FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

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Forensic face matching: Procedures and application

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Abstract

Forensic face matching evidence has been presented in UK courts for over 30 years to provide crucial identification evidence in criminal investigations. To be admissible as evidence in UK courts, this evidence must be conducted by a suitably qualified expert using scientifically validated procedures. Contrary to this notion, however, the field has been largely self-regulated, with little empirical investigation into the validity of face matching procedures, with extensive criticism of forensic face matching procedures in the academic literature. Practitioner working groups are now addressing these criticisms and standardising working practices, but further effort is required to ensure that the procedures used for forensic face matching are reliable and the limitations known. This chapter will provide a critical analysis of the forensic face matching procedures used in the UK and internationally by forensic face examiners, alongside studies and case examples that have challenged and tested the reliability and accuracy of these procedures.

Keywords: Forensic face matching, face examiners, forensic procedures

Introduction

Face images provide vital evidence in criminal investigations, such as matching CCTV images of an offender to mugshots of a suspect in a murder investigation, identifying victims in child sexual abuse imagery or linking multiple burglaries committed by the same perpetrator. Each of these scenarios is an example of applied face matching, the process of comparing two or more faces that are unfamiliar to the observer, to establish whether the faces are of the same individual. A related but distinct process is the recognition of familiar faces, which is also commonly used in police investigations and as evidence in the UK courts, for clarity this will be referred to as familiar recognition. The term face identification will be used when referring in general terms to the various processes used to determine who someone is based on their face.

Face matching is used in a range of different policing and criminal justice applications, which may not always result in an output that can be presented as admissible evidence in the courtroom. These applications include gathering intelligence about particular individuals to provide substantive lines of enquiry in an investigation, reviewing results from automated face recognition systems, or controlling access at a point of entry such as at a major event or to a restricted area. In the UK, when used as evidence in the courtroom face matching is classed as type of opinion-based evidence rather than evidence of fact, meaning that the evidence is derived from the subjective opinion of the person presenting the evidence, rather than a substantiated fact. Opinion-based evidence is largely inadmissible in court unless presented by an expert witness. In face matching such experts are known as forensic face examiners who conduct forensic facial comparisons or face examinations (Facial Identification Scientific Working Group, 2019).

Forensic face matching examinations are universally accepted in UK courts and have been presented as expert evidence for over 25 years (*R v Stockwell*, 1993). This evidence can be given substantial weight to a case. For example, in 1999 a defendant was convicted solely on the basis of facial comparison evidence (*R v Hookway*, 1999). Many commercial companies now provide a forensic face matching service and in 2003 it was estimated in the UK that approximately 600 forensic face examinations were presented in court a year (Bromby & Plews, 2003). However, forensic face matching has been largely self-regulated for the 25 years since its introduction into UK courts. As a result, there has often been inconsistency in working practices between different examiners and little attempt at scientific validation of forensic face matching

procedures and processes (Campbell-Tiech, 2005; Edmond, Biber, Kemp, & Porter, 2009; Mallett & Evison, 2013).

More recently there have been attempts to standardise forensic face matching procedures through the work of practitioner-led international working groups such as the Facial Identification Working Group and the European Network of Forensic Science Institutes. The guidance and best practice documentation of these working groups is freely available online ^{1 2}. Several academic studies have now published data on the accuracy of face examiners and forensic face matching procedures (Norell et al., 2015; Phillips et al., 2018; Towler et al., 2017; White, Dunn, Schmid, & Kemp, 2015; White, Phillips, Hahn, Hill, & O'Toole, 2015). These are significant steps towards understanding how reliable forensic face matching procedures really are.

This chapter will begin by discussing the various ways facial identification can be presented as evidence in UK courts, including forensic face matching, then move onto discuss the scientific validity of the processes used in forensic matching and finally present a mock-case example demonstrating how face matching procedures are used in practice.

Face identification evidence in UK courts

In the UK criminal justice system face matching evidence is classed as a form of opinion-based evidence (note that the courts frequently refer to face matching evidence as *facial mapping*). As mentioned above, opinion is only admissible as evidence if it is given by an individual that the court recognises as a suitably qualified expert witness. The law is not prescriptive on what constitutes suitable qualification, but refers in general terms to specialised knowledge based on study, training and professional experience. The two pieces of UK legislation that govern the admissibility of expert evidence are part 19 of the Criminal Procedure Rules (2015), which governs the contents of expert reports and division V part 19A of the Criminal Practice Directions (2015), governing the reliability of expert opinion evidence. Two key exceptions to the expert opinion rule specific to face matching and face recognition are:

¹ <https://fiswg.org/documents.html>

² <http://enfsi.eu/documents/best-practice-manuals/>

FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

1. That the jury are entitled to their own opinion when matching face images, in order to fulfil their role as the trier of fact (i.e. to decide whether the defendant is guilty or not guilty).
2. If someone is personally familiar with a person and recognises them from an image or video this is also admissible as evidence in the UK even if that person is not deemed an expert witness.

