Are two views better than one? Investigating three-quarter view facial composites

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Abstract
Purpose – The introduction of a three-quarter-view database in the PRO-fit facial-composite system has enabled an investigation into the effects of image view in face construction. The article examines the impact of constructing full-face and three-quarter-view composites under different encoding conditions. It also examines the potential value of three-quarter-view composites that can be generated automatically from a front-view composite. We also investigate whether there is an identification benefit for presenting full-face and three-quarter composites together.
Design/methodology/approach – Three experiments examine the impact of encoding conditions on composite construction and presentation of composites at the evaluation stage.
Findings – The work revealed that while standard full-face composites perform well when all views of the face have been encoded, care should be taken when a person has only seen one view. When a witness has seen a side view of a suspect, a three-quarter-view composite should be constructed. Also, it would be beneficial for a witness to construct two composites of a suspect, one in full-face view and one in a three-quarter-view, particularly when the witness has only encoded one view. No benefit emerged for use of three-quarter-view composites generated automatically.
Originality/value – No research to date has formally examined the impact of viewpoint in facial-composite construction.
Keywords facial composite, three-quarter view, viewpoint, PRO-fit, eyewitness memory, forensic cognition
Paper type Research paper

Introduction

Computerised composite systems assist witnesses in constructing a facial likeness of a suspect. In the UK, E-FIT and PRO-fit are used as well as newer, more sophisticated systems such as EvoFIT (Frowd et al., 2013) and EFIT-V (George et al., 2008).

Research has demonstrated that computerised systems produce better likenesses than older systems such as Photofit (e.g. Brace et al., 2000; Cutler et al., 1988; Davies et al., 2000; Koehn and Fisher, 1997; Wogalter and Marwitz, 1991) and newer systems can produce very good likenesses under some circumstances (e.g. Frowd et al., 2005a, 2005b, 2013). However, despite these improvements, composites can still portray a poor resemblance to the target. This is because constructing a composite is a difficult task. Witnesses remember the face of someone they have only seen once, perhaps for a very short time. The resulting image is circulated such that someone who is familiar with the suspect will recognise him or her from the composite. Due to their forensic importance, it is vital then that researchers examine methods for improving the identification of composites.

Some of this research has improved the effectiveness of composites *after* they have been constructed. For example, researchers have examined morphing composites from single and multiple witnesses (e.g. Brace et al., 2006; Bruce et al., 2002), caricaturing composites (Frowd et al., 2007b) and by 'splitting' a composite horizontally (McIntyre et al., in press). Although this research has had success in improving recognition rates, no research has examined the impact of viewpoint on both construction and subsequent identification of a composite image. In this context, viewpoint refers to the relative horizontal rotation of the target face to the viewer (e.g. full-face, three-quarter and profile views).

Consideration of viewpoint is likely to be important. In a real-life situation, witnesses will have seen a face that is usually unfamiliar, three-dimensional and in motion; however, when constructing a face, the result is a two-dimensional static representation. Evidence on the role of movement for unfamiliar face recognition has indicated that non-rigid (natural) motion at encoding may help us to form a robust three-dimensional representation (e.g. Bruce and Valentine, 1988; Pike et al., 1997; Schiff et al., 1986). As witnesses may have encoded such a representation of the face, what is the best viewpoint to use? Would it be easier for them to construct a three-quarter-view composite rather than a full-face composite?

Indeed, witnesses may have only seen a side view of the face, and so is it appropriate to ask them to construct a composite in a different view? Frowd et al. (2014) indicate not, as such changes reduce composite identification (for a holistic system). Also, one might question whether constructing a composite in a single view sufficiently captures the three-dimensional nature of the face to facilitate later identification of the composite image? While research has not examined both issues for composite construction, researchers have investigated whether one particular view is preferred in face recognition (e.g. Bruce et al., 1987; Hill et al., 1997; Lui and Chauduri, 2002; Newell et al., 1999; Schyns and Bülthoff, 1994). This research stems partly from research on object recognition that has suggested not only that object recognition may be viewpoint dependent (e.g. Edelman and Bülthoff, 1992; Tarr and Pinker, 1990), but also that certain views of an object are preferred (e.g. Palmer et al., 1981).

For recognition of faces, as a three-quarter view is centred between full-face and profile, it may contain information that is available in both views. As such, a three-quarter view could be a canonical representation. When multiple views of a face are seen at study, some researchers report that profile views (90˚) perform poorly but recognition performance for full-face (0˚) and three-quarter views (45˚) do not differ significantly (Hill et al., 1997; Newell et al., 1999). Similar results have been obtained by Logie et al. (1987) using ‘live’ targets. Bruce et al. (1987) also found a three-quarter view advantage for unfamiliar but not familiar faces; Baddeley and Woodhead (1983) and Krouse (1981) report a similar three-quarter view advantage for unfamiliar faces.

