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Research into witness identification images typically occurs within the laboratory and involves subjective likeness and recognizability judgments. This study analyzed whether actual witness identification images systematically alter the facial shapes of the suspects described. The shape analysis tool, geometric morphometrics, was applied to 46 homologous facial landmarks displayed on 50 witness identification images and their corresponding arrest photographs, using principal component analysis and multivariate regressions. The results indicate that compared with arrest photographs, witness identification images systematically depict suspects with lowered and medially located eyebrows (p=

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Police Witness Identification Images: A geometric morphometric analysis

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Abstract

Research into witness identification images typically occurs within the laboratory and involves subjective likeness and recognisability judgements. This study anaylsed whether actual witness identification images systematically alter the facial shapes of the suspects described. The shape analysis tool, geometric morphometrics, was applied to 46 homologous facial landmarks displayed on 50 witness identification images and their corresponding arrest photographs, using principal component analysis and multivariate regressions. The results indicate that compared to arrest photographs, witness identification images systematically depict suspects with lowered and medially located eyebrows ($p=<0.000001$). This was found to occur independently of the Police Artist, but did not occur with composites produced under laboratory conditions. There are several possible explanations for this finding, including any, or all, of the following: the suspect was frowning at the time of the incident, the witness had negative feelings towards the suspect, this is an effect of unfamiliar face processing, the suspect displayed fear at the time of their arrest photograph.

Keywords: forensic science, police composites, facial expression, identification

When a person is a witness of a crime and the identity of the perpetrator(s) is unknown, it is an established practice for appropriately trained police personnel (Police Artists) to work with the witness to produce a likeness of the suspect's head and face. Current practice makes use of computer graphic programs to produce this image, and there are a range of different systems available (*1, 2*). The witness interview is also often conducted as a 'cognitive interview', which is a structured sequence of questioning designed to be compatible with how people mentally store, and recall, human faces (*3*). This research uses geometric morphometric analysis to compare witness identification images with their corresponding arrest photographs so as to identify whether, overall, witness identification images systematically alter the facial shapes of a suspect.

Research into the effectiveness of witness identification images has tended to focus on the comparative benefits of different methods (*1, 2, 4*), including whether it is better to attain an image of a suspect by warping a holistic image of a face rather than building it up from its component parts (*5*), or if the images produced are improved by having a number of witnesses describe a suspect and morphing the results together (*6, 7*). Other research has focussed specifically on witness performance, and examined the level of degradation of memory over time (*8*), if feelings towards the suspect impact on the face a witness produces (*9, 10*), whether returning the witness to the scene of the crime enhances the accuracy of their recall (*11*), if showing a range of composites of the same suspect improves identification rates (*12*), and if witnesses are influenced by discussing their recollection of a suspect (*13*). Within these, and other studies, both the production and evaluation of the 'witness' identification images tends to occur within the laboratory. That is, a volunteer 'witness' describes the face of a celebrity, or is exposed to a photograph/recording or an actual face for a set period of time, and the witness and/or a different group of volunteers evaluate the likeness and/or recognisability of the result (*1, 2, 4, 6, 7, 11*). Common to much of this research is a conclusion that witness identification images tend to be poor representatives of the suspect's face (*14*), and that there is a lot of variation across different Police Artists (or other operators fulfilling this role) as to the perceived quality of the result (*1, 3*).

To date there does not appear to have been much examination of witness identification images produced under the circumstances for which they were designed, which is that of a

victim and/or a bystander recalling and describing the facial features of a perpetrator of a crime. Nor has there been much exploration of the use of geometric morphometrics, which concerns statistical analysis of shape differences and is most typically applied to identifying variance across biological forms. This method of analysis has been applied to 2D images of the face to identify changes to facial shapes due to: variations in head pose (*15*); artistic depiction during realistic portraiture (*16*); individual differences in facial features related to age and sex (e.g. *17*); and as an aid to clinical diagnosis of diseases affecting the shapes of the face (e.g. *18*).

In Australia, the Victoria Police Criminal Identification Squad currently use a system known as F.A.C.E. (Facial Automated Compositing & Editing) for both the production of witness identification images and in enhancing the appearance of forensic facial approximations (*19*). The standard practice for a witness interview is that, following a series of questions designed to enhance recall, the witness is taken through the stages of building up the suspect's face starting with hairstyle and outer face shape, followed by the facial features, all the while having the witness select particular features from a database of facial parts, each of which can be modified to better fit the memory of the witness. Once the image of the suspect is complete to the satisfaction of the witness, it is circulated with the aim of generating leads to apprehending the suspect.

