The Influence of Holistic Interviewing on Hair Perception for the Production of Facial Composites

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Abstract

There is mounting evidence to suggest that the external features of a person face—shape, ears and, in particular, hair—exert a detrimental effect on the construction of a facial composite. The effect was first demonstrated for EvoFIT, a software system whereby constructors repeatedly select whole faces from arrays of alternatives, with 'breeding', to 'evolve' a face. In research by Frowd and Hepton (2009), volunteers saw a target face and, 24 hours later, were interviewed to describe the face in detail and then used EvoFIT in one of two ways: constructors saw face arrays containing hair that was either similar-to or exactly-matched hair on a target face. The study found that using exactly-matching hair promoted much-more identifiable composites than using similar hair. More recent research, however, has found that system performance is improved following use of a novel interview given to constructors. This holistic-cognitive interview prompts constructors to recall the target face in detail and then make seven personality-type judgments about it, with the aim of improving their face-recognition ability and thereby produce a better-quality composite. In the current research, we carried out a partial replication of Frowd and Hepton using the holistic-cognitive interview. It was found that identification of composites constructed in this way did not differ significantly by type of hair, and so the enhanced interview appears to mask inaccuracies in presented hair, promoting more identifiable images. Theoretical implications of the research are discussed for EvoFIT along with other system developments that have focused on the potential influence of hair.

Keywords: *EvoFIT, holistic-cognitive interview, facial composites*

1. Introduction

Law enforcement often rely on witnesses and victims to produce a picture of a criminal they saw commit a crime. These pictures are known as facial composites and are used to locate the whereabouts of the person who committed the offence—police normally publish such images in newspapers and on TV crime programmes so that a member of the public will recognize the face and contact them with a name. There are various methods to produce facial composites including pictures from a sketch artist and from 'feature' composites made by eyewitnesses selecting individual facial features: eyes, hair, nose, mouth, etc. Both of these construction techniques, however, do not typically promote identifiable images (e.g., Frowd et al. [1]-[5], Koehn & Fisher [6]). In addition, there are 'evolving' systems that involve eyewitnesses repeatedly selecting from arrays of complete faces, with 'breeding', to 'evolve' a face. Since these methods have been designed to copy the way we normally recognize faces, as wholes [7]-[8], they have the potential to produce more identifiable faces. For the past 13 years, we have been intensively developing one of these evolving software systems, EvoFIT—for examples, see Frowd et al. [9]-[16]; see also [17] for a recent overview of EvoFIT and [18]-[19] for examples of other evolving-type systems.

As described in Frowd et al. [14], at the heart of EvoFIT is a face generator, built using the statistical modeling technique Principal Components Analysis, that can randomly generate high-quality faces of a given age, race and gender. People building the face—face 'constructors'—normally select a given set of external features (hair, ears and neck) to apply to each generated face. They are next shown screens of random faces, selecting first for shape information in the face and then for texture information—an example of a typical array presented to face constructors can be seen in Figure 1. The aim is for selections to be made on the basis of the complete face, rather than on individual facial features, given evidence to suggest that we naturally see faces in a holistic way (e.g., [7][8]). Selected items are 'bred' together, to produce further choices for selection, achieved through proportional-selection fitness of the selected items and uniform cross-over of the underlying face parameters; mutation is also applied to 10% of combined coefficients in an attempt to maintain variability in the population of faces. Further, at the end of the initial generation, constructors select the best-matching face, an individual that is both given twice the number of breeding opportunities (i.e., increased selection pressure) and carried forward unaltered into the next generation as part of an 'elitist' strategy. After a single cycle of breeding, the constructor selects a best likeness, a face which is then enhanced using 'holistic' tools to improve perceived age, health, masculinity and other overall attributes of the face [15]. Further software tools are applied as required to manipulate shape and position of individual features.

