Effects of the Change Temporal Order technique on eyewitness memory

Coral J. Dando & Thomas C. Ormerod (c.dando; t.ormerod@lancaster.ac.uk)

Department of Psychology, Lancaster University, LA1 4YF, UK

Abstract

An experimental study is reported of the retrieval by mock eyewitnesses of a scripted video crime event, comparing free recall against Change Temporal Order (CTO) recall, in which event retrieval is prompted in reverse order. Contrary to proponents of the technique who suggest that CTO allows greater discovery of script incidental information and increases the amount of information recalled, CTO was found to impair retrieval, leading to fewer script consistent events, reduced recall of correct information, increased confabulations, and lowered accuracy proportional to items retrieved. The disruptive effects of CTO are interpreted as providing further evidence for the role of temporal clustering highlighted in the CMR model of memory. Impairment induced by the CTO technique continued to influence retrieval negatively even during a secondary free recall phase. We suggest that CTO prevents the blocking of confabulations, and that these confabulations may subsequently contribute to forgetting by population dilution.

Keywords: Memory retrieval; Scripts; Eyewitness testimony; Cognitive Interview; Temporal clustering; Population dilution.

Introduction

Retrieving witness information is typically a one-off opportunity. Facilitated by an interviewer, the aim of the retrieval process is to elicit as much correct information as possible while limiting errors of commission and omission. To that end, investigators in the UK are taught to implement the Cognitive Interview procedure (Fisher & Geiselman, 1992). This procedure comprises a number of individual mnemonic components designed to maximize opportunities for accurate retrieval of witnessed episodes. One of these components is the *change temporal order* technique (CTO), in which witnesses are instructed to attempt retrieval in a backwards order, from either the last memorable act/event or some other prominent memorable point of the to-be-remembered scenario. The imposition of this technique is intended to displace the natural memorial strategies of individuals to good advantage. In doing so, it assumes that schematic organisation of memory (e.g., Schank, 1999) can play a negative role in determining accurate witness recall. In this paper, we present data showing that, while it does to some extent displace schema-driven recall strategies, the CTO technique appears to reduce the retrieval of target events, regardless of whether the events are central or incidental to a typical event script held by the participant population. Moreover, we propose that the technique may impact adversely on individuals' use of temporal contiguity as a retrieval cue (e.g., Polyn, Norman & Kahana, 2009).

In an eyewitness context, Fisher and Geiselman (1992) promote the efficacy of the CTO technique on the grounds that it may limit the influence of predictive schemata/script-based retrieval (Schank & Abelson, 1977). Scripts are organizational structures that capture appropriate sequences of events in particular contexts, supporting abstraction from specific episodes as well as generating expectations about likely events, both prospectively and retrospectively (Schank, 1999). The role of scripts in understanding and organizing sequential event material in memory has received much empirical support (e.g., Mandler, 1984; Pezdek et al., 1989; Taylor & Crocker, 1981). Scripts seem to capture, not only everyday events of which people have personal experience (Bower, Black & Turner, 1979), but also less common events that have not been personally experienced (e.g., Holst & Pezdek, 1992; Tuckey & Brewer, 2003).

One of the implications of script-based theories of event memory organization is that individuals will make strategic use of scripts to guide retrieval of complex events. In the context of witness memory, this may provide a source of errors, particularly errors of commission in which items are included in retrieval that are present in a generic event script but absent from the episode itself. Crime-related scripts have been shown to be a significant source of gap-filling errors of commission in eyewitness performance (Greenberg et al., 1988; Holst & Pezdek, 1992; Tuckey & Brewer, 2003). The CTO technique is assumed to disrupt a strategy of script-based retrieval and hence it should reduce errors of commission, since it prevents individuals from retrieving events based on their typical temporal sequence rather than on their actual appearance.