This suggests that there may be a three-quarter-view advantage when more than one view is presented at study. However, Liu and Chaudhuri (2002) and others (e.g. Davies et al., 1978; Laughery et al., 1971) have failed to find an advantage. Indeed, Schyns and Bülthoff (1994) compared two different side views (18˚, 36˚) with a full-face view and found that no one view was preferred. It seems that when multiple views are encoded at study, recognition performance is equivalent for both full-face and three-quarter views.

When single full-face images are seen at study, researchers have failed to find a three-quarter view advantage at test (Newell et al., 1999; Patterson and Baddeley, 1977; Woodhead et al., 1979). However, three-quarter views do seem to have an advantage over full-face when generalising to novel views. One reason for this may be the symmetry hypothesis (e.g. Schyns and Bülthoff, 1994; Troje, 1998). This hypothesis suggests that as a face is bilaterally symmetrical (albeit not perfectly), side-views can be thought of as non-singular, as a symmetrical view can be generated from them, whereas full-face views are singular, as a symmetrical view cannot be generated. As such, when a three-quarter view is presented at study, a ‘virtual view’ could be generated, resulting in successful recognition for a novel view. Indeed, Schyns and Bülthoff (1994) found strong generalisation for 36˚ and -36˚ faces compared with 18˚ and 0˚; they also found inverted U shape recognition for full-face (0˚), with sharp decreases for each increased angle of rotation. Similar results were obtained by Hill et al. (1997) using full-face, three-quarter view (45˚) and profile (90˚) views, with peak performance observed for the opposite (‘symmetrical’) three-quarter view. Hill et al. (1997) also report that while full-face and three-quarter views did not generalise well, generalisation from a three-quarter view did not depend on the view at test.

These results suggest that unfamiliar face recognition is viewpoint dependent and that generalisation to novel views from only one view is dependent on the learned view. Also, different patterns of dependence are observed for different learned views. In particular, performance of a full-face view appears to give an inverted U shape function. Similarly, while generalisation for side views decreases slightly, there is often a peak in performance for the opposite, symmetrical view. This suggests that learning may result in better generalisation for side than full-face view.

So, unfamiliar face recognition is viewpoint dependent. It is unclear, however, if the same pattern of results would be observed for face construction. For systems such as PRO-fit, face construction can be described primarily as a recall task. When facial features are presented, witnesses search their memory to decide whether they ‘match’ those stored in memory. Overall, the process of recalling a feature (or face) is more difficult than recognising a face. Indeed, authors have noted the reconstructive nature of recall. Davies et al. (pg. 22) state that "Photofit making... becomes an act not of reproduction but of reconstruction…". Bartlett (1932) argued that stored items could become combined at retrieval, resulting in the recollection of incorrect information, suggesting that successful retrieval may be dependent on the cues available at test. Indeed, the encoding specificity principle (e.g. Tulving and Thomson, 1973) states that retrieval will be more successful when retrieval cues more accurately match those in the original encoded experience. For face construction, the retrieval cues (facial features) will never precisely match those in the original target face; however, retrieval may be more successful when the cues (features) are displayed in a more three-dimensional way—that is, in a three-quarter than a full-face view (the latter of which captures little of the three-dimensional information available at encoding). Also, retrieval may be enhanced further when viewpoint is matched at encoding and retrieval (construction).

Aims

The present study investigated the importance of viewpoint in facial-composite construction by examining whether participants would construct a more identifiable composite in a three-quarter compared with the standard full-face view. In the first experiment, participants constructed both a full-face and a three-quarter-view composite after having been presented with all views of a face. This format at encoding should ensure that a difference between these two sets of composites would be due to view at construction and not at encoding. Target faces were presented on video and revealed equal amounts of all views, in an attempt to emulate an everyday interaction. The aim was also to investigate encoding specificity (e.g. Tulving and Thomson, 1973) and viewpoint dependency in more detail by investigating whether composites are more effective when retrieval cues (facial features) are more similar to those at encoding (i.e. more three-dimensional).

As well as investigating ways to improve the construction of composites, Experiment 2 examined whether use of different views would improve the effectiveness of composites after they had been constructed. Research has found that presenting varied information from multiple witnesses increases identification rates. In particular, showing multiple composites (Brace et al., 2006) and combining composites from four different witnesses (Bruce et al., 2002) increase correct identification above that of a single composite. Similarly, combining composites from the same witness using two different composite systems also increases identification (Ness et al., 2003). This benefit appears to be driven primarily by presentation and combination of varied information from different witnesses. As two different views of the same person can look very different and may contain different kinds of information (more 3D structure in a three-quarter-view composite), we examined whether presenting both full-face and three-quarter-view composites together would increase identification above that observed for a single composite.