Frowd and Hepton [23] also explored the impact of external features on face construction using EvoFIT. They found that identification of composites produced with poorly-matching hair—a different style or length with respect to the target—was very low indeed, but identification was much better when hair was a good match to the target: identification was even better when hair matched exactly, by presenting the actual hair seen on the target. They demonstrated then that hair was an important factor to the person constructing the face and that more accurately-matching hair promoted more identifiable composites.

A second important factor for producing an identifiable image is the type of interview eyewitnesses receive prior to using a composite system. For traditional feature systems, the interview typically involves eyewitnesses describing the face in as much detail as possible, without guessing and without interruption. This 'free' recall is normally followed by a 'cued' recall phase whereby they are asked to recall more information about each individual feature—hair, eyes, nose, ears, etc. The aim here is that the description is valuable to the person controlling the composite system—typically a police composite-officer—, to help them locate individual facial-features within the system for presenting to the eyewitness. This type of cognitive interview has also been used with EvoFIT both in the laboratory for system development (e.g., Frowd et al. [24]) and for police forces to use with witnesses and victims of crime (e.g., Frowd et al. [1]).

This type of interview, however, has considerable focus on individual facial-features, and so is at odds with the way we naturally recognize faces, as wholes—indeed, recent work has shown that this type of interview interferes with our ability to construct feature-based composites [21]. It is for reasons such as these that we ask constructors using EvoFIT to choose faces that are *overall* similar to the target face (or offender) and not faces that may have a single feature that is similar to the target's. The potential problem is that thinking about a target face in terms of its individual features can still carry over to the selection of faces from EvoFIT face arrays, reducing composite quality. We have developed a new interview to overcome such an issue. It is called the holistic-cognitive interview (H-CI) and requires constructors, after describing the face by free and cued recall, to think about the personality of the face and then make seven whole-face judgments about it: for example, constructors are asked to estimate, among other things, how masculine, healthy and attractive the target face appeared. Carrying out this additional procedure encourages holistic- rather than feature-based processing for composite construction. The H-CI has been shown to be very effective for a feature system [28] and more-recently for EvoFIT [24].

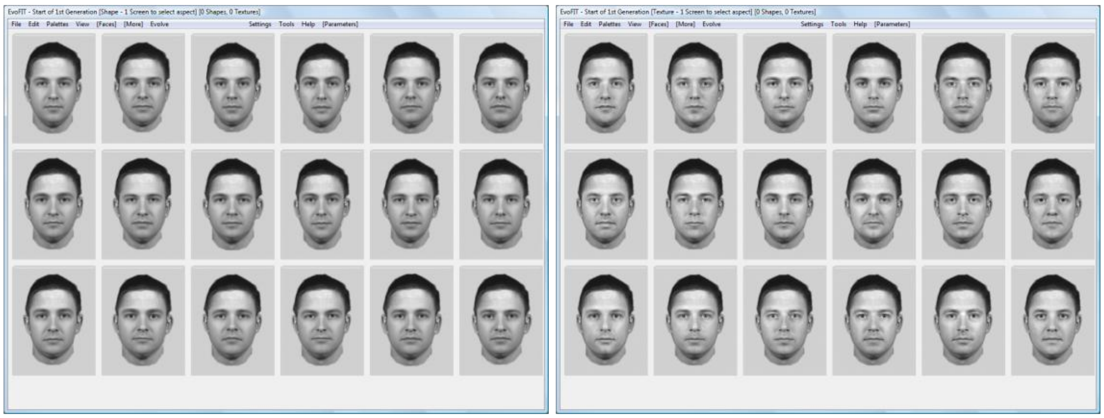

Figure 1. Example EvoFIT face arrays used in the current study; in the first generation, faces were presented with random characteristics. Constructors first select from such arrays of facial shape (left) followed by facial texture (right). In the second generation, faces were presented based on constructor's choices made in the first generation (as part of 'breeding'). See Discussion for alternative methods of presenting faces to constructors (using blurring or masking of external features).