This study presents the results of a geometric morphometric analysis of actual witness identification images produced by five Police Artists from the Victoria Police Criminal Identification Squad during the past five years. The overarching aim of this research was to see whether, overall, witnesses identification images systematically alter the face of a suspect. The expectation was that, based on anecdotal evidence in the literature concerned with both portrait and forensic depiction (e.g. *3, 20*), there would be a tendency for witnesses to exaggerate certain known salient features, such as eye size (*21, 22*). Two main sub-questions (both provisionally indicative given the relatively small size of the sample) was whether each of the five Police Artists had a discernable style that affected the overall result, and if actual witness identification images differ from those produced by a different Police Artist under laboratory conditions.

Methods

Each of the five Police Artists who volunteered to be involved in this project selected witnesses identification images according to sex and population affinity (male, European), whether there was a subsequent arrest image of the suspect (and it must be noted that in some cases this may not be the same individual as described to the Police Artist), the clarity of the facial features displayed in both images (e.g. the face and its features were not obscured by glasses, facial hair, etc.), and that the witness identification image was, in their opinion, appropriately representative of the quality of their work. Although this selection process introduces a subjective bias into the sample, this study evaluates, as a sub-question, the impact of each of the five Police Artists' style, which necessarily includes the influence of each individual Police Artist's selection.

The main image set numbered 100 (50 witness identification images, 50 corresponding arrest images). Each image was de-identified, and coded according to the age of the suspect, the crime committed, the age, sex, population affinity of the witness, the experience of the Police Artist, the length of time between the crime and the witness description, and the length of time between the circulation of the image and the apprehension of the depicted. All suspects selected were male and of European population affinity, with an average age of 24.4 years. The witnesses (20 female, 30 male, average age 31.5 years) were also mostly European (40), with the remaining population affinities being Asian (5), Indian (3), African (1), and Middle Eastern (1). One of the five Police Artists was female, all were of European population affinity, and the average level of experience was 141.8 months at the time of the interview (range 4-254 months). The crimes included, in order of frequency: armed robbery (9), burglary (9), aggravated burglary (8), robbery (8), assault (3), indecent assault (2), rape (2), theft (2), attempted burglary (1), blackmail (1), deception (1), indecent act (1), serious assault (1), wilful and obscene exposure (1), and there was one case of false imprisonment. Most of the witnesses were victims (n=43). On average, the interviews were conducted 7.7 days after the incident, with most occurring within three days (n=30). The suspect was arrested, on average, 32.3 days after the witness identification image had been circulated, with most arrests occurring within 2 weeks of the witness interview (see Table 1).

The set of laboratory 'witness' composite images were produced by a different Police Artist of comparable age and experience (European male, 38 years, 120 months experience) from

the WA Police Forensic Imaging Unit, and at the time of the image production this Police Artist was unaware of the existence of this study. The laboratory 'witnesses' and 'suspects' were also unaware of this study, and comprised volunteer staff and postgraduate students drawn from the School of Anatomy and Human Biology, University of Western Australia (Ethics approval University of Western Australia's Human Ethics Committee for the use of all volunteers in this study: Ref RA/4/1/1518, including the right to reproduce images). Each of the laboratory 'witnesses' (4 females, 3 males, mean age 45 years) described a different volunteer male colleague (7 males of European population affinity, mean age 51.7 years), with the laboratory 'witnesses' having known the colleague they were requested to describe for an average period of nine years (minimum 2 years, maximum 28 years). The laboratory 'arrest' images were achieved by photographing the volunteer 'suspects' in a neutral pose analogous to a "mug shot".

Once the database had been established, each image was analysed using geometric morphometrics. Geometric morphometric analysis identifies changes to biological shapes, such as the human face, by comparing a suite of homologous facial landmarks. Previous studies (*15, 16*) have established a set of reliable landmarks (n=46) specifically designed to deal with different images of the face as it is depicted in 2D (see Figure 1 and Table 2), and these were recorded on each image using the computer software TPSdig (*23*). The computer program *morphologika2* (*24*) was used to compare these landmarks as they occurred on the different individuals, and between the different image types, to identify both the patterns of shape change and the comparative size and significance of this change (variance). In order to account for differences between the images regarding orientation and scale, *morphologika2* includes the option to subject the images to Procrustes registration (each suite of landmarks are scaled, and rotated, for comparable fit) before performing the Principal Component analysis. Further applications provided by *morphologika2* and used in this study are covered in the Results.

Results

In order to more clearly identify shape changes occurring between the two image types (arrest photographs and witness identification images), each image type was first analysed independently. Once the image types had been compared these were then analysed according

to individual Police Artist to account for any influence of individual style or image selection. Finally, each image type (witness identification image and arrest photograph) was compared to the 'witness' composites and 'mug shots' produced under laboratory conditions.