At present, national police guidelines (e.g. ACPO, 2009) do not prohibit construction of more than one composite by a witness, although the implication is that one image will be produced. In Experiment 2, as well as constructing composites in both front and three-quarter views, unique functionality in PRO-fit was used to generate a three-quarter-view composite from participants' full-face image. From a theoretical perspective, if the three-quarter-view acts as a more efficient retrieval cue then constructed composites should contain a more accurate likeness of a target than automatically generated ones. From an applied perspective, if performance increases when full-face and automatically-generated composites are presented together, then use of an additional system-generated face could be beneficial as a witness would still only need to construct a single image, as per existing guidelines.

Experiment 3 examined the encoding-specificity principle in more detail. View at study was full-face, three-quarter or both views, with participants constructing faces at both views. At the composite-evaluation stage, full-face and three-quarter-view composites were presented alone and in pairs.

All composites were constructed here using PRO-fit software, the procedure for which is described in detail in Fodarella et al. (2016). For our investigation, two white female databases were used, full-face and three-quarter[1] view. Both databases contained facial features that had been captured from the same photographic subjects at a front and side view. Each feature is coded to enable the program to create the corresponding view (e.g. three-quarter from full-face) with equivalent features.

Experiment 1

In Stage 1, participants viewed a video and then constructed a single composite of the face from memory at a full-face view and another at a three-quarter-view. In Stage 2, a further set of three-quarter-view composites were generated automatically from the full-face composites. In Stage 3, participants rated the composites for likeness. In Stage 4, further participants who were familiar with the targets attempted to identify the composites.

Stage 1: Construction of Composites

Materials

The target faces were extracted from the same video and photographic set used to create the female databases in PRO-fit, specifically four female members of staff from the Psychology Department at the University of Stirling. While not an ecologically-valid situation—as in reality, offenders' features would not be in such a database—it uniquely allowed a comparison to be made between composite likeness and the number of correct features in the image. It is perhaps worth mentioning that it is not possible to construct a face containing all of the target's features since PRO-fit only uses a maximum of five features per photographic subject.

Targets were 30-second video clips. They comprised frames of a target extracted and digitised without sound using the Media 100 video-editing package. Each consisted of 15 seconds of movement (rotating in chair from left to right: shaking head from side to side, nodding up and down) and 15 seconds of full-face view.

Composites were constructed using PRO-fit on an ASUS Hi-Grade AS8400 laptop.

Participants

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[1] This particular database displays faces at a 30º angle, which is consistent with research (e.g. Troje and Bülthoff, 1996) which has found optimal performance for recognition between 25º and 40º

Sixteen adults aged between 18 and 40 years and with same ethnicity as the targets were recruited from the Psychology department of Queen Margaret University College, Edinburgh. All participants were unfamiliar with the targets. Participants received a £10 payment.

Design

A 4 (target) by 2 (construction view) Mixed-Factorial design was used, with target as the between-subjects factor and construction (full-face and three-quarter) view as the within-subjects factor. Each participant viewed a 30-second video clip of one target and constructed two composites of that same target, one in a full-face view and one in a three-quarter-view. There were four targets and sixteen participants, creating 32 composites (16 full-face and 16 three-quarter-view). The order of construction was counterbalanced: eight participants constructed a three-quarter-view composite first and eight constructed a full-face composite first.

The sixteen full-face composites were then used to generate a further set of three-quarter-view composites using PRO-fit. This created another sixteen composites and resulted in a total of forty-eight composites (16 full-face, 16 three-quarter-view created by a participant and 16 three-quarter-view generated automatically).

Procedure

Stage 1: Composite Construction

Participants were tested individually, as was the case elsewhere in this paper. They were invited to view a 30-second video clip. They were not told that they would have to remember this person. After viewing the clip, the true nature of the experiment was revealed. A cognitive interview (incl. free and cued recall) was used to elicit a description of the face, and this information was entered into PRO-fit. The full procedure is explained in Fodarella et al. (2016). All features were edited using the tools available in PRO-fit. If further alterations were required, the composite was exported into Adobe Photoshop. Construction of the composite ceased when participants were either confident that the image represented a good likeness of the target, or indicated they could not suggest any further changes to make.

On completion of the first composite, the description of the face was entered into the second PRO-fit database (full-face then three-quarter-view, and vice versa). Both databases contain the same features but PRO-fit does not present them in the same order. This outcome limited participants from simply selecting the same features again (e.g. the third hairstyle), thereby reproducing the first composite in a different view. As normal, participant and experimenter worked together to construct a composite; no time limit was placed on construction of either composite. The time to conduct the cognitive interview and construct both composites was around 90 minutes.

Stage 2: Automatic generation of three-quarter-view composites

A further set of three-quarter-view composites were automatically generated from the full-face composites. In order to do this, PRO-fit uses an index table to associate matching features. However, any editing changes made to a full-face composite are not ‘transferred’ to the generated image. A detailed list of alterations was therefore maintained by the experimenter, and each generated composite was altered in the same way as the original full-face composite; for example, if the fringe had been removed on the full-face image, it was similarly removed on the generated image. This editing procedure commenced (without assistance from participants) once all of the composites had been constructed.