In addition to a role in suppressing script-based retrieval, Fisher and Geiselman (1992) also suggest that CTO is an effective method for accessing previously inaccessible memories, by encouraging witnesses to use an unusual retrieval path. They refer to the *multiple trace hypothesis* (Bower, 1967), suggesting that reversing the order in which individuals retrieve episodic information activates different traces, which increase the probability of item recall. However, recent theories of temporal order effects on long-term memory lead to the opposite prediction. Kahana (1996) found that temporal clustering of items can be more influential than semantic relatedness in determining effective retrieval. Polyn, Norman & Kahana (2009) embody temporal clustering in their Context Maintenance and Retrieval (CMR) model, in which semantic, temporal, and source factors combine to organize material in memory. According to this theory, similarities in temporal clusters between internal and external event representations lead to

enhanced retrieval, while their disruption will impair it. If CTO acts to disrupt the access of temporal clusters in memory, then according to the CMR model, one might expect CTO to impair rather than facilitate retrieval.

Despite having been part of the cognitive interview procedure since its inception, CTO has received limited empirical validation. Indeed, a review of the literature reveals that little is known as to whether the technique actually enhances eyewitness memorial performance as posited by Fisher and Geilselman (1992) or detracts from it. One might expect that, when assessing the efficacy of CTO in an eyewitness context, empirical research would consider both (i) script consistent/inconsistent recall performance and (i) overall memorial performance. The former provides an indication as to whether the procedure limits the influence of predictive schemata/script-based recall, while the latter indicates whether CTO might be an effective method of accessing previously inaccessible memory codes. However, this has not been the case. Researchers have considered only overall memorial performance (quality and quantity), and have never employed a scripted crime event. Even so, results have been mixed. Some have found CTO to be an effective method for eliciting extra details (Boon & Noon, 1994; Whitten & Leonard, 1981), while others have found it no more effective than a *free recall* or *try harder* retrieval attempt (Milne & Bull, 2002; Memon, Cronin, Eaves, & Bull, 1996). Recently, CTO has been found to increase erroneous recall, resulting in a significant reduction in memorial accuracy rates (Davis, McMahon & Greenwood, 2005).

The purpose of the present research was to investigate the efficacy of the CTO technique in a mock eyewitness context. The primary aims were to explore whether CTO is useful (i) as an additional retrieval strategy and (ii) as method of limiting script guided recall. To address the second aim, a script-consistent stimulus was produced, consisting of crime film depicting a mobile phone robbery.

Given that the mock witnesses in this research were undergraduate students, we assessed empirically their script norms for a mobile phone robbery. One hundred undergraduate students (who did not participate as mock witnesses) completed a questionnaire designed to collect information concerning the actions they believe typically occur during a mobile phone (cellphone) robbery event, and in what order (a procedure adapted from Bower et al., 1979; Holst & Pezdek, 1992). The criterion for inclusion was any action event mentioned by at least 60% of respondents. Once identified, ten script-consistent event actions (see Table 1 for a list of the items) were incorporated in the film alongside ten script-incidental event actions (see Table 2). The latter were action events that had not been mentioned by any of the 100 respondents.

As we were primarily interested in enhancing practical methods for eliciting eyewitness memory in criminal enquiries, the CTO technique was incorporated into an interview procedure, comprising two distinct retrieval attempts. This procedure facilitated analyses of memorial performance as a function of both interview procedure and retrieval attempt. If a positive CTO effect exists, as predicted by Fisher and Geiselman (1992), then including CTO in an interview procedure should increase overall memorial performance (total amount of information recalled) *per se*. Further, a CTO interview should increase recall of script-incidental action events compared to a free recall interview procedure. An alternative hypothesis, derived from the CMR model, is that a CTO interview will be no more effective in terms of enhancing overall memorial performance or eliciting script incidental events compared to a control *free recall* interview, and might even impair memorial performance relative to free recall since temporal clusters that contribute to organisation of, and therefore access to, long term memory are disrupted.

Table 1: Empirical script norms for mobile phone robbery action events (N = 100.) indicates inclusion in scripted stimulus event.