Arrest photographs

In a geometric morphometric analysis the largest variance is captured by the first Principal Component (PC1), with all subsequent PCs showing shape differences that are independent of the PCs which precede them. When just the arrest photographs were analysed (n=50) the largest variation in overall facial shape was due to the habitual head pose displayed by the suspects, and as can be seen in Figure 2, this was primarily the extent to which the photograph showed the suspect with an upwards or downwards head pitch (PC1 accounts for 43.7% of the overall variance). There was no significant relationship between the age of the suspect and their particular head pose, and a multivariate regression using age as the independent variable showed that the age of the suspect accounted for 4% of the overall variance and was not statistically significant ($p=0.13$). As can be seen in Figure 2, the differences in the suspects' facial shapes that are related to age are that the younger males display a fuller lower lip, a narrower jaw and a lower chin height.

Witness identification images

Analysis of the witness identification images in isolation (n=50) also showed an impact of head pose on the facial shapes, though this was less than that displayed within the arrest photographs (PC1 23.6% variation). Age differences accounted for 2.2% of the overall variance between the images, were not statistically significant ($p=0.6$), and as can be seen in Figure 3, follow a similar, but reduced, age related pattern as that displayed in the photographs (lip fullness and jaw width).

Overall differences between the arrest photographs and the witness identification images

Both the witness identification images (n=50) and their corresponding arrest photographs (n=50) were entered into *morphologika2* as a single data file. As with both the arrest photographs and the witness identification images, PC1 indicated that individual differences

in head pose predominated, with PC1 accounting for 35% of the variance. Therefore two multivariate regressions with image type as the independent variable were performed. The first multivariate regression included PC1, while the second excluded PC1. The results were very similar, with both multivariate regressions showing that the difference between the image types accounted for 3.9% of the variance, and both were statistically significant ($p<0.000001$). Only the results which excluded PC1 (differences due to head pose) are shown here (see Figure 4).

The main differences between the images types principally involved the shape of the suspects' eyes and brows. In order to more clearly visualise shape changes (in this instance whether the image was an arrest photograph or a witness identification image), *morphologika2* performs a thin plate spline analysis (TPS), and allows the results to be exaggerated to a chosen factor (2-8 times). In Figure 4, the TPS analysis has been exaggerated to a factor of four, and this more clearly illustrates that the witness identification images predominantly differ from the arrest photographs in lowering the eyebrows and shifting them medially.

Style of the Police Artist

A separate analysis was undertaken for each Police Artist (n=5) by entering the witness identification images they worked on together with the corresponding arrest photographs as a separate file in *morphologika2*. For each Police Artist file a multivariate regression was undertaken with image type as the independent variable. The number of witness identification images varied between the different Police Artists, but for each Police Artist PC1 consistently displayed the main difference between the arrest photographs and the witness identification images to be related to head pose. The extent to which head pose was displayed in the arrest photographs varied, however, as did the extent to which the witness identification images varied, overall, from the arrest photographs (see Table 3). The TPS results of the multivariate regressions are shown in Figure 5, and as can be seen, while only one multivariate regression was significant (PA02: $p=0.02$), there is a tendency for all witness identification images to depict the suspect with the eyebrows more medially located and slightly lowered, though this is less clearly evident with one Police Artist (PA04).

Difference between laboratory and actual witness identification images

A further analysis was undertaken comparing the witness identification images (n=50) with a sample of images produced under laboratory conditions (n=7). A *morphologika2* file was created containing both the actual and laboratory produced witness images (n=57) and a multivariate regression was undertaken with witness type as an independent variable (actual witness, laboratory witness). The results of this analysis show the difference to account for 4.65% of the overall variance, and that this difference is significant ($p<0.001$). As can be seen in the unexaggerated TPS grids displayed in Figure 6, the laboratory produced composites tend to depict the volunteer 'suspects' with their eyebrows in a relatively raised position, and therefore do not conform to the overall pattern displayed by the actual witness images.

To see how the volunteer 'suspects' themselves compared to the actual arrest photographs a separate multivariate regression was undertaken of the arrest images and volunteer 'mug shots' (n=57), with arrest image type as an independent variable (actual arrest image, laboratory 'mug shot'). The results were that 9.34% of the overall difference is due to image type ($p<0.00001$), and that, compared to the actual arrest images, the volunteer 'suspects' tend to display a more turned head, lower medial brow heads, and thinner, closed mouths (see Figure 7). That the mouths of the volunteers are shown to be narrower is likely an influence of age-related factors (25, 26), given the volunteer 'suspects' are, on average, older (mean age 45 years) than the individuals displayed in the arrest photographs (mean age 24.4 years).