Stage 3: Evaluation of Composites

Likeness Ratings

Materials

Each full-face and three-quarter-view composite was presented with greyscale photographs depicting the relevant target in both views (one full-face and one three-quarter view). This ensured that as much information as possible was available for the task. See Figure 1 for example composites. All images measured 13cm in height. Photographs were edited to ensure that brightness and contrast were constant.

Figure 1

Participants

Forty volunteers aged between 18 and 57 years were recruited from Queen Margaret University College and local Tesco supermarkets. All were the same ethnicity as the target faces and were unfamiliar with the targets.

Design

Participants rated the composites for likeness. The composites were divided into two books each containing 24 composites (eight from: full-face, constructed ¾ view and generated composites, with an equal number for each of the targets). Each participant saw one of two books, randomly assigned with equal sampling. Composites were printed on single sheets of A4 paper and displayed with two monochrome photographs of the target (one full-face and one three-quarter view, printed side by side on a separate sheet of A4 paper).

Procedure

Participants were told that the composites were constructed after a participant-witness had seen a 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 informed that his or her task was to rate how good were the composite likenesses on a scale of 1 (low) to 10 (high). This procedure was repeated for all twenty-four composites. Participants received a different random order of presentation.

Results

From Figure 2, it can be seen that the highest likeness ratings occurred for the three-quarter-view composites ($M = 4.1$, $SD = 0.95$), followed by the full-face composites ($M = 3.7$, $SD = 1.27$), and then the generated three-quarter-view composites ($M = 2.5$, $SD = 0.89$). A 3 (composite type) by 4 (target) RM ANOVA revealed a significant main effect of composite type [$F(2,78) = 32.031$, $p < .001$, $\eta_p^2 = .451$]. Further analysis revealed that the generated three-quarter-view composites were rated significantly lower than both the full-face composites [$t(39) = 6.555$, $p < .01$] and the constructed three-quarter-view composites [($t(39) = 8.058$, $p < .01$]. The ANOVA also revealed a significant main effect of target [$F(3,117) = 26.146$, $p < .001$, $\eta p^2 = .401$] and a significant interaction between composite type and target [$F(6,234) = 7.348$, $p < .001$, $\eta p^2 = .159$].

Figure 2

Further analysis revealed that, for three of the four targets, the full-face and three-quarter-view composites were rated significantly higher than the generated three-quarter-view composites, and there was no reliable difference between full-face and constructed three-quarter view composites ($p > .05$). For Target 1, the three-quarter-view composites ($M = 5.18$, $SD = 1.10$) were rated as better likenesses than both the full-face ($M = 3.87$, $SD = 1.70$) and generated three-quarter-view composites ($M = 2.36$, $SD = 1.50$; $p < .001$ for both respectively). Ratings for Target 2 were poor across all three conditions and did not differ significantly (full-face, $M = 2.65$, $SD = 1.32$; three-quarter-view, $M = 2.51$, $SD = 1.17$; generated three-quarter-view, $M = 2.40$, $SD = 1.50$; $p > .05$). For Target 3, both three-quarter-view ($M = 4.10$, $SD = 1.60$) and full-face composites ($M = 3.51$, $SD = 1.90$) were rated as better likenesses than generated composites ($M = 2.40$, $SD = 1.30$; $p < .05$). Similarly, for Target 4, full-face and ($M = 4.3$, $SD = 2.10$) and three-quarter-view composites ($M = 4.50$, $SD = 1.80$) were both rated reliably higher than generated composites ($M = 2.80$, $SD = 1.50$; $p < 0.05$).

As the composites were split into two booklets, a composite type (3) by booklet (2) ANOVA was conducted. This again revealed a main effect of composite type but no main effect of booklet [$F(1,39) = 2.780$, $p > .05$, $\eta p^2 = .067$] and no interaction [$F(2,78) = 1.595$, $p > .05$, $\eta p^2 = .151$]. Also, as each participant constructed two composites, a further analysis was conducted on the order of construction: there was no effect for order of construction [$F(1,15) = 0.712$, $p > .05$].

The individual features that were correctly chosen by different participants were ears (2), nose (2), eyes (3) and hair (6). No single participant chose more than one correct feature, and there were no differences between views. This finding is comparable to previous research by Koehn and Fisher (1997) who also reported very few correct features selected using the Mac-A-Mug Pro system. In their investigation 25 composites did not have any correct features, 19 composites had one correct feature and two composites had two correct features.

Stage 4: Identification

Participants

Thirty-two members of staff participated from the Department of Psychology at the University of Stirling. All participants were familiar with the target faces and were aged between 23 and 58 years old.

Design

Participants who were familiar with the targets were asked to identify the composites. In order to avoid priming effects caused by presenting multiple composite images of the same identity, each participant was presented with only one composite for each target. Twelve books were constructed, each containing one type of composite for each of the four targets. Thus, participants saw one book (of four composites) containing one composite of each target, and at least one of each type of composite (full-face, three-quarter-view and a generated three-quarter-view).