Scripted action event	% respondents mentioning event
Victim is talking on the phone	65
Robber watches victim	60
Robber is in a gang/group	60
Robber follows victim	80
Robber runs up to/approaches victim	61
Robber shouts/demands phone	60
Robber pushes/grabs victim	82
Victim cries/shouts	75
Robber grabs phone	65
Robber runs away	80

Method

Design A between subjects design was employed. The independent variable was retrieval interview on three levels, each comprising two retrieval attempts that were manipulated according to condition by varying the combination and order of presentation ; (i) Free recall – Free recall (FR-FR), (ii) Free recall – CTO (FR-CTO), and (iii) CTO-Free recall (CTO-FR). The dependant variables were memorial performance measured (i) by the number of correct items recalled, incorrect items recalled (e.g., saying the girl's hat was black rather than brown), the number of confabulations (mentioning a item/event that was not present or did not happen), and accuracy rate (proportion of correct details as a percentage of the total number of items recalled), and (ii) recall of script incident/inconsistent actions/occurrences.

Participants Fifty-four undergraduates volunteered to participate as mock witnesses. The sample comprised 34

females and 20 males with a mean age of 22 years (SD = 2.90), ranging from 18 to 27 years.

Table 2: Script incidental action events in event order

Robber has a dog
Gang member covers face with a scarf
Robber removes his hood
Gang member hands his mobile phone to robber
Robber uses mobile phone
Robber calls gang member by name (Peter)
Robber drops mobile phone
Peter kneels on victims back
Robber puts stolen phone in coat pocket
Robber's dog runs after a passing car

Materials and Procedure At Time 1, mock witnesses individually viewed the stimulus crime film. The film was one minute 20 seconds in duration and depicted a mobile phone robbery. At Time 2 (48 hours later) participants returned and were randomly allocated to one of three retrieval conditions and were interviewed accordingly.

Interviews were conducted by the first author. The protocols for each of the three retrieval conditions were based on the current UK investigative interview model (see Milne & Bull, 2001). Each was similarly structured, comprising the same number of phases and retrieval attempts in the same order, according to condition; (i) explain procedure (identical across conditions), (ii) first retrieval attempt (according to condition), (iii) second retrieval attempt (according to condition), (iv) interview closure (identical across conditions). Retrieval instructions were read verbatim by the interviewer.

When inviting free recall retrieval, participants were instructed to "Please tell me what you remember about the film you saw a couple of days ago, in any order that you wish…just as you remember it". When inviting a CTO retrieval, participants were instructed "I would like you to tell me what you remember about the film you saw a couple of days ago. Before you tell me about the film I would like you to try something that sometimes helps people to remember more. What I am going to do is to ask you to tell me what happened backwards. I know it sounds hard but I am going to help you. OK to start what is the very last thing that you remember happening...What happened before that…What happened just before that". This prompt was repeated until the participant reaches the beginning of the TBR event (Milne & Bull, 2001). All retrieval attempts were uninterrupted by the interviewer and participants were allowed unlimited time.

Interviews were recorded and scored as follows. A comprehensive list of all events/occurrences in the film (inclusive of the 10 script-consistent and 10 script-incidental events) was compiled, totaling 143 items of information. Recordings of each interview were analysed using the scoring template technique (Memon et al., 1996). Every item of information, when first mentioned, was classified as either correct, incorrect or a confabulation. Its position within the interview was also noted (retrieval attempt 1 or 2). Information items were scored only once. Any further mention was disregarded, provided the initial classification remained consistent. However, where recall was inconsistent (i.e. initially correct but repeated incorrectly later in an interview and/or vice versa) both classifications were scored. Any preceding and/or subsequent statements were disregarded (e.g., "I'm not sure but I think she was wearing a black hat" was treated as "she was wearing a black hat). Subjective statements or opinions were disregarded. To assess inter-rater reliability, 15 interviews were selected at random and then scored by a second researcher. Pearson correlations for the three overall memorial measures were calculated (as positive relationships were expected analyses were one-tailed). Results revealed a good inter-rater reliability between the coders for all three measures; total correct items r (15) = .915, $p < .001$, total incorrect items r (15) = .927, $p < .001$, and total confabulations r (15) = .876, $p < 001$.

Results

Univariate analyses of variance were conducted (applying Bonferroni's correction) for each of the overall memorial performance dependant variables (correct, incorrect, confabulations, and accuracy). Significant findings were examined using the Games – Howell *post hoc* test.