Discussion

This study analysed 50 witness identification images against 50 corresponding arrest photographs, all of which were selected by five Police Artists from the Victoria Police Criminal Identification Squad, and all of which involved suspects who were male and of a European population affinity. It should be noted that the photographs of the suspect are arrest, not conviction, photographs and therefore irrespective of guilt or conviction, it could be that the witness was describing a different person. However, the overarching research question was to see whether a geometric morphometric analysis would show that witness identification

images (n=50) systematically alter the faces of the suspects described, and therefore the analyses were not concerned with the one-to-one correspondence between individual pairs of images (as is more often the case in laboratory based studies of 'witness' accounts). To identify any pattern of systematic change, first each image type (n=50) was analysed separately to identify overall face shape patterns, such as the impact of head pose and age related differences. Both image types were then compared to see (a) how the witness identification images differed from the arrest photographs and, (b) if each individual Police Artist had a discernable style and therefore a possible impact on the variance. Finally the witness identification images and arrest photographs were compared to a set of images produced under laboratory conditions (n=7x2), to see if the differences identified also occurred within the laboratory.

Analysing each image type separately showed that head pose was captured by PC1, and accounted for the main difference between individuals depicted in the arrest photographs, and the main difference between individuals depicted in the witness identification images. Age related differences were also present, but these were not significant for either image type, though in the witness arrest images there was a tendency for a reduced variance in head pose and age related differences. Although this reduction in variance may be related to witness recall, a reduction in variance is also a logical outcome of the facial composite image process, as any data base of facial parts will likely have a smaller range of individual differences in facial features than those which naturally occur within a given group of individuals.

While head pose was reduced, that any aspect of head pose was present in the witness identification images was surprising. However, this may be due, in part, to the witness identification images being composed of facial elements drawn from a pooled database of arrest photographs (Victoria Police and Western Australia Police). In a previous study it was found that head pose has a major impact on face shapes in photographs, and in particular outer face shape, with an upwards head pose widening the mid-face and jaw (*15*). It is possible, therefore, that witnesses selected wider mid-faces and jaws from facial composite parts which had been derived from arrest photographs displaying individuals with an upwards head pose.

The main expectation of this study was that witness identification images would tend to exaggerate certain known salient features of the face. This expectation was not supported, although the witness identification images did differ from the suspect arrest photographs in the area of the eyes. That is, the witness identification images differed from the arrest photograph in that the eyebrows were lower and more medially located. This difference was found to occur independently of shape differences occurring with head pose, as similar results occurred when the regression analysis was undertaken both including and excluding the main shape changes due to variations in head pose (PC1). The analysis which compared Police Artist style/selection, while tending not to reach statistical significance due to the sizes of the samples, nonetheless indicated that depicting the suspect with brows that are lowered and shifted medially occurred independently of the Police Artists involved. Finally, the analysis which compared a set of laboratory produced images (n=7) to the actual witness identification images showed that the laboratory produced 'witness' images did not tend to display the volunteer 'suspect' with lowered and more medially located brows.

It could be that the effect of lowered brows in witness composite images is an artefact of the composite system, and not a systematic pattern related to witness descriptions of suspects. When witnesses are describing a suspect to a Police Artist, they select what they perceive to be the best match of eyes and eyebrows as a complete facial segment, and this segment is entered into the evolving 'face' of the suspect. Although this initial placement may contribute to the effect observed in this study, four factors suggest this is not likely to be the case. Firstly, witnesses select the eyes and eyebrows as a segment, not separately, and the eyebrow lowering effect identified here is in relation to the eyes, not the face. Secondly, the eye-eyebrow segments are drawn from a database of arrest images, and this analysis has shown that compared to composite images, the arrest images, overall, do not tend to display suspects with medially lowered brows, and therefore this effect is unlikely to be an inherent feature of the arrest image component parts. Thirdly, once all the facial segments are entered into the composite 'face', the Police Artists take direction from the witness to alter the features (such as raising or lowering the eyebrows) to better fit with the witness' recollection of the suspect. Finally, although only a small sample of laboratory produced images (n=7) were compared to

actual witness composites (n=50) examined in this study, the results indicate that laboratory produced images do not, compared to actual witness identification images, display the volunteer 'suspect' with lowered brows.