Procedure

Participants were informed that the composites were constructed after a person had seen a target face, someone from their psychology department, for 30 seconds. It was emphasised that the composites were constructed from memory and that they represented a likeness of the target. They were encouraged to provide a name or identifiable semantic information about the person. Participants received a different random order of presentation. On completion, the target identities were revealed.

Results

A composite's identification was scored correct ('hit') if a participant gave a name or identifiable semantic information that correctly identified the person. If a participant provided an incorrect name or semantic information that identified another person, this was counted as a false positive. The mean hits and false positives was similar for both full-face composites (23% correct with 9% false positives) and three-quarter-view composites (22% correct with 9% false positives), with generated composites performing worse (13% correct with 28% false positives).

The data were collapsed across target and a Friedman test conducted on the hit rate. This analysis revealed a non-significant effect of composite type [$X^2(2) = 1.55$, $p > .05$], although the trend is clearly in line with the rating scores above. Identification rates are clearly low, but this situation is usual for facial composites and is in line with rates observed in previous research (e.g. Bruce et al., 2002; Frowd et al., 2005a).

Discussion

The results did not show a three-quarter-view advantage, but instead revealed that three-quarter-view composites performed as well as full-face composites. This finding is in line with face recognition research which has found that when all views were presented at study, no one view is preferred at test (e.g. Hill et al., 1997; Schyns and Bülthoff, 1994). As a result of exposure to different views, sufficient information may have been encoded and resulted in successful generalisation to either of the two views. The generated three-quarter-view composites performed poorly and, while it may be advantageous practically to automatically generate an additional composite, it is clear that producing an image directly from a full-face composite does not result in a good likeness. The issue of encoding specificity will be explored later in Experiment 3 where viewpoint at encoding and construction is investigated in more detail.

Experiment 2

Experiment 1 examined whether constructing an image in a three-quarter-view would produce more identifiable composites. The results did not support a three-quarter-view advantage but did indicate that three-quarter-view composites were as effective as full-face composites. This was investigated further in Experiment 2 by examining whether presenting both composites (full-face and three-quarter-view) would increase identification above the level observed for a single full-face composite. While likeness ratings and identification rates were similar for both types of composites in the previous experiment, it is possible that three-quarter-view composites may contain different or more information than full-face composites (e.g. more 3-dimensional information about the structure of the face). As two different views of the same face can look very different, and often are more different than two different people, presenting both composites together may increase identification rates similar to previous research using composites from multiple witnesses and systems (e.g. Brace et al., 2002, 2006; Ness et al., 2003). Stages 1 and 2 below utlilise composites constructed and generated from Experiment 1.

Stage 1: Full-face and three-quarter-view composites

Participants

Thirty-two participants were recruited from the Psychology department at the University of Stirling. They consisted of third and fourth year psychology students and three members of staff, none of which had participated in Experiment 1. Participants were familiar with the targets. They ranged in age from 21 to 53 years.

Design and Procedure

The aim was to examine whether presenting an additional three-quarter-view image would increase identification. To do this, composites were used from Experiment 1. However, poorly-rated composites were avoided as it is unlikely that adding another composite of this quality would increase identification, and so intermediate- and highest-rated composites were chosen. Only three of the three-quarter-view composites were rated better than the corresponding full-face images, making it unlikely that any potential advantage of presenting both views would be a result of simply including a better-quality composite.

Each full-face composite was presented alone and with its corresponding three-quarter-view (i.e. the one that was constructed by the same participant). This created a total of 16 presentations (four best and four intermediate at full-face alone, and four best and four intermediate at full-face and three-quarter-view together). Participants were shown one type of composite for each of the four targets. This resulted in each participant seeing one best full-face alone, one best full-face and one best three-quarter-view, one intermediate full-face, and one intermediate full-face and one intermediate three-quarter-view for each of the four targets.

The procedure was the same as the original (revised) identification procedure in Stage 3 of Experiment 1.

Results and Discussion

Figure 3 illustrates identification rates for presenting full-face composites alone, and with their corresponding three-quarter-view. Cochran's Q revealed that full-face and three-quarter composites shown together were identified more accurately overall than single full-face composites [$Q(3) = 8.43$, $p < .05$]. Further analysis using McNemar tests revealed, for intermediate-rated images, that composites shown together (full-face and three-quarter-view, M = 53%) were identified better than full-face composites (M = 19%; $p < .05$); for best composites, there was no reliable difference ($p > .05$), although the trend was in the same direction (M = 28 to 37%).