The number of correct items recalled revealed a significant difference across conditions, F (2, 51) = 4.969, p =.011, η^2 = 0.19. More correct items were recalled by participants in the FR-FR condition (M = 48.94), p = .013 than by those in both the FR-CTO (M = 42.16) and the CTO-FR (M = 38.67) conditions, with no difference between the latter two conditions. The number of confabulations also revealed a significant difference, F (2, 51) = 6.702, p = .003, η^2 = 0.26. Participants in the FR-FR (M = 0.23) condition confabulated less often than those in the CTO-FR (M = 1.44) condition, $p < .001$. There was no difference between the FR-FR and FR-CTO (M = 0.68) conditions. Accuracy rates differed significantly between conditions, F (2, 51) = 7.191, p = .002, η^2 = 0.28. Participants in the FR-FR condition were more accurate (M = 97.60), p = .021, than participants in both the FR-CTO (M = 93.80) and CTO-FR (M = 91.70) conditions, with no difference being found between the latter two conditions. The amount of incorrect information recalled revealed no significant differences among conditions, F (2, 51) = .527, p = .594.

Means and standard deviations for overall performance measures as a function of retrieval attempt are presented in Table 3. There was a significant difference among conditions for the amount of correct information recalled in both retrieval attempt 1, F (2, 51) = 4.910, p = .011, η^2 = 19 and retrieval attempt 2, F (2, 51) = 8.156, p = .001,η^2=18. .

Table 3: Adjusted means (standard deviations) for memorial performance as a function of retrieval attempt.

	FR-FR		CTO-FR		FR-CTO	
	Retrieval 1 (FR)	Retrieval 2 (FR)	Retrieval 1 (CTO)	Retrieval 2 (FR)	Retrieval 1 (FR)	Retrieval 2 (CTO)
Correct	38.56 (11.49)	10.38 (1.45)	29.00 (10.76)	13.16 (5.72)	34.47 (12.51)	4.20 (3.84)
Errors	0.72 (0.42)	0.56 (0.50)	0.94 (1.04)	0.98 (0.67)	1.03 (0.93)	0.38 (0.29)
Confabulations	0.12 (0.46)	0.11 (0.39)	1.22 (0.39)	0.22 (0.42)	0.11 (0.26)	0.57 (0.80)

Participants in the FR-FR (M = 38.56) and FR-CTO (M = 34.47) conditions recalled more correct information at retrieval attempt 1 than those in the CTO-FR condition (M =29.00), with no difference between the former conditions. At retrieval attempt 2, participants in both the FR-FR (M = 10.38) and CTO-FR (M = 13.16) recalled more correct information than those in FR-CTO condition (M = 4.20), with no difference being found between the former two conditions.

The number of confabulations revealed a significant effect at retrieval attempt 1, F (2, 51) = 17.978, p = .001. Participants in both the FR-FR (M = .12) and FR-CTO (M = .11) conditions confabulated less than those in the CTO-FR (M = 1.22) p = .001 condition, with no difference between the former conditions. There was no significant difference among conditions at retrieval attempt 2, F (2, 51) = 1.541, p = .223. Moreover, no significant difference emerged for the number of errors at either retrieval attempt 1, F (2, 51) = .794, p = .457 or retrieval attempt 2, F (2, 51) = 3.006, p = 0.58.

An analysis of retrieval of script-consistent and script-incidental information was also conducted. Irrespective of retrieval condition, significantly more script-consistent events (M = 8.20) were recalled than script incidental events (M = 4. 04), t (54) = 17.677, p = .001. No significant effect of retrieval condition emerged for total recall of script consistent events, F (2, 51) = 2.401, p = .085, or for script incidental events, F (2, 51) = 4.483, p = .748.