Eyebrows that are located both medially and downwards are associated with the facial expression of frowning, and involves movement of the corrugator supercilii and the orbicularis oculi *(27)*. Frowning is understood to be one of the clearer indicators of negative emotions *(28)*, but may also be present when an individual is engaged in a task requiring physical effort *(29)*. It is not unreasonable to assume that the real witnesses involved in this study may have observed the real suspect bearing this facial expression, as many of the incidents would likely have involved the perpetrator expressing negative emotions and/or experiencing some degree of physical effort. However, it is also possible that the witnesses may have invoked this facial expression, particularly if they were the victim of the observed incident. This is related to the laboratory based findings that laboratory 'witnesses' will depict a 'suspect' bearing more negative traits if they are informed that the 'suspect' is a murderer (*10*), and frowning is one of the clearer ways of displaying a negative emotion.

It is also possible that the findings of this study could be related to differences in unfamiliar and familiar face processing. Research has shown that considerable difficulty is experienced by volunteers when asked to perform a simple face matching task involving unfamiliar faces under optimal viewing conditions *(30)*, and that in contrast familiar faces are relatively easily recognised from very low resolution images *(31)*. Therefore, it is possible that the findings of this study may be due to differing cognitive processes, given it concerns actual witnesses describing an unfamiliar face, and a small number of laboratory 'witnesses' describing a very familiar face. In other words, it is possible that describing a face with medially and downward placed eyebrows is an effect of unfamiliar face processing.

A further possibility is that the results of the geometric morphometric analysis have been influenced by the facial expressions captured by the arrest photographs. While, as has been suggested, it is not unreasonable to assume a perpetrator of a crime may frown during the

incident, and/or that a witness may invoke the negative facial expression of frowning onto a person who has victimised them, it is also not unreasonable to assume a suspect will display a different facial expression during the time of their arrest photograph. When the TPS grid showing how the arrest photographs differ from the witness identification images is examined (refer left image, Figure 4), the major changes involve raising the eyebrows and shifting them laterally. Paying attention, and the emotional displays of surprise and fear may all involve an elevation of the eyebrows, but unlike frowning, the emotional displays of fear and surprise also typically involve opening the mouth (*32*). As can be seen, there is some indication on the TPS grid that the arrest photographs tend to display a mouth that is more opened than the witness identification images (see Figure 6), and this characteristic is more evident when the arrest photographs are compared to the volunteer 'mug shots' (see Figure 7). It is possible, therefore, that the arrest photographs depict the suspects displaying some level of fear and/or surprise, which is largely an inversion of the facial expression of frowning. Given that it is most likely that some time had elapsed between the apprehension of the suspect and the taking of the arrest photograph, fear is the more probable of these two facial expressions of emotion. Therefore, the effect of the composite images displaying lowered and medially located brows may have more to do with the facial expressions displayed in the arrest photographs than those displayed in the witness identification images.

This study found that a group of witness identification images (n=50) appear to systematically differ from the facial appearance of the suspects. When these witness identification images were compared with the arrest photographs of the suspects, this geometric morphometric analysis found that the witness identification images tended to depict the suspect with their eyebrows lowered and more medially located, which is associated with the facial expression of frowning. Further, it appears that that this tendency occurs independently of the Police Artist involved in the process, and does not tend to occur when volunteer 'witnesses' describe a colleague under laboratory conditions.

We suggest four possible explanations for witness identification images being found to depict the suspect with a frowning facial expression, and these are summarised as follows:

1. The witnesses were recalling the face of a suspect involved in a criminal incident, and it is possible that the suspects were frowning at the time, either due to some degree of physical effort and/or in a display of negative emotions towards the witnesses;

2. The witnesses had negative feelings towards the suspects, and therefore, as has been suggested in other studies, tended to recall, and depict, the suspects with negative facial expressions – the clearest of which is frowning;

3. Describing a suspect with a frowning facial expression could be an aspect of unfamiliar face processing;

4. The suspects may have displayed fear (or a related expression) at the time of their arrest photograph, which raises the eyebrows, opens the mouth, and is largely an inversion of the facial expression of frowning.

In support of the explanations proffered here there is some suggestion in our analysis that laboratory witnesses who have not witnessed an actual suspect, do not tend to depict the volunteer 'suspect' with lowered brows, and that volunteer suspects also do not tend to display raised brows or slightly opened mouths in their 'mug shots'. However, as this comparative study only involved fourteen volunteers, further research would need to be undertaken to verify this apparent difference. It should also be noted that the possible explanations listed above are not mutually exclusive, and that our findings could be due to the suspect frowning at the time of the incident, the victim having negative feelings towards the suspect, the witness describing an unfamiliar face, and the suspect experiencing some level of fear at the time their arrest photograph was taken.

