An investigation into the use of CCTV footage to improve likeness in facial composites

Conference or Workshop Item

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Introduction

Facial composites are an important investigative tool and have been used in numerous high-profile cases (e.g. Yorkshire Ripper). Despite this, a great deal of research has indicated that composites often portray very poor facial resemblance to the suspect/target. While some of the difficulties with the older composite systems (e.g. Photofit and Identikit) were due to system design (see e.g. Ellis, Shepherd & Davies, 1975; Davies, Ellis & Shepherd, 1978; Laughery & Fowler (1980), the hit rate for composites constructed with more modern systems (e.g. E-FIT and PROfit) can still be very low (e.g. Frowd et al. 2005). While research has indicated that composite likeness can be improved at test by combining composites from multiple witnesses (e.g. Bennet, Brace, Pike, & Kemp 1999; Bruce, Ness, Hancock, Newman, & Rarity, 2002; Ness, 2003) research on improving composites during construction has produced mixed results.

One of the main difficulties is that we still do not fully understand the memorial processes that are involved in composite construction. It has been assumed that when a witness constructs a composite they will both recall the face/feature and recognise whether the presented image 'matches' their internal representation of the face. Single-process or generation-recognition models of memory (e.g. Anderson & Bower, 1972; Kintsch, 1970) assume that recall and recognition involve the same underlying process and indicate that it is the level of activation that determines whether an item will be remembered. That is, if an item is weakly represented in memory, the item will be less likely to be recalled, but effective retrieval cues contained in a recognition test may lead to successful recognition. As recall involves both a generation and a recognition stage, whereas recognition only involves the latter, these models assume that recognition will always be better than recall.

However, research has also indicated that participants can recall words that they fail to recognise (Flexser & Tulving, 1978; Tulving & Flexser, 1992), indicating that recall and recognition may in fact be two distinct aspects of the same process. Flexser and Tulving demonstrated that the relationship between recognition and recall is a function of the amount of information that is available. In particular, the information that is available in a recognition task is uncorrelated with the information that is available in a recall task and reflects retrieval independence. This instead provides support for the encoding specificity principle (Thomson & Tulving, 1970; Tulving & Thomson, 1973), rather than single-process models of memory. The encoding specificity principle states that recall and recognition are distinct aspects of the same retrieval system, and that successful retrieval is dependent on the degree of overlap between the information at encoding and the information that is available at retrieval. As such, more accurately matching the cues at encoding and retrieval may increase recall performance.

Indeed, there is some support for this, both for face recognition (see Memon & Bruce, 1985 and Davies & Thomson, 1988 for reviews and Smith & Vela, 2001 for a meta-analysis) and composite construction. For example, early research found that mentally reinstating the original context improved face recognition (e.g. Malpass & Devine, 1981; Krafka & Penrod, 1985). However, others, such as Smith & Vela (1997) reported an effect of physical reinstatement of context but not mental. Furthermore, an improvement in face recognition has been observed when the background context has been held constant (e.g. Klee, Leseaux, Malai & Tiberghein, 1982) and when clothing, background and orientation were all reinstated at test (Thomson et al, 1982). Furthermore, Davies & Milne (1982) reported that face recognition performance decreased when changes were made to the background context, pose and facial expression. Despite important methodological and conceptual differences within the context literature (see Davies & Thomson, 1988) a review of the factors that affect eyewitness performance found that the effect of context was one of the most important indicators of accuracy (Shapiro & Penrod, 1986). In particular, Shapiro & Penrod's meta-analysis revealed that when context was reinstated, face recognition was greatly enhanced, compared with when the original context was not reinstated.