Face matching by the jury

In the UK criminal justice system the jury are entitled by case law to make a comparison of face images of the offender to the defendant. In *R v Dodson & Williams* (1984) two men were captured on CCTV committing an armed robbery. There were no witnesses available who could recognise the defendant from the CCTV. It was therefore deemed permissible to show the CCTV directly to the jury and allow them to make the decision on whether or not the images depicted the defendants. In such a scenario a jury member will be even more likely to make the incorrect decision if the images are low quality, such as from a CCTV system. We also know that people are generally poor at understanding their own face matching ability (Bindemann, Attard, & Johnston, 2014). These factors could have profound consequences if jurors are left to compare face imagery unaided in the courtroom, particularly if members of the jury are very poor at face matching and are not aware of this fact.

It has been widely evidenced in the academic literature that people are, on average, surprisingly poor at comparing unfamiliar faces. Even when face images are taken on the same day and under the same conditions, observers only make the correct decision on average 80% of the time (Burton, White, & McNeill, 2010). As quality and capture conditions between the images become more dissimilar (e.g. low resolution, non-matching pose or obscured features), the chance of someone correctly matching the faces images decreases (Fysh & Bindemann, 2017; Kramer, Mohamed, & Hardy, 2019). Individual accuracy varies substantially even on the same face matching test, with some people achieving 100% accuracy and others performing close to chance (Burton et al., 2010). This is further exacerbated by the fact that people are largely unaware of the difficulty of unfamiliar face matching and frequently overestimate their own ability (Bindemann et al., 2014). This variability in accuracy, particularly for low quality images such as CCTV, is a major issue for criminal investigations that rely on face matching to determine whether a suspect is guilty of committing a crime.

FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

In 2002 the UK Attorney General elaborated on the ruling in *R v Dodson & Williams* that the jury are entitled to make comparisons of *sufficiently clear images* (Attorney General's Reference No. 2, 2002, para. 19):

(i) where the photographic image is sufficiently clear, the jury can compare it with the defendant sitting in the dock (Dodson & Williams);

In situations where the image is not '*sufficiently clear*' the reference states that a suitably qualified '*facial mapping*' expert can provide an opinion on the images (*R v Clarke*, 1995; *R v Hookway*, 1999; *R v Stockwell*, 1993).

(iv) a suitably qualified expert with facial mapping skills can give opinion evidence of identification based on a comparison between images from the scene, (whether expertly enhanced or not and a reasonably contemporary photograph of the defendant, provided the images and the photograph are available for the jury (Stockwell 97 Cr App R 260, Clarke [1995] 2 Cr App R 425 and Hookway [1999] Crim LR 750).

However, the reference does not elaborate on what constitutes a sufficiently clear image and does not appear to acknowledge that face matching is a challenging, error-prone task even when images are clear and of high quality.

Familiar recognition

The majority of face identification evidence entering the UK courts actually derives from familiar recognition rather than unfamiliar face matching. It is therefore, worthwhile making clear the distinction between face matching evidence, where the faces are unfamiliar or unknown to the observer and familiar recognition evidence, where the observer recognises a person as someone they know. The recognition of a suspect from an image, by someone who knows and is familiar with them is widely used as evidence in UK police investigations. In 2017, visual recognitions provided primary identification evidence in 1741 investigations, greater than that of fingerprint evidence (1200 investigations)³. Unlike face matching evidence, familiar recognition evidence (or visual recognitions) does not need to have been carried out by an expert to be

³ https://www.met.police.uk/SysSiteAssets/foi-media/metropolitan-police/disclosure_2018/october_2018/information-rights-unit---crimes-detected-and-feature-forensic-sanction-detentions-from-2013-to-2017

admissible in the courtroom. In fact, in the UK the admissibility of expert face matching evidence and visual recognition evidence are governed by entirely different laws.

Typically, familiar recognitions are made by police officers being more likely to have encountered suspected offenders and have first-hand familiarity. However, any individual, such as eyewitnesses to a crime, may make a visual recognition from an image or video, provided that the means by which the recognition was made complies with Code D Section 3 Part (B) of the Police and Criminal Evidence Act (1984) (hereafter referred to as PACE Code D for brevity). PACE Code D includes a series of steps meant to safeguard against visual recognitions being mistaken or made under collusion. These steps include the following requirements (Police and Criminal Evidence Act Code D, 1984, para. 3.35):

- (a) that the films, photographs and other images are shown on an individual basis;*
- (b) that any person who views the material;*
 - (i) is unable to communicate with any other individual to whom the material has been, or is to be, shown;*
 - (ii) is not reminded of any photograph or description of any individual whose image is shown or given any other indication as to the identity of any such individual;*
 - (iii) is not be told whether a previous witness has recognised any one*

When recording their recognition the witness must also include the reason they know the person, the wording used when they recognised them, any expressions of doubt and what, if any, specific features triggered the recognition. This information will be used by the court to evaluate the reliability of the evidence. A recognition may only be submitted as evidence if it complies with the requirements of PACE Code D.