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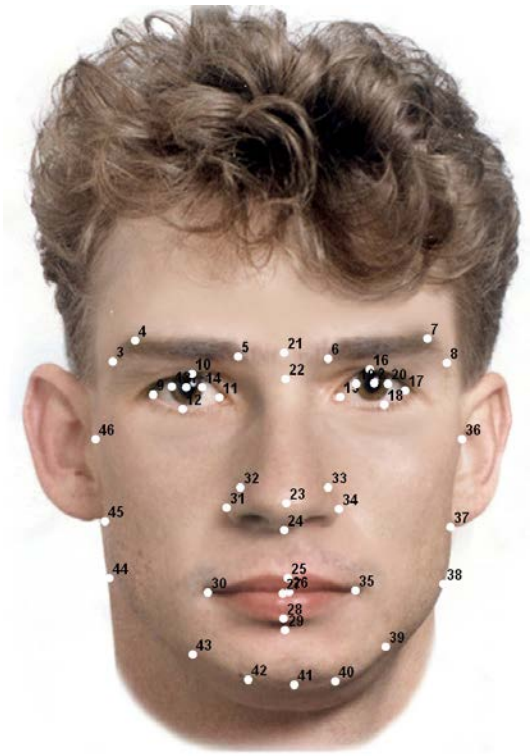
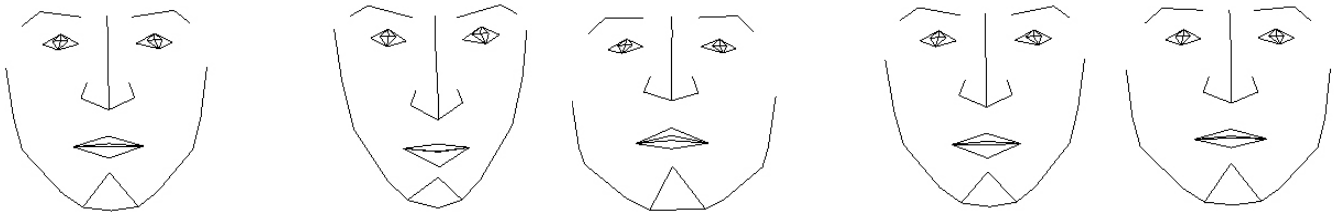
Figure 1: The facial landmarks



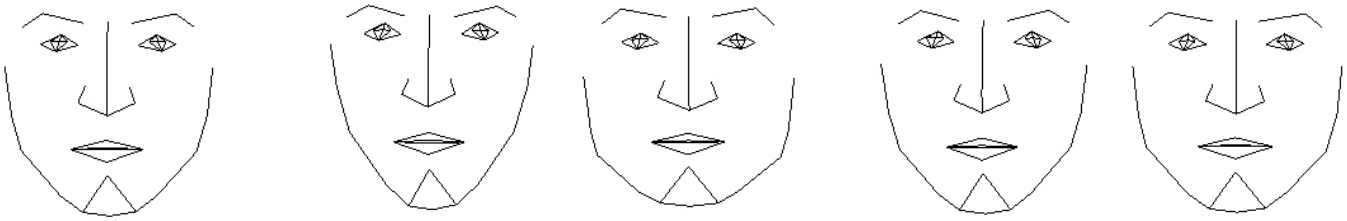
Ethics Approval to reproduce this composite image of a volunteer: University of Western Australia Ethics Committee Ref RA/4/1/1518.

Figure 2. Geometric morphometric analysis of arrest images (n=50)



Left: Average head shape of the sample. Centre: Shape changes according to an upwards (centre left) and downwards (centre right) head pose (PC1: 43.7% variation). Right: Shape changes according to youth (left) and age (right) (4% variation, p=0.13)

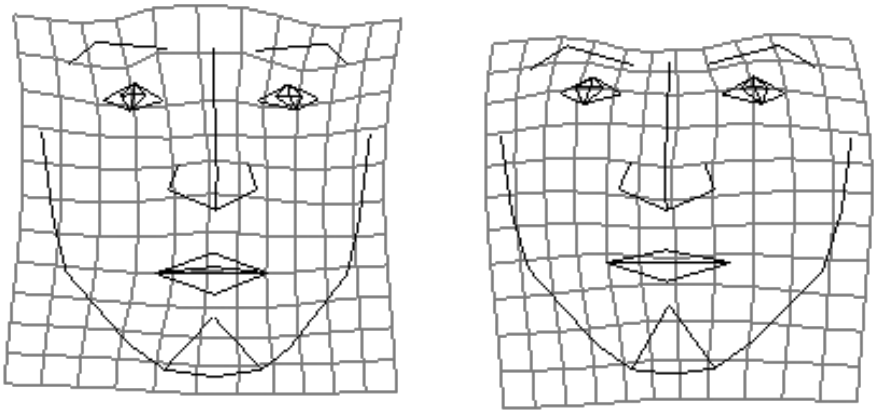
Figure 3. Geometric morphometric analysis of witness identification images (n=50)



Left: Average head shape of the sample. Centre: Differences according to head pose (PC1: 23.6% variation).

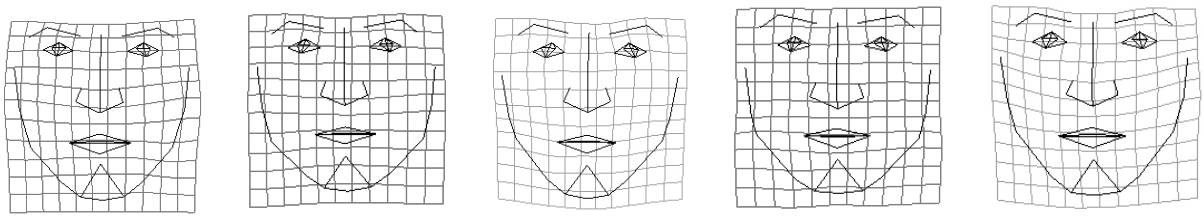
Right: Shape changes according to youth and age (2.2% variation, p=0.6)

Figure 4: Analysis of the differences between the arrest photographs and the witness identification images



Left:. TPS analysis showing how the witness identification images differ from the arrest photographs Right: TPS analysis showing how the arrest photographs differ from the witness identification images (3.9% variation, $p<0.000001$)

Figure 5: Separate TPS grids resulting from multivariate analyses of arrest images and witness identification images by individual Police Artist (n=5).



From left: PA01, PA02, PA03, PA04, PA05

Figure 6. Difference between the witness identification images (left, n=50) and the laboratory produced 'witness' images (right, n=7)

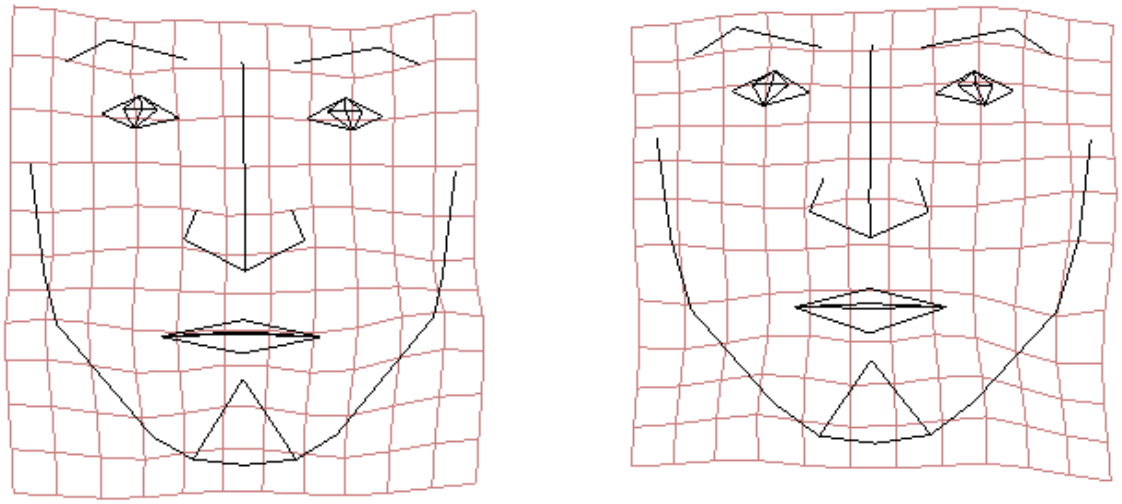
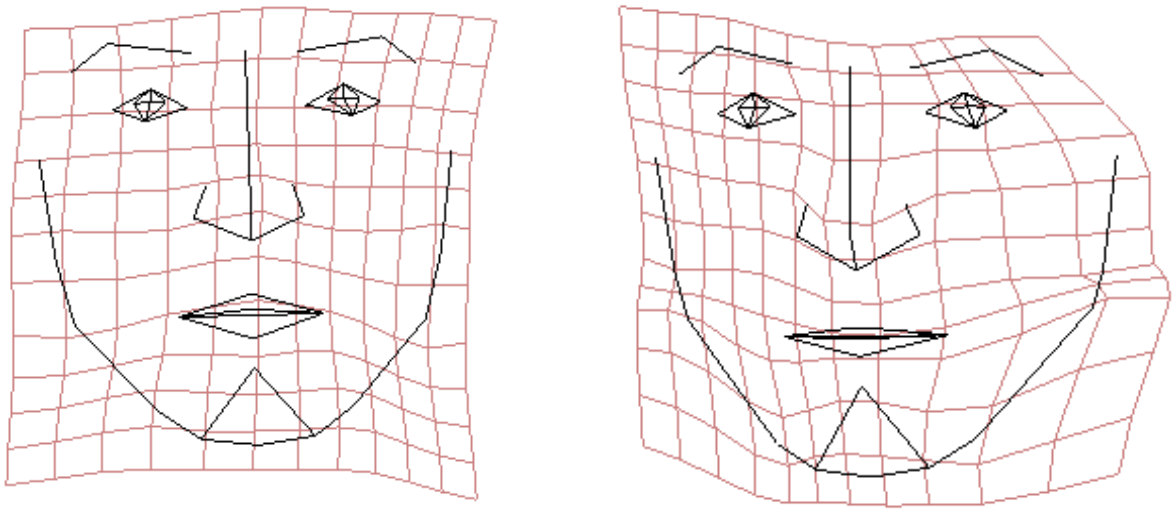