The research on reinstatement of context led to the development of the Cognitive Interview which is more widely used now in composite construction. A great deal of early research indicated that the cognitive interview increased the amount of accurate information recalled, compared to a standard interview, without increasing the amount of inaccurately recalled information (e.g. Fisher, Geiselman & Amador, 1989; Geiselman, Fisher, MacKinnon & Holland, 1985; Koehnken, Schimmossek, Aschermann & Hofer, 1995; Mantwill, Koehnken & Aschermann, 1995). However, other more recent research has reported no difference in performance between cognitive and standard interviews (e.g. Memon & Stevenage, 1996; Memon, Wark, Holley, Bull & Koehnken, 1996b). Similarly, there have been mixed findings when examining the use of the Cognitive Interview and composite construction. Davies & Milne (1985) found that the use of guided instructions (mental reinstatement of context) significantly improved facial composites that had been constructed from memory. Likewise, Luu & Geiselman (1993) reported a similar increase in composite performance using the Cognitive Interview. Interestingly, Clark (2001) examined the effect of imaging during composite construction (rather than before construction which is the usual practice) and found that mentally reinstating the face (re-imaging the face) during composite construction decreased the likeness contained in the image. In addition, Ness, Hancock, Bowie & Bruce (2001) provided moderate support for the encoding specificity hypothesis, by revealing that three-quarter-view composites achieved a higher level of performance when a three-quarter-view had been presented at study, compared to a full-face view.

Examining encoding specificity and context effects with composite construction can be problematic because the information that is available at retrieval (the features within the composite) will be inaccurate. Therefore, while the encoding specificity effect has been observed in some instances, in general it is extremely difficult to achieve any significant degree of informational overlap. A possibility for overcoming this may be to essentially 'physically reinstate' the external context (Davies & Thomson, 1988) rather than the internal context (mental reinstatement) during construction. One method of doing this is to utilise CCTV footage of the original crime. The usual procedure for CCTV footage is to display it in the media in the hope that someone who is familiar with the person will identify them. However, this led to the question; would allowing a witness to view this footage during composite construction improve the likeness portrayed in the image? Ness, Bruce & Hancock (2004) examined this. A simulated crime was filmed using both a high-quality video camera and a poor quality web-cam (used to emulate poor quality CCTV footage). Two 7 second clips were taken from the poor quality web-cam footage. In one clip, only the back and side of the target's head was visible. In the second clip the target was also looking at the camera. A 3 (mode of construction) by 4 (target) between-subjects design was adopted. The modes of construction were 1) construction of a composite with NO additional CCTV footage 2) construction of a composite with the 7 second CCTV footage that contained only minimal facial information (back and side of head) and 3) construction of composite with the 7 second CCTV footage that contained facial information (target looking directly at the camera). Each participant was initially asked to view the high-quality 30 second video-clip. They were then randomly assigned to one of the three construction groups. The composites were evaluated using identification and sorting tasks.

Overall, the results revealed that the composites that had been constructed using additional CCTV footage performed better than the composites that were constructed without the use of this additional footage. Interestingly, this effect was only observed when the face was visible. The composites that were constructed when the head was blocked performed poorly. This result was surprising and suggested that the incidental background information in the video had not been stored in memory. It may be that even though the participant-witnesses in this experiment were not aware that they had to recall the person in the video, they may have focused on just the person and not on the whole scene. As witnessing a crime is a distinctive event for an eyewitness, this experiment investigated the effect of context further by increasing the distinctiveness of the target. This was achieved by changing the colour of each target's clothing so that it was highly distinctive.

Method

Overview

The main aim of this experiment was to investigate the effect of distinctiveness and context in composite construction. The first experiment had already indicated that a more recognisable composite could be constructed when participant-witnesses had access to additional footage that depicted the target's face, even though visibility was extremely poor. However, for the conditions where the face could not be seen, performance was no better than if no additional footage was given. As witnessing a crime is a distinctive event for an eyewitness, this experiment investigated the effect of context further by increasing the distinctiveness of the target. This was achieved by changing the colour of each target's top so that it was highly distinctive (bright pink).