However, as previously described, the retrieval interviews comprised 2 retrieval attempts. Hence, an analysis was conducted as a function of retrieval attempt (1 and 2) across conditions. Means and standard deviations for script consistent and script inconsistent information recalled across retrieval attempts are presented in Table 4. There was a significant difference between conditions for script consistent events elicited in recall attempt one, F (2, 51) = 14.731, p < .001, $\eta 2$ = .45. Participants in the CTO-FR (M = 5.47) condition recalled significantly fewer script consistent events compared to both the FR-FR (M = 7.13) and FR-CTO (M = 7.73) conditions. No significant differences were found between the latter two conditions. No significant difference was found for the number of script consistent events elicited in recall attempt two, F (2. 51) = 3.097, p = .621. Furthermore, there was no significant differences between conditions for the number of script incidental events elicited in recall attempt one, F (2, 51) = 1.205, p = .317 or attempt two, F (2.51) = 2.000, p = .104.

Table 4: Adjusted means (standard deviations) for script consistent and script incidental memorial performance as a function of retrieval attempt.

	FR-FR	CTO-FR	FR- CTO
Script consistent retrieval 1	7.13 (0.74)	5.47 (0.74)	7.73 (0.80)
Script consistent retrieval 2	1.20 (0.68)	1.87 (1.06)	1.00 (0.53)
Script incidental retrieval 1	3.07 (1.03)	2.14 (0.92)	2.67 (1.44)
Script incidental retrieval 2	1.53(0.91)	1.27 (0.96)	1.00 (0.53)

Discussion

In this study, we set out to test the efficacy of the Change Temporal Order (CTO) technique, which is one of a battery of mnemonics included in the cognitive interview approach to interviewing witnesses of criminal events. We assessed mock witness memorial performance by measuring their recall of a scripted video stimulus event involving a mobile phone (cell phone) robbery. Forty-eight hours after having viewed the video, participants took part in retrieval based interviews. Two of the three retrieval conditions (FR-CTO & CTO-FR) included the CTO technique followed or preceded by free recall (FR). Compared to a FR-FR interview, both CTO interviews elicited fewer items of correct information and more confabulated information, resulting in a significant reduction in accuracy. Consideration of the individual retrieval attempt data reveals where these differences emanated from. For recall attempt 1, a *free recall* retrieval (as in FR-CTO & FR-FR

conditions) elicited more correct information and fewer confabulations than an initial CTO retrieval (CTO-FR). A similar pattern of results emerged for retrieval 2. Where the second retrieval attempt was a *free recall* (as in the CTO-FR & FR-FR conditions), again more correct information and fewer confabulations were elicited compared to a second CTO retrieval (FR-CTO).

These results indicate that CTO, either as part of a homogenous procedure or as an individual technique, does not improve eyewitness memorial performance *per se*. We found CTO not to be an effective method of facilitating access to new memories, suggesting that previously inaccessible items had not been accessed using this technique. If this had been the case one would expect to see enhanced memorial performance, but we did not. In some respects this is surprising, since one might anticipate that the effort of reversing temporal order of retrieval might lead to more overlaps with the conditions experienced at encoding, and it is known that effortful processing at encoding and retrieval enhances recall (Dewhurst & Brandt, 2007). In the current research, the additional effort of CTO did not enhance retrieval.

The question arises as to why as part of an interview procedure or when used in isolation, does a CTO retrieval apparently reduce the amount of correct information elicited and increase confabulations, irrespective of order of presentation? Importantly, recovery after CTO retrieval during free recall at the second attempt was not complete. Some other interventions that alter natural retrieval strategies, such as collaboration during retrieval of information encoded individually (e.g., Finlay, Hitch & Meudell, 2000), allow complete recovery once free recall by individuals is allowed. This, combined with the increased number of confabulations arising through use of the technique, suggests that CTO is operating as a proactive interference mechanism. It provides access to traces that ought to be excluded from verbalization, but they are not, Moreover, their verbalization continues to impact on retrieval once the strategic demand of changing retrieval order is removed.

Multiple trace theory (Bower, 1967) posits that a to-be-remembered event is represented by a multiplicity of traces. Therefore, essentially, retrieval is as a process of selecting the appropriate traces (or targets) from a population of potential targets (cf. Lansdale, 2005). Recently, it has been suggested that a population of potential targets comprises three subsets 'C', 'E' and 'W', each of which, once elicited in a retrieval attempt, impacts in different ways upon subsequent retrieval attempts (Lansdale & Baguley, 2008). C traces are correct, E traces are erroneous, and W traces (also referred to as null traces) are those which a participant usually holds back as he/she *knows* them to be incorrect. Lansdale & Baguely provide a compelling mathematical model that demonstrates the consequences of varying the relative proportions of C, E and W traces over repeated retrieval trails. As the number of trials that elicit E and W traces increases, it dilutes the relative population of C traces, leading to predictable changes in retrieval efficacy over trials.