In the current work, we asked the question whether face constructors would still produce more identifiable images using exactly-matching compared to similar-matching hair when a holistic-cognitive interview was used (i.e., in the previous research by Frowd and Hepton [23], the interview involved just recalling the face in detail using a cognitive interview). To answer this question, we recruited two groups of volunteers (also known as *participants*). One group was shown an unfamiliar target face and constructed a single EvoFIT composite the following day using either similar or exactly-matching hair in the face arrays. All participants received an H-CI before constructing the face. A second group was shown the faces that had been constructed and were asked to name them. We expected use of exactly-matching hair to again yield more-identifiable faces than use of similar-matching hair. Details of this psychological study, organized into face construction and face naming stages, are presented below. The results were expected to inform of best practice for using EvoFIT.

2. Constructing the Composite Images using EvoFIT

2.1. Participants

Twenty-four participants volunteered to construct the composites. They were sampled fairly-widely from the area of Stirling, UK, and their ages ranged from 25 to 45 years with an average age of 41.6 years. Participants were sampled opportunistically. Twelve constructed a face using exactly-matching hair (to the target) and 12 using similar-matching hair.

2.2. Materials

The targets were 12 current pop stars, six male and six female, a sufficient number in total, as found in past research (e.g., [23]), to give good experimental power to investigate the proposed effect of hair. Two different photographs of each celebrity were obtained from the Internet. One photograph depicted the face in a frontal pose with good lighting and was generally unsmiling—these images were used for face construction. The other photograph was similar but displayed the face a different pose—used for face naming. Hairstyles varied across the set by length, colour and style. None of the targets wore glasses, hats or any other accessory that occluded the hair. Males were clean shaven or had minimal stubble. The target photographs were reproduced in colour to a size of 6cm (wide) x 8cm (high).

The 12 celebrity photographs in frontal pose were converted to greyscale. The accurate hairstyles from these photos were transferred into EvoFIT. A further 12 styles were selected, as nearest matches to these hairstyles in the current EvoFIT system. Image sets were created off-site to facilitate a double-blind study—that is, neither experimenter nor constructor (participant) knew which hairstyle was being used in the construction of the composite. Furthermore, the experimenter was unaware of which target the constructor had selected.

EvoFIT version 1.3 was used to construct the composites.

2.2. Procedure

Participants were tested individually. The 12 target photographs were constructed once by a participant who constructed the face using similar-looking hair and once by a second person using accurate hair; selection of participants to targets was random. A participant selected a target photograph at random from the set and confirmed that the face was unfamiliar (if the face was familiar another photograph was selected randomly; this was repeated until an unfamiliar face was located). The person then studied the picture for 60 seconds.

The experimenter met with the constructor between 22 and 26 hours later. She first administered a holistic-cognitive interview, as described in Frowd et al. [28]. This involved participants describing the target face in as much detail as possible, but without guessing, and recalling more information through 'cueing' of each facial feature. Next, with the aim of improving constructors' face-recognition ability, they then thought to themselves about the personality of the face, silently for one minute, and then made seven overall (holistic) judgments about the face—these judgments were intelligence, friendliness, kindness, selfishness, arrogance, distinctiveness and aggressiveness Judgments were made using a three point scale of 'low', 'medium' and 'high'. When completed, the session moved onto face construction using EvoFIT.

Next, EvoFIT was run and hair selected for the relevant target and condition with which the participant was assigned (similar- / exactly-matching hair). All faces presented were given the selected hair in subsequent face arrays. Constructors were first shown a screen of 18 faces and they selected a single a face that had the most appropriate aspect ratio—a best match for height and width with respect to the target's. Once selected, a further three screens of facial shape were presented, images that varied by shape and position of individual features, and head shape. Constructors were required to select two different faces from each screen that looked overall like the target. On a fourth screen, they were asked to make alternative choices and then select a 'best match' face. Facial textures were then generated with this preferred facial shape.