Figure 3

An examination of intermediate composites by target revealed reliable increases for presenting both views for Targets 1 and 4 ($p < .05$) but not for Targets 2 and 3 ($p > .05$). With such a small pool of targets, it is inevitable that differences will emerge; however, it is unclear why a significant increase was observed for intermediate but not for best composites. Results are again consistent with previous research (e.g. Bruce et al., 2002) by indicating that presenting more information (composites of different views) improves identification. Results are also important from an applied perspective: as there is no way of knowing whether a composite is 'average' or 'good', our results suggest that asking a witness to construct two composites of the same person in different views would be advantageous regardless of quality.

Stage 2: Full-face and automatically-generated three-quarter-views

In Experiment 1, automatically-generated composites performed poorly when presented alone, in comparison to the constructed composites. However, they may still facilitate identification when presented with their corresponding full-face composite. In order to examine this possibility, the same full-face composites that were used in Stage 1 of Experiment 2 were used. However, instead of presenting them with their constructed three-quarter-view composites, they were also presented with their corresponding automatically-generated three-quarter-view.

Materials

An identification task was not undertaken here due to limited availability of participants who were familiar with the targets. Instead, a six alternative-forced-choice (AFC) task was administered, as used in facial-composite research (e.g. Bruce, et al., 2002; Frowd et al., 2007a). To create arrays for this task, five distractors were chosen for each of the four target faces, each matched for hair style/colour, face shape and age. These distractors were presented along with the relevant target as greyscale photographs in an array format on a single sheet of A4. Images were adjusted to have consistent brightness and contrast.

Participants

Forty-eight participants aged between 17 and 50 years were recruited from local businesses in Edinburgh. They were unfamiliar with the targets. No participant had taken part in any of the previous experiments.

Design

The same best- and intermediately-rated composites were used. The full-face composites were shown alone and both with their corresponding three-quarter-view *and* generated composites. There were 24 composite types in total (eight full-face, eight full-face and constructed three-quarter, and eight full-face and automatically-generated three-quarter). As in Stage 1, each participant was shown one type of composite for each of the four targets. Each composite type was presented with an array of six greyscale photographs (one target and five distractors). This method was designed as a way of assessing composite quality, not as a formal 'line-up' procedure.

Results

The overall correct matches were 52% for single full-face composites, 73% for full-face with constructed three-quarter-view composites, and 42% for full-face with generated composites. A Friedman test revealed that these observed differences were significant [$X^2(2, 48) = 7.078$, $p < .05$]. Further, Wilcoxon Signed Rank tests indicated significantly more correct matches for full-face with constructed three-quarter-view composites than full-face and automatically-generated composites ($p < .05$). The advantage of full-face with three-quarter-view over single full-face composites approached significance ($p = .068$), but the trend is clearly in line with results obtained in Experiment 1. There was no significant difference between single full-face, and full-face and generated composites ($p > .05$).

Discussion

While there appears to be a benefit for presenting two views, this is only apparent when composites have actually been constructed: The automatically-generated composites performed poorly when presented alone (Experiment 1) and when presented with their corresponding full-face equivalent. The results suggest that a three-quarter-view composite does act as an efficient retrieval cue, as performance was significantly better for constructed three-quarter-view compared with automatically-generated composites. The results also suggest that just presenting more information does not facilitate identification. Instead, they provide supporting evidence for presentation of different types of information, as reported by Brace et al. (2006) and Bruce et al. (2002).

Experiment 3

The results from Experiment 1 revealed that a three-quarter-view performed as well as a full-face-view composite when all views were presented at study. This finding is in line with face recognition research (e.g. Schyns and Bülthoff, 1994). Experiment 3 examined the effect of encoding specificity (e.g. Tulving and Thomson, 1973) in more detail. In a real-life situation, a witness may have only seen one view of a face. Here, the view at both encoding (full-face, three-quarter, all views) and test (full-face, three-quarter) was manipulated. If the encoding-specificity principle is correct, performance should be facilitated when the view at encoding matches that at construction.

Stage 1: Composite Construction

Materials

Targets were four females from Queen Margaret University, Edinburgh. Each person was videotaped using a Sony Hi8 camcorder for approximately three minutes. Each person was asked to sit in a chair and converse with an experimenter while looking straight ahead and moving (rotating in chair from left to right: shaking head from side to side, nodding up and down). Thirty-second video clips were then created for each target: the first clip displayed the target looking straight-ahead (full-face condition), the second displayed the target at a 30-degree angle (three-quarter-view condition), and the third contained 15 seconds looking straight ahead and 15 seconds of movement (all view condition). Frames were extracted and digitised without sound using Media 100. Targets were also photographed using a Digital Olympus C-900 camera in a full-face and three-quarter view.

Participants

Twenty-four adults aged between 18 and 40 years were recruited from the University of Stirling. Participants were unfamiliar with the targets and received a £10 payment.