Both the familiarity of the subject to the witness and the innate ability of the observer in recognising people they know can affect the reliability of recognition evidence. Recognition ability varies across the population. At the extreme end of the distribution are prosopagnosiacs, individuals with ‘face blindness’ caused by either a congenital condition or acquired brain injury that prevents that individual from being able to recall faces. However, it should be mentioned that prosopagnosia manifests to different extents in different people and is certainly not a homogenous condition (Bate & Tree, 2017). At the other end of the spectrum are purported ‘super recognisers’, individuals with extraordinary face recognition ability first demonstrated by Russell, Duchaine, & Nakayama, (2009). Like prosopagnosics, super recognisers are also not a homogenous group, with

SR performance varying on different types of face recognition and face matching tasks (Bate et al., 2018).

It has long been acknowledged by the courts that human recognition is variable, with the 1976 Devlin Committee into visual identification evidence commenting that *‘The capacity to memorise a face differs enormously from one man to another, but there is no way of finding out in the witness box how much of it the witness has got; no-one keeps a record of his successes and failures to submit to scrutiny’* (Devlin, 1976, para. 4.25). Despite a plethora of recent research into human face recognition there is limited consensus in the academic research community on a standard, accurate measure of recognition ability (Ramon, Bobak, & White, 2019a). Given that the leading researchers in the field cannot agree, it looks to be a long time before such a measure could be considered suitably reliable to be used to assess recognition witnesses in court.

Super recognisers

There has been much attention in the both the academic literature and the media on the existence of super recognisers (SRs), those with superior, innate face identification abilities. Some researchers have been quick to point out that SRs may provide a potential solution to the issues of reliability of face matching evidence (Davis, Lander, Evans, & Jansari, 2016; Edmond & Wortley, 2016). However, based on our current understanding of SR ability it is something that is innate rather than a skill based on specialist knowledge and training (Noyes, Phillips, & O’Toole, 2017). The UK Forensic Science Regulator has clearly stated that the work of SRs in police units does not constitute a *‘forensic science’* (Forensic Science Regulator, 2018, pp. 19–20):

‘Super recogniser’ is a popular term for an individual who is believed to have above average face processing ability, which may include a greater propensity to remember and recall familiar faces. The Regulator’s input was sought on a review of the work of ‘super recognisers’, following a case that had been discontinued when the ‘identification’ made by a ‘super recogniser’ was found to be flawed.

Work undertaken by super recognisers may have investigative value. However, the Regulator does not consider it to be forensic science for the following reasons:

a. the work is generally carried out within an operational policing unit, with no separation to ensure independence and impartiality;

b. photographs of known suspects or offenders are studied prior to watching the footage containing unknown individuals, without implementing safeguards against cognitive bias; and
c. although there is scientific literature to support the fact that some people have a greater propensity to match faces, the 'super recogniser' process of attempting to match faces from photographs against CCTV footage is not based on scientifically validated methodology, nor are error rates known.'

There is now a substantial body of research demonstrating the existence of SRs in the general population (Bate et al., 2018; Anna K. Bobak, Pampoulov, & Bate, 2016; Russell et al., 2009). The benefits of recruiting SRs into operational roles that conduct quick face matching decisions in high risk environments (e.g. a police investigator or border guard) are self-evident (Bobak, Dowsett, & Bate, 2016), particularly given the limited effectiveness of short professional training courses at improving face matching accuracy (Towler et al., 2019). However, because face matching by SRs is based on natural ability rather than a demonstrable scientific method it does not meet current UK admissibility requirements for expert evidence. That is not to say that a SR could not become an expert in forensic face matching, and would likely be a good candidate for the role, but until there is further research and a wider academic consensus on who superior face processing ability is measured and defined, caution should be exercised in using SRs in operational situations like forensic face matching (Moreton, Pike, & Havard, 2019; Ramon, Bobak, & White, 2019b).

As a counter-argument SRs as a group have been shown to perform as accurately as forensic face examiners in controlled face matching tasks, though are more likely to make high confidence errors (Phillips et al., 2018). Although SRs are currently excluded from providing expert opinion on face matching, UK courts have readily allowed self-regulated face matching experts to present compelling evidence derived from methods with little or no scientific validity. Edmond & Wortley, (2016) discuss an interesting potential alternative to the current *status quo*, whereby face matching evidence from an SR could be presented alongside evidence from a cognitive psychologist as a novel form of expert opinion. Further investigation into the roles and interoperability of SRs and forensic face examiners in the courtroom will be an interesting avenue for future research.

Forensic face matching

In order to be admissible as expert evidence, first and foremost the expert's opinion must provide knowledge and expertise beyond the experience of the jury. According to *R v Turner*, (1975) if the judge and jury can form their own opinion unaided then the knowledge of an expert witness is unnecessary. This raises an interesting question for forensic face matching. Unlike other forensