cold case investigations without addressing ways in which investigators can avoid the pitfalls of being influenced by potential errors in the original investigation. Of particular importance, investigators should consider the possibility that individual pieces of evidence may have been influenced by the investigative theory of the case at the time of the original investigation. As Kassin (2012) argued, knowing about one piece of evidence can corrupt the interpretation of a subsequently encountered piece of evidence, a concept known as corroboration inflation. Corroboration inflation can lead to illusory strength of both the subsequent evidence and the case more generally because, although there are two pieces of evidence, the value of the second is contingent on the value of the first. For example, knowing a suspect (truthfully or falsely) confessed to the crime can lead investigators to discount a witness who confirms the suspect's alibi, or over-value an unreliable witness who claimed to have seen the suspect near the location of the crime. In the latter case, there is the illusion of two strong pieces of evidence—a confession and a witness—but the value of the witness was determined after receiving the confession evidence.

Similarly, Roach (2017) argued that cold case investigators inherit a "chain of decisions" from the initial investigation that requires a completely new investigation with fresh eyes. While a full case review may also involve searching for previously unidentified linkages to other cases and evaluating evidence that might benefit from new developments in science, the decisions made by investigators during the original investigation should also be a focus of investigator attention, particularly with respect to evaluating individual pieces of evidence independently from the case as a whole. To this end, it might be useful

to avoid talking with original investigators until all of the evidence has undergone an initial review (see Rossmo 2016). Such an approach helps to avoid influence from prior confirmation bias, or tunnel vision, (see Kassin 2012).

In a review of potential sources of biased thinking in police investigations, Rossmo (2016) outlined four stages for "rethinking" an unsolved case, while limiting bias from previous investigative decisions: (i) identify the evidence (not the theories, assumptions, and inferences), (ii) interpret the evidence (reasonable conclusions that can be derived from the evidence), (iii) look for patterns across the constellation of evidence, and (iv) use the evidence to generate and analyze investigative hypotheses (focus on diagnostic evidence that can help discriminate between theories). These four steps will help minimize the influence of bias on an investigation. Ultimately, the recommendations for conducting interviews in an open-ended manner when possible and using evidence-based practices will work against the influence of unintentional bias.

Finally, we provide a note of caution. When investigators have few leads, it may be tempting to use unconventional memory retrieval strategies. The desire to obtain a larger volume of information must be balanced with the potential cost of obtaining inaccurate information that will take substantial resources to follow-up. In cold cases, investigators will inevitably be working with witnesses with relatively weak memories. When memories are weak, they are more susceptible to the influences of suggestive practices and more vulnerable to memory contamination and distortion. The authors of the current paper are researchers and practitioners who work regularly with investigators; we have numerously encountered investigators with an interest in exploring the possibility of hypnotizing witnesses or using other last-ditch pseudoscientific practices that lack an evidence base. Unfortunately, such efforts may ultimately corrupt the memory rendering any future attempts at retrieval unsuccessful, risk credibility issues in forward court proceedings, and also waste resources that could be more productively used elsewhere.

Major Gaps in Research

There are several key areas which we believe will reap the most benefits to both cold case investigators and to those interested in advancing theoretical understanding of eliciting long-term memory evidence, including:

(i) Understanding the impact of a poor initial interview on long-term recall, and exploring how to minimize any potential negative effects
(ii) Examining how to best leverage existing memory retrieval techniques for effective use in retrieving long-term memories
(iii) Developing new and innovative methods for eliciting long-term memories
(iv) Identifying the parameters for the effective use of images in cold case investigations

These key areas should be considered during a re-investigation but also included in the training of cold case investigators. With specialized courses, workshops, and resources devoted to understanding the relevant memory considerations and memory retrieval options, investigators will be more fully equipped to evaluate previously gathered evidence and identify the most promising lines of inquiry.

Perhaps the most salient knowledge gap is the lack of research exploring optimal retrieval cues after long delays. Though logistically and practically difficult to conduct, there are methodological opportunities available to researchers now that did not exist even a few years ago. With so much of everyday and eventful life captured in social media posts and on smartphones, researchers should consider approaches that allow such records to serve as to-be-remembered events. This approach brings complications of rehearsal and record-keeping bias, but there is likely sufficient material available that creative researchers can use such information as a baseline from which to conduct future interviews.

Overlaid on top of these important areas for future growth is a thread woven through many investigations: witnesses may not know that they have seen something important (see Harvey et al. 2023). Thus, all the research discussed above must also be considered in the context of facilitating recall of an *event that was experienced as unremarkable*. Retrieving memories from events of interest will involve recalling events that were not experienced as notable at the time (e.g., when someone's child goes missing from a playground but those present do not know until later that a child was gone). The strategy for questioning, and the expected information obtained, is likely to differ from an interview that takes place about an event to which the witness attended carefully and encoded as notable. Finally, there is a critical need for investigator training that is unique to the particular challenges of cold case investigations.

Conclusion

Given the advances in understanding of memory and interviewing techniques, it may be possible to revisit cold cases and apply our updated understanding of memory and interviewing in a way that brings new strategies and evidence to cold cases. Critically, researchers must make efforts to collaborate with investigators, particularly in jurisdictions in which the researcher–police relationship is not well established. In 2016, the US National Institute of Justice made

several recommendations for conducting cold case investigations, including to "utilize academic resources when possible and appropriate". These resources may include technologies, students, and faculty with subject matter expertise (see also Toolin et al. 2022). The large bodies of literature reviewed here clearly show that researchers have much to offer cold case investigators. However, much more research must be done—both basic research and communication of those findings to investigators—to ensure these investigators have the tools derived from decades of research into memory and memory retrieval.

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Declarations

Ethics Approval and Consent to Participate This article does not contain any studies with human participants performed by any of the authors.

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