Figure 7. Difference between the arrest photographs (left, n=50) and the laboratory produced ‘mug



shots’ (right, n=7)

Tables and headers

Table 1: Witness Interview and Arrest Image Data.

	Scale	Min.	Max.	Mean	Std. Deviation
Suspect age	years	14	38	24.4	7.5
Witness age	years	8	82	31.5	15.1
Police Artist age	years	33	52	43.4	6.5
Police Artist Experience	months	4	254	141.8	94.7
Time elapsed between incident and interview	days	1	39*	4.6	5.8
Time elapsed between interview and arrest photograph	days	1	288	32.3	61.7

**There was one interview that was undertaken 187 days after the incident, which has not been included in these calculations*

Table 2 Facial landmark definitions

Right	Left	Midline	Name	Definition
1	2		**pupil**	Centre of the pupil/iris
3	8		**eyebrow tail**	Most lateral extent of dense eyebrow hairs
4	7		**eyebrow peak**	Most superior point of dense eyebrow hairs
5	6		**eyebrow head**	Most medial point of dense eyebrow hairs
9	17		**exocanthion**	Lateral intersection of the eyelids
10	16		**superior lid**	The highest point of the upper eyelid (when the upper eyelid fold is pronounced, this point may move medially)
11	15		**endocanthion**	The midpoint of the lateral corruncular margin
12	18		**inferior lid**	The lowest point of the lower eyelid
13,20			**iridion laterale**	The lateral edge of the iris on the IPL*
14,19			**iridion mediale**	The medial edge of the iris on the IPL*
		21	**glabella**	Between the eyebrow heads in the midline
		22	**nasion**	The angle of the nasal bridge
		23	**nasal tip/pronasale**	The centre of the rounded tip of the nose
		24	**subnasale**	Where the septum meets the philtrum at the base of the nose
		25	**superior upper lip**	The highest midpoint of the upper lip
		26	**inferior upper lip**	The lowest midpoint of the upper lip
		27	**superior lower lip**	The highest midpoint of the lower lip (when the mouth is closed this will be the same as the inferior upper lip)
		28	**inferior lower lip**	The lowest midpoint of the lower lip
		29	**labiomental**	The point where the mouth curtain meets the chin, often marked by a slight crease
30	35		**cheilion**	The most lateral point of the oral fissure
31	34		**alare wing width**	The widest point of the nose wing
32	33		**alare wing height**	The highest point of the nose wing (often more medially located than the wing width)
46	36		**tragion**	The edge of the face at the level of the tragus
45	37		**lobe**	The edge of the face at the lowest point of the ear lobe
44	38		**ramus base/gonion**	The lower edge of the ramus, often corresponding to the widest point of the mandible
43	39		**jowl**	The point on the jawline at the front of the jowl scallop. Where jowls are not obvious, this point is placed on the jawline directly below the cheilion
42	40		**chin**	The point on the jawline marking the lateral extent of the chin
		41	**menton**	The lowest point of the chin in the midline

**IPL: Inter-Pupillary Line: A horizontal line connecting the midpoint of the pupils*

Table 3: Separate analyses of arrest photographs and witness identification images by Police Artist

Police Artist	Average Experience (months)	No. witness identification images	Impact of head pose on overall variance (PC1)	Size and significance of variance as identified by multivariate regression
PA01	182.2	10	31.0%	11.6% (p=0.06)
PA02	244.6	14	42.9%	3.5% (p=0.02)
PA03	36.8	8	34.3%	14.2% (p=0.2)
PA04	43.4	9	35.2%	14.5% (p=0.2)
PA05	24	9	47.4%	16.9% (p=0.2)