Constructors were presented with three screens of 18 textured faces—images that varied by greyscale colouring of eyes, brows, mouth and overall skin tome—and were asked to select faces from four screens, the same as for shape. Combinations of selected shape and texture were presented next over two screens and constructors selected the best overall likeness. All selected items were then bred together and the procedure repeated for selecting shape, texture and combinations. The resulting best face was enhanced using holistic and shape tools. The holistic tool contained 19 scales that were used to improve a range of properties of the face including perceived age, pleasantness, masculinity and honesty. The shape tool was used to manipulate shape and position of individual features. Once constructors had achieved the best likeness they thought possible, resulting composites were saved to disk. Testing sessions lasted approximately 30 to 40 minutes. Example composites are presented in Figure 2.

Figure 2. Example EvoFITs produced by different constructors in the study. Both are of the pop singer, Pink. The image on the left was produced using hair that exactly-matched the target's hair; the image on the right, using hair that was a similar match. For the composite-naming stage, images were presented to participants with external parts of the face blurred, as illustrated here, to limit recognition being cued by hair.

3. Evaluating the quality of the composites by naming

Participants first evaluated the quality of the composites by attempting to name them; we refer to this procedure as un-cued or *spontaneous* naming. Participants were then presented with the target photographs and asked to name them, as a check that they were familiar with the relevant celebrities. To provide more data for analysis, thereby increasing statistical power, participants were asked to name the composites for a second time, in a procedure which we refer to as 'cued' naming.

3.1. Participants

Twenty young-adult participants, aged between 19 and 25 years, volunteered to name the composites. They comprised an opportunity sample drawn from staff and students at the University of Stirling and Forth Valley College, UK. Ten participants were presented with 12 composites from one naming booklet and the other ten presented with 12 composites from a second booklet (details below).

3.2. Materials

Composites were prepared for naming as follows. First, to ensure that naming did not favour composites showing exactly-matching hair, we replaced hair on images created with similar hair with the relevant hair in the exactly-matching condition—thus hair did not change for the two composites created (by different constructors) of the same identity. Second, to further limit naming based on hair cues, external features were filtered using Gaussian blur (8 cycles per face width) on all composites, as is illustrated in Figure 2.

The 24 composites were split equally into two booklets, each containing six composites created using exactly-matching hair and six created using similar hair: we refer to these below as Book 1 and Book 2. As described in Section 2.2, the photographs used for target naming were different to the photographs used for composite construction; in this part, photographs depicted head angle that was not frontal, to limit participants making naming decisions based on specific properties of the picture in cued-naming—for a discussion of this issue relevant to face recognition, see [26].

3.3. Procedure

Participants were tested individually and informed that they would be shown composites of famous, current pop stars and that they should attempt to name as many as possible. Each person was presented with 12 composites, sequentially, from either Book 1 or Book 2, selected randomly with equal sampling. Each person provided a name as requested (for spontaneous naming). Afterwards, the target photographs were presented sequentially and participants also asked to name those. Finally, the composite images were presented again, in the same order as before, and participants were given another opportunity to name them ('cued' naming). Answers from participants were recorded as positive identification (correct name given), false identification (incorrect name) or non-name (unknown). Each person was given a different random order of presentation for composites and target photographs.

3.4. Results

The first analysis examined correct naming of target photographs. Across participants, targets were named 57.1% correctly for exact hair and 63.0% for similar hair. This difference was not significant in a two-tailed paired-samples t-test [$t(19) = 1.1$, $p = .297$]. This analysis indicates that participants were equally familiar with targets in both conditions (if they were not, then composite naming would have been affected in the same way).

Composite accuracy for each participant was calculated as the average number of positive identifications (correct names) minus the average number of false identifications (incorrect names). This measure of discrimination was calculated for both spontaneous and cued naming tasks. Figure 3 illustrates that, for both tasks, there was, on average, more false than correct identifications—hence the negative mean scores (see the following Discussion for interpretation of these negatively-signed data). Note that, for this metric, less negative scores indicate better-quality composites. It can also be seen that, contrary to expectation, face arrays presented with similar hair yielded more identifiable composites than face arrays with exact hair.

These data were subjected to Repeated-Measures Analysis of Variance (RM ANOVA) with factors of hair type seen in the arrays (similar / exact) and naming type (spontaneous / cued). This analysis was not significant for naming type [$F(1,19) = 0.8$, $p = .558$], task type [$F(1,19) = 2.0$, $p = .169$], and for the interaction between these two factors [$F(1,19) = 0.0$, $p = 1.0$]. We note that separate analyses were carried out for positive and for false identification with the same overall result for hair type. For brevity, these analyses are omitted.

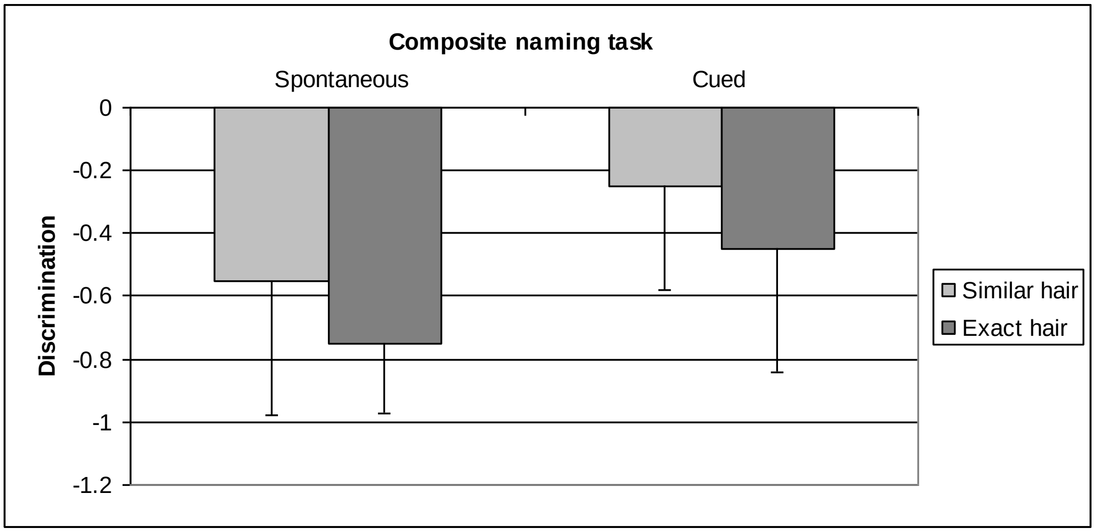

Figure 3. Discrimination of the composites constructed using hair (in the EvoFIT face arrays) that was a similar or an exact match to the target's hair. Using this measure, more positive values indicate better-quality composites.

4. Discussion

Producing a recognizable face from the memory of a witness or victim can provide law enforcement with valuable intelligence to locate the whereabouts of an offender. The traditional approach to construct a face involves eyewitnesses selecting individual facial features, but this rarely produces good-quality images (e.g., Frowd et al. [3][4]). One aim of EvoFIT has been to create an identifiable image, to maximize the effectiveness of the system for law enforcement to detect offenders. This aim has manifested into a system whereby eyewitnesses can construct a composite with identifiable internal features—the region in the centre of the face containing eyes, nose, mouth, etc. which is important for recognition by another person (e.g., Ellis et al. [20]). Thirteen years of intensive research has yielded a composite that other people are able to name well (e.g., Frowd et al. [27]), thus providing value for law enforcement.

The current EvoFIT approach is based on repeated selection and breeding of whole faces from arrays of alternatives. What is apparent from past research, however, is that the exterior part of the face presented to constructors has an impact on the quality of their final image. Frowd and Hepton [23] found that presenting very accurate hair (extracted from the target picture) in the face arrays led to much more identifiable images than presenting similar hair. While use of such accurate hair represents an unrealistic situation, since an image of an offender's hair is normally not available for face construction, their work illustrates that fairly-minor differences in hair can exert a large impact on the person building the face. In the current work, we replicated this part of their experiment, except that constructors were given a more recent type of interview prior to constructing the face, the holistic-cognitive interview (H-CI). It was found that the H-CI removed any advantage conveyed by the use of accurately-matching hair: exact and similar hair promoted composites of equal quality.

The current work provides further indication that the initial interview has an impact on face construction (i.e. here, differences in hair did not have an impact on composite quality, unlike Frowd and Hepton [23]). There is already evidence that the 'holistic' interview (thinking about the face as a whole and then making seven holistic-type judgments) when it follows a face-recall interview improves the quality of a constructor's composite (relative to when face construction follows just face-recall) both for a feature system [28] and for EvoFIT [24]. Also, without the use of a holistic interview, users are sensitive to differences in hair, as found by Frowd and Hepton [23]: with holistic interviewing, differences in hair have less impact. While it would be appropriate to manipulate both interview (CI / H-CI) and hair type (similar / exact) within the same experiment, to replicate our findings as part of follow-up work, the suggestion from the current study is that improving a constructor's face recognition ability through the H-CI is a useful procedure. In particular, the H-CI may be shifting a constructor's focus of attention towards the central part of the target face; in doing so, hair may be generally less noticeable, leaving constructors better-able to focus on the important central part of the face in the presented arrays.

There are other ways that influence of hair can be reduced. In Frowd et al. [10], we demonstrated that presenting EvoFIT face arrays with external-features blurred substantially improved a person's ability to produce an identifiable image (blurring was also used for the naming part of the current experiment, which is discussed further below). The level of blurring used was 8 cycles per face width, a setting which is known to render recognition difficult if extended across the entire face (e.g., Thomas & Jordan [25]). Once the face is evolved, blurring is disabled, to allow the face to be seen intact, for enhancement with the tools mentioned above and for saving to disk. Frowd et al. [16] has since replicated the advantage of external-features blurring for EvoFIT.

In a follow-up experiment, Frowd et al. [27] used infinite blurring in the face arrays—image filtering that essentially masks (removes the presence of) external features—and this led to composites that were about twice as identifiable as using the previous, 'high' level of blurring: correct naming increased from 25% to 45%. The work shows that, far from being useful, external features are a distractive influence to the person building the face. The improved interface using 'internals-only' construction appears to generalize outside of the laboratory since police officers given this version of software report a marked increase in the number of EvoFIT composites named—Frowd et al. [29]. Ongoing research also indicates benefit of external-features masking for face construction using traditional feature systems.

So, while blurring of external features is perhaps not the best procedure to use with eyewitnesses for face construction, could it be used in some way at a later stage in the process, for instance when people attempt to recognize the composite? In the current work, we did just this: presenting composites for participants to name with the external part of the face blurred. This was done to minimize naming being influenced by accuracy of hair, which we know it can (e.g., Frowd et al. [27]). The approach led to some difficulty in correctly naming the composites and is perhaps the reason for mean negative rather than positive discrimination scores in Section 3.4. However, the general approach may have a practical application since criminals sometimes attempt to conceal their identity by changing style, colour and/or length of their hair before or after committing a crime. In this case, a composite made of them may therefore not reflect their current appearance, potentially limiting identification, and so blurring the outer region of their composite (to some extent) may limit the impact of changes to hair. Current research is exploring this issue.

4. Conclusion

Our aim is to explore methods for producing recognizable faces from human memory. One of the key factors modulating ability to do this is the external parts of the face—face shape, ears, forehead and, in particular, hair. We have demonstrated in the current work that effects caused by variations in hair presented to constructors are minimized with the use of a new face-recall interview that focuses a constructor's attention on the target face as a whole (rather than on its individual facial features). More recent research indicates that face construction is best achieved in the absence of external features: only when the internal part of the face has been finalized is the external part selected and seen. Future work is exploring the potential value of blurring the external features in a finished composite, when members of the public attempt to recognize the image, to compensate for changes a criminal may have deliberately made to this region of his or her appearance.

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