Design

The design was 4 between-subjects (target) by 3 between-subjects (encoding view: full face, ¾ view or all views) by 2 within-subjects (construction view: full face or ¾ view) mixed-factorial. Participants saw one unfamiliar target in one construction viewing condition. They were then asked to construct two composites of this target, one in a full-face view and one in a three-quarter-view from memory. There were six participants for each of the four targets, ensuring that for every target, two participants saw the target in a full-face view, two saw the target in a three-quarter-view and two saw all views of the target. This created a total of 48 composites, 12 per target. Target order was randomised and construction order was counterbalanced across participants.

Procedure

The procedure for composite construction was identical to the Procedure in Stage 1 of Experiment 1.

Stage 2: Evaluation of Composites

Likeness Ratings

Participants

Twenty-two participants aged between 18 and 45 years were recruited from the University of Stirling. None had participated in any of the previous experiments and were unfamiliar with the targets.

Design, Materials and Procedure

All 48 composites were randomly ordered in one presentation book. Each composite was printed on a single sheet of A4 paper and displayed with two monochrome photographs of the target (one full-face and one three-quarter-view, printed side by side on a separate sheet of A4 paper). The Procedure was identical to that used for collecting likeness ratings in Stage 3 of Experiment 1.

Results and Discussion

A 2 (composite type: full-face or three-quarter-view) by 3 (encoding view: full-face, three-quarter or both views) Repeated-Measures ANOVA revealed a significant main effect of composite type [$F(1,21) = 8.013$, $p < .05$, $\eta_p^2 = .276$], with higher ratings for full-face ($M = 3.90$) than for three-quarter-view composites ($M = 3.70$). There was also a significant main effect of encoding view [$F(2,42) = 13.676$, $p < .001$, $\eta_p^2 = .394$), with both views yielding higher rating scores ($M = 4.21$) than full-face ($M = 3.60$) and three-quarter-view composites ($M = 3.71$; $p = .001$ for both comparisons).

The interaction between composite type and encoding view was also reliable [$F(2,42) = 19.091$, $p < .001$, $\eta_p^2 = .476$]. Full-face composites were rated as significantly better likenesses when participants had seen all views of the face at encoding ($M = 4.62$, $SD = 1.02$) compared with seeing a full-face view only at encoding ($M = 3.71$, $SD = 1.19$) or a three-quarter-view ($M = 3.59$, $SD = 1.22$; $p < .001$ for both). For the three-quarter-view composites, however, ratings were *worse* when a full-face view had been seen at encoding (M = 3.42, SD = 1.18) compared with three-quarter-view (M = 3.88, SD =1.19) and all views (M = 3.75, SD = 1.08; $p < .05$ for both). There was no reliable difference in composite quality when encoding the three-quarter-view or both views ($p > .05$).

These results provide some initial support for a moderate encoding-specificity effect. The three-quarter-view composites were rated as worse likenesses when a full-face view had been encoded. Similarly, the highest ratings were obtained when three-quarter-view composites had been constructed after encoding the face in a three-quarter-view; however, this difference only approached significance. There was no three-quarter-view advantage. Instead, when more 3-dimensional information was available at study, composites were rated as significantly better likenesses. This finding also provides support for the symmetry hypothesis (e.g. Hill et al., 1997; Schyns and Bülthoff, 1994) and for viewpoint-dependency effects in composite construction, as generalisation to novel views in a face-construction task is dependent on the view at learning. The results from full-face composites also suggest that presenting more information at encoding facilitates face construction.

In order to further examine the above effects, an additional measure was undertaken, the 6 AFC array task similar to the one used in Experiment 2.

Stage 2: Array Task

Materials

Target-absent and target-present arrays were assembled for each of the four targets. The target-absent arrays contained greyscale photographs of six similar-looking females. The target present arrays contained one greyscale photograph of the target and five distractor photographs. The same distractors were used in both arrays and were matched visually for hairstyle/colour, face shape and approximate age. All images were standardised for height (7cm) and were presented on a single sheet of A4 paper. Brightness and contrast were adjusted for consistency. Four sets of arrays were created by target presence and view: target present full-face view, target present three-quarter view, target absent full-face view and target absent three-quarter view.

Participants

A total of 288 participants aged between 18 and 55 years were recruited from the University of Glasgow and Queen Margaret University, Edinburgh. They were unfamiliar with the targets and had not participated in other experiments in this paper.

Design

Individual composites were presented with target-present and target-absent arrays. View was held constant (i.e. three-quarter-view composites were presented with three-quarter-view arrays, and full-face composites were presented with full-face arrays). As composites had been constructed of one target in both views (full-face and three-quarter), these were also presented together. So, there were a total of 144 presentations (48 single composites, 24 ‘pairs’ of composites presented, both of these with target-present and target-absent arrays). Careful consideration was given to the view used in the arrays for pairs. As each pair contained one full-face composite and one three-quarter-view composite, the optimum array would contain both views. However, as an advantage for presenting both views had been previously found in Experiment 1 using full-face arrays, full-face arrays were used.

To ensure that each participant saw only one composite for each of the four targets, 36 separate presentation books were constructed. Each book was balanced for type of composite, initial encoding view and array type. There were eight participants per book (36 x 8 = 288 participants).