Our data reveal that the CTO technique increased the amount of confabulated (completely false) information recalled. This result suggests that participants may be verbalizing W traces rather than suppressing them as they would under free recall. It may be that the cognitive effort associated with recalling events in a reverse order impedes a witness's ability to exercise a *report option* (Goldsmith & Koriat, 2007) over the W traces. In other words, when sampling the population of available traces, if a witness is directed to retrieve information in an unnatural manner, this detracts from their ability to exercise control over false information. As a consequence, the population of traces becomes diluted, in this case with W traces. That freely recalled retrieval performance does not display a similar pattern of results serves to supports this further. During free recall, participants are able to exercise control over the information they report, uninfluenced by the interviewer and any mnemonic techniques that may be utilized. Hence, W traces can be held back.

Analysis of erroneous retrieval revealed no differences across conditions in the current experiment. We suggest that this too fits a population dilution model. Lansdale and Baguley differentiate between E and W traces in terms of the former being errors based on partial but inaccurate recall, the latter being entirely fabricated. Presumably, participants are unaware that an E trace is an error. If this is the case they are unable to exercise a report option or to censor them, so the mode of retrieval has no impact on their frequency of occurrence.

Equally, our pattern of results is consistent with predictions made by the CMR model of memory (Polyn et al., 2008). If the probability of retrieval is simultaneously affected by semantic, temporal, and source information, then we would expect retrieval performance to be negatively affected when one of these processes is disrupted. In this study we disrupted temporal clustering by 'forcing' reverse order retrieval. Considering retrieval performance as a function of retrieval attempt, it can be seen (Tables 3 & 4) that where temporal clustering is disrupted in the first retrieval attempt (as in the CTO-FR condition), memorial performance is significantly reduced. This is the case, not only when measuring overall performance (Table 3; fewer correct items and more confabulations) but also in a reduction in script consistent (correct) recall. When CTO is presented as the second retrieval method (FR-CTO) a slightly different pattern of results emerges. CTO again reduces the amount of correct information recalled, relative to two trials of free recall, but does not increase errors or reduce the amount of script consistent recall. It seems that an initial free recall trial provides some protection against the negative effects of CTO, perhaps because it increases the relative proportion of C traces in memory, again a result that seems consistent with the population dilution model of Lansdale & Baguely (2008).

Given the importance of witness information, this pattern of results is concerning. The CTO technique is advocated by the current investigative interview model in the UK, yet we have found no clear evidence to support its inclusion as an eyewitness retrieval mnemonic. Indeed, our findings suggest that the technique, far from reducing errors of commission and omission, appears to increase them. That its negative effects are less serious if it is preceded by a free recall trial is of some comfort. As is the fact that CTO is only one of a number of techniques in cognitive interview provides some degree of protection. Historically cognitive interview research has tended to consider the efficacy of the procedure as a homogenous technique. Such research has frequently reported an increase in erroneous recall performance. However, all too often this finding has been paid scant attention, possibly viewed as an acceptable trade off in light of the fact that the cognitive interview consistently out performed retrieval interviews employed prior to its implementation. Only latterly have researchers begun to argue that each individual component should contribute individually to the cognitive interview superiority effect (e.g., Dando, Wilcock, & Milne, 2009; in press). Certainly, in the current study, there is no positive evidence that it is of value. Where the technique may prove of use is in retrieving occasional items in witness memory that simply cannot be accessed by other means. To assess this will require a content analysis of the details of retrieval, to check for qualitative differences in both the items retrieved and the nature of errors and confabulations that arise under free recall versus CTO. This analysis is in progress. It is clear, however, that a simple assumption that changing witnesses' retrieval strategy will have positive benefits, is erroneous. Witnesses can be made to forget just as much as they can be helped to remember.

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