In the first stage of the experiment participants viewed a 30-second video clip of an unfamiliar male target. The participants were then asked to describe the target's face through the use of Cognitive Interview techniques and to work with the experimenter to construct a composite of his face. One group of participants constructed the composite from memory and had no access to any additional CCTV footage. A second group of participants were given a 7 second CCTV clip of the target where only the side and back of the head were visible. A third group of participants were given a 7 second CCTV clip of the target where the head was completely blocked out. In stage 2, participants who were unfamiliar with the targets rated the composites for likeness. In stage 3, a further group of unfamiliar participants were asked to try to 'pick out' the target from an array (6AFC task).

Stage 1: Construction of Composites

Materials

Each video clip depicted a mock crime that was filmed in the psychology department at Stirling University. For each of the clips, a member of lecturing staff was filmed walking into the room and stealing a mobile phone from a rucksack. Each video clip lasted approximately thirty seconds. Importantly, the mock crimes were filmed both with a high quality camcorder and with a low quality webcam (to emulate poor quality CCTV) at exactly the same time but at different angles. The high quality camcorder was used at close range and this footage was used as the target video. The footage from the webcam was edited and used during composite construction. Seven second clips were taken from the webcam footage. These clips depicted the side and back of each target's head (at no time was the full-face visible). The same 7 second clips were then edited further to produce a second set of clips where each target's face was completely blocked out. In order to 'block out' the face on the webcam footage, a black box was placed over the head using the editing tools in Adobe Photoshop 7.0.

In order to make the video clips more distinctive, all of the clips were edited so that the target was wearing a bright pink (fluorescent) top. As it was not possible to 'isolate' the colour of the top and change this using the automated tools in Adobe After Effects, in order to achieve this change (and to block out the face), Virtual Dub (v1.6.14) was used to save each clip as individual frames. Each individual frame was then altered in Adobe Photoshop 7. In order to change the colour of each target's top, the area was selected and then the variation tool was used to change the colour. This tool has an advantage over the standard paint bucket tool, as it retains some of the shading. This was important when changing the whole torso area, as it was important that shading around the arms was retained, to prevent the change resembling a 'block' of colour. Another advantage of using this tool was that it was possible to save the final colour change as an individual file, which could be used for the other targets. This ensured that the colour change for each of the targets was identical. Once all of the frames had been edited in Photoshop, the Adobe Premiere video editing software was used to 'piece' the frames together again and form a new clip. The ratio of 25 frames per second was maintained to ensure that the clips were identical to the original apart from the colour change. Each target was also photographed using a high quality digital camera. Composites were constructed using PROfit (Windows version 3.1) on an ASUS Hi-Grade UltiNote AS8400 laptop computer.

Insert figure 1 here please

Participants

Twenty-seven participants aged between eighteen and fifty years old were recruited from Napier University, Edinburgh and Stirling University. The participants from Stirling were not familiar with the psychology department. All participants were unfamiliar with the targets. Each participant received a £5 payment.

Design

A 3 (target) by 3 (CCTV) between-subjects design was adopted. The three CCTV conditions were 1) no face (only the back and side of the head were visible) 2) no head (the head was completely blocked out) and 3) no additional footage (see figure 1 for stills of footage). Each participant viewed a thirty-second video clip of *one* target and constructed one composite of the target from memory. During construction, the participants in conditions 1 and 2 were given complete control over the additional footage. They could view the clips as often as they wished and for as long as they wished, pausing and rewinding where necessary. Occasionally, participants did forget that the footage was there and they were prompted by the experimenter. All participants viewed the footage at least twice during construction. While the experimenter was familiar with the targets and had edited the videos, each of the clips was assigned a number by an independent researcher. This ensured that during construction the experimenter was not aware of the specific identity of each target and did not view any of the clips until the experiment had been completed. This ensured that the experimenter remained as blind as possible to target identity during construction. The number of targets was less than in previous experiments due to the complexity of the editing. To counter this, the number of participants was increased from 2 per target in each condition to 3. Therefore for each condition there were 9 participant-witnesses (3 per target), resulting in a total of 27 composites. The order of construction was randomised.

Procedure

Each participant was asked to view a thirty-second video clip. The participant was not initially told that they would have to remember this person. After the participant had viewed the clip they were given procedural instructions which lasted approximately five minutes. The Cognitive Interview was then conducted and the participant was encouraged to close their eyes and visualise the face. For the first recall attempt (free recall) they were asked to describe the features in any order and were encouraged to describe everything they could see, even if they thought it was irrelevant. The second recall attempt was more structured in that the participant was asked to focus on each feature separately, starting at the top of the head and working their way down the face slowly. If a third recall attempt was needed the order was varied (e.g. starting at the bottom of the face and working upwards). If the participant had omitted any information, questions were then directed at these areas (e.g. Can you recall/describe the shape of the mouth?). No questions were directed at features or aspects of features that the participant had said that they could not recall. This description was then entered into PROfit.

PROfit is very similar to other computerised composite systems as it displays a small facial shaped icon. A drop-down menu that provides a breakdown of each part of the feature accompanies every feature in this icon. For example, when you click on the face, the drop-down menu displays ‘face shape, chin shape, length, width, age, fleshiness, forehead’ etc. Within each of these categories there are a range of options. For example, for ‘face shape’ the options are ‘oval, round, triangular, square and angular’. If a descriptor did not match the word(s) the participant had used to describe that feature, then the participant chose the descriptor that they felt was the closest alternative. The experimenter offered no advice. If a participant did not recall a feature or aspect of a feature e.g. size of eyes, then the ‘average’ option was entered. Where this was not possible, no descriptor was chosen.

When the *full* CI elicited description had been entered into PROfit, the participant and experimenter worked together to produce a facial likeness, by viewing chosen features, selecting alternative features and editing both features (e.g. changing size, shape, shade etc) and configuration. All features were edited using the tools available in PROfit. If further alterations were needed (e.g. highlights, shadows, laughter lines) the composite was exported into Adobe Photoshop 7. Construction of the composite ceased when the participant was either confident that the image represented a good likeness of the target, or they could not make any further changes.

Stage 2: Likeness Ratings
Materials
Each composite was presented with a full-face monochrome photograph of the target. All images measured 13cm in height and were printed on A4 paper (side-by-side). The photographs were edited using Adobe Photoshop 7 to ensure that brightness and contrast were constant.

Participants
Twenty unpaid participants were recruited from both the Science Centre in Glasgow and Napier University. All were unfamiliar with the targets.

Design
Unfamiliar participants rated the composites for likeness on a scale from one (low) to ten (high). All twenty-seven composites were randomly ordered in one booklet. Presentation order was randomised.

Procedure
Each participant was told that the composites were constructed after a ‘participant witness’ had only seen the target face for 30 seconds. It was stressed that the composites were constructed from memory and that they represented a likeness of the original target. Each participant was then informed that his or her task was to rate how good the likenesses were. They were asked to study each pair of images (composite and photographs) and rate the composites for likeness on a scale of 1 (low) to 10 (high). This

was repeated for all twenty-seven composites. No time limit was placed on this procedure.

Results

Insert figure 2 here please

Figure 2 illustrates the mean likeness ratings for all conditions. As can be seen, the facial composites that were constructed without the use of any additional CCTV footage (No CCTV) were the lowest rated composites (Mean = 3.4; SD = 1.2). The facial composites that were constructed with the use of CCTV footage that displayed the back and side of the head (No face CCTV) were rated slightly higher (Mean = 3.8. SD 0.96). Those constructed with the use of CCTV footage that completely blocked out the face and head (Blocked head CCTV) were rated the highest (Mean = 4.3; SD=1.10). A 3 (Type of CCTV footage) by 3 (Target) repeated-measures ANOVA was conducted. This revealed a significant main effect of CCTV type ($F (2, 38) = 9.87$, $p < 0.001$), no main effect of target ($F (2, 38) = 0.21$, $p = 0.815$) and a significant interaction ($F (4, 76) = 6.43$, $p < 0.001$). Further repeated-measures ANOVAs and paired-samples t-tests were conducted for each target. These revealed significant differences for target 1 ($F (2, 38) = 8.20$, $p = 0.001$) as both the Blocked Head CCTV (mean 4.8) and No CCTV (mean 4.1) composites were rated significantly higher than the No Face CCTV (mean 2.4) composites ($p < 0.05$ for both).For target 2 ($F (4, 76) = 7.75$, $p = 0.002$) both the Blocked Head (mean 4.3) and the No Face CCTV (mean 4.8) composites were rated significantly higher than the No CCTV (mean 2.6) composites ($p<0.05$ for both). For the third target ($F (4, 76) = 6.34$, $p = 0.004$) the Blocked Head composites (mean 5.05) were rated significantly higher than the No CCTV composites (mean 3.5) and the No Face CCTV (mean 3.3) composites ($p<0.05$ for both).

To summarise, the Blocked Head composites were rated significantly higher than the No CCTV and the No Face composites for two targets. Additionally, the No Face CCTV composites performed as well as the Blocked Head composites for one target. While the No CCTV composites did perform well for target 1, this effect was only observed for one target and they did not perform better than the Blocked Head composites. These findings suggest that there was a benefit for ‘physically’ reinstating the context for all of the targets in this experiment. This was investigated further using a six-alternative forced choice task.

Stage 3: Array task (6AFC)

Materials

Each composite was presented with a target present array. The arrays contained one monochrome photograph of the target and five distractor photographs. The position of the target in the array differed for each target. Due to inconsistencies in the verbal descriptions given by participants the faces were matched visually for hairstyle/colour, face shape and approximate age. All six photographs were standardised for height (7cm) and were presented on a single sheet of A4 paper. Adobe Photoshop 7 was used to ensure that brightness and contrast were consistent.

Participants
Seventy-two unpaid participants were recruited. Sixty-five participants were recruited from the Science Centre in Glasgow and the remaining seven were recruited from Napier University. All were unfamiliar with the targets.

Design
Unfamiliar participants were asked to 'pick out' the target from the target present arrays. Nine booklets were constructed, each containing one composite for each of the targets and one of each condition (1 No CCTV, 1 No head CCTV and 1 No face CCTV composite for each of the 3 targets). Each participant saw only one booklet. There were eight participants per booklet (72 participants in total).

Procedure
Each participant was told that the composites were constructed after a 'participant-witness' had only seen the target face for 30 seconds. It was stressed that the composites were constructed from memory and that they represented a likeness of the original target. Each participant was then informed that the original target was in the photographic array and that his or her task was to examine all of the images carefully and to try to 'pick out' the target. No time limit was placed on this procedure. On completion, each participant was thanked for their time and debriefed.

Results

Insert figure 3 here please

Figure 3 displays the mean number of correct matches for each condition and target. As can be seen, a similar pattern of performance is observed for both the array data and likeness ratings. The percentage number of correct matches was 28% for the composites that were constructed without the aid of CCTV. For the No Face condition, this increased to 32% and for the Blocked Head condition, the number of correct matches was 43%. A Cochran Q test was performed on the data and this revealed significant differences ($\chi^2=29.8$, DF=8, $p<0.001$). Further analyses was conducted for each target and this revealed that while there were more correct matches for the Blocked Head composites for target 1, there were no significant differences ($\chi^2=3.29$, df=2, $p>0.05$). For target 2, the differences approached significance ($\chi^2=4.8$, df=2, $p=0.09$). However, for target 3 there were significant differences ($\chi^2=7.13$, df=2, $p<0.05$) with the Blocked Head composites performing significantly better than either the No CCTV or the No Face composites ($p<0.05$) for both. While the trend supports the likeness rating data, the Blocked Head composites are only significantly better for one target here. Furthermore, for target 2 the No Face composites perform almost significantly better than the other two conditions.

Discussion

Overall, the results from the likeness rating and 6afc task provide a similar pattern of results; that reinstating the context by allowing a participant-witness to view CCTV footage during construction significantly improves facial composites. The two tasks provide a slightly different pattern of results when examining the performance of each individual target face. In general, the CCTV footage has aided construction and what is particularly encouraging is that there is no occasion where the CCTV composites performed worse than the composites that were constructed without the aid of additional footage.

These results therefore appear to provide support for the encoding specificity principle (Thomson & Tulving, 1970; Tulving & Thomson, 1973), as increasing the overlap between the information that was available at encoding and the information at retrieval appears to have aided construction. However, this effect only appears to be strong when the head was completely blocked in the CCTV footage. This is surprising and contrary to the results from the first experiment, where composite construction was enhanced when facial information could be seen in the footage.

Gronlund's (2005) account of Estes' (1997) perturbation model may go some way to help explain these results. According to Gronlund, when a person is encountered (or studied) there will be a memory representation that will have to be maintained throughout the retention interval. So, in the case of composite construction, the memory representation of the target face has to be maintained throughout multiple exposures to misleading stimuli (features/faces). Gronlund states that when a similar event is then encountered, the information is recoded. This recoding is subject to error and it is the accuracy (or inaccuracy) of this recoding that is measured by the perturbation model. So this suggests that when the additional CCTV footage is viewed during composite construction, the original memory representation of the person (and their face) may be recoded. It may be that the amount of 'useful' information in the video may help to determine how accurate this recoding is. So, when the footage contains useful facial cues (as in experiment 1) this recoding may be fairly accurate. However, when the footage contains poor facial cues (back of head) then recoding may be more inaccurate. However, if this were the case, why were the composites better when no facial cues were evident?

The only aspect of the CCTV footage that changed from the first experiment to this one is the distinctiveness of the clothing. While research (e.g. Valentine & Bruce, 1986; Valentine, 1991a) has indicated that typical and distinctive faces are stored and processed differently, it is not the face that is distinctive in this experiment, it is the clothing which could be thought of as 'novel' within the scene. Research on the effect of novelty (e.g. Friedman, 1979) has indicated that memory for a novel item is enhanced. In particular, novel items may be "processed more fully and deeply" than familiar items (Sakamoto & Love, 2005, pg 1). Indeed, Tulving & Kroll (1995) proposed a hypothesis to explain this effect of novelty. They suggest that there are specialised networks in the brain that encode novelty information. The networks encode the information on two levels. Firstly, an assessment is made regarding the level of novelty and then if the item is judged to be sufficiently novel (rather than just familiar), higher-order encoding takes place.

If the distinctiveness of the clothing resulted in a higher level of encoding for other aspects of the target and scene, could this explain the effect? Well, it might if taken together with Gronlund's (2005) account of Estes' (1997) perturbation model. If the original memory representation is updated or recoded when the additional CCTV footage is viewed, then more errors in recoding may occur in the No Face (back and side of head) condition. This is because the participants may be actively focusing on the extremely limited facial cues that are available in the footage and updating their existing memorial representation with a new representation that is error-prone. However, when the head is completely blocked out, just viewing the novel item (the bright clothing) may serve to further enhance the existing memorial representation.

If the results from this experiment are a consequence of distinctiveness or novelty effects, then this would explain why the same pattern of results were not obtained in experiment 1, (Ness et al, 2004) where no element of the event was distinctive or novel. However, much more work needs to be conducted in order to assess this in more detail. Nevertheless, this experiment provides a clear indication that reinstating the context by allowing a witness to view additional CCTV footage increases facial likeness in composites.

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