Procedure

Participants were told that the composites had been constructed from memory and that they represented a likeness of the original target. They were told that when they saw two composites, these represented two views of the same person. Participants were instructed to examine all images closely and that the target may or may not be present in the array. They were asked to indicate whether or not they thought the target was present and, if so, to indicate the appropriate photograph.

Results and Discussion

Correct matches (summarised in Figure 4) were collapsed across target and encoding view and were significant using a Friedman test [$X^2(2) = 6.049$, $p > .05$]. Wilcoxon Signed Rank tests revealed that when both composites were presented, performance was significantly better compared with presenting single full-face composites ($p < .05$). Also, performance was marginally better for both composites than a single three-quarter-view composite ($p = .08$).

Figure 4

A Cochran's Q test on the number of correct matches by type and view revealed significant overall differences [$Q(8) = 22.688$, $p < .05$]. Further analysis on composite type revealed significant differences for full-face composites [$Q(2) = 11.806$, $p < .05$). McNemar tests revealed significantly more correct matches when all views of the face had been encoded compared with both the three-quarter-view encoding ($p < .05$) and the full-face encoding conditions ($p < .05$). There were no significant differences for the three-quarter-view composites. However, the difference between the full-face and the three-quarter-view condition approached significance ($p = .065$). No significant differences were observed when both composites were presented, although the trend is clearly in line with the results from Experiments 1 and 2.

So the results are similar to the likeness-rating data in Stage 2 of Experiment 3: for full-face composites, presenting both views of the face at encoding results in better quality composites. For three-quarter-view composites, the quality is poorer when only a full-face has been encoded, with no difference between the three-quarter-view and both view encoding conditions.

General Discussion

The results from both the rating and array tasks indicate that a full-face composite represents a better target likeness when a (participant) witness has encoded all views of the face (cf. full-face or three-quarter-view encoding). While there was no increase in performance from three-quarter-view to all-views encoding for three-quarter-view composites, performance was still high and there was a marked increase for the full-face composites. The results also suggest that when a witness has encoded a three-quarter view, performance will be better for construction of a three-quarter-view rather than full-face composite. Curiously, construction of a full-face composite is inferior when a full-face view has been seen (cf. all views).

The advantage of three-quarter-view composites in the three-quarter-view encoding condition provides initial support for the encoding-specificity principle (e.g. Tulving and Thomson, 1973). However, such an advantage was not the case for full-face composites. Also, similar performance of three-quarter-view composites in both three-quarter and all-view encoding conditions indicates that similar information was encoded from both encoding presentations. This appears to provide support for the symmetry argument proposed by Vetter et al. (1994): learning one view of a bilaterally-symmetrical object can be sufficient to generalise to other views; as a face is generally bilaterally symmetrical, then a side view (non-singular) may contain enough information to generalise to other views. The results from Experiment 1 also support this research by indicating that when all views of a face are presented, no one view is preferred (similar results were obtained by Hill et al., 1997; Schyns and Bülthoff, 1994). However, if the symmetry argument is correct, then performance of the full-face composites should have been higher when a three-quarter-view had been encoded. In Experiment 3, performance was indeed slightly higher in the array task; however, likeness ratings provided support for the encoding-specificity principle: full-face composites were better for full-face (cf. all-views) encoding. Therefore, the pattern of results obtained for full-face composites are not explained well by either the encoding specificity principle or the symmetry argument.

Previous research has utilised various recognition tasks and the different findings in these experiments may reflect qualitatively different task demands. Composite creation is a reconstruction task where participants need to recall individual features and recognise whether presented features ‘match’ features represented in memory. It is unclear at this stage whether face recall and recognition is a continuous process, and what effect this has on constructing composites in differing views. Further research needs to be undertaken to examine this issue.

Experiments 2 and 3 suggest that when more information is provided at the composite-evaluation stage, performance increases. This increased performance for presenting two views of a face is only observed when both composites have been constructed (cf. when one of the pair has been generated automatically). This supports previous research (e.g. Brace et al., 2006; Bruce et al., 2002) by suggesting that presentation of varied information increases identification. Several experiments (Ness, 2003) have found that simply presenting more information does not increase identification (i.e. presentation of more than one composite by the same participant in the same view). This may explain the poor performance for presenting a full-face composite with a very similar automatically-generated three-quarter-view.

To conclude, the theoretical issues surrounding viewpoint dependency and encoding specificity in a composite construction task need further research. The practical implications of the current research, however, are important. While standard full-face composites using PRO-fit perform well when all views of the face have been encoded, care should be taken when a person has only seen one view. When a witness has seen a side view of a suspect, results indicate that a three-quarter-view composite should be constructed. Also, it would be beneficial for a witness to construct two composites of a suspect, one in full-face view and one in a three-quarter-view, particularly when the witness has only seen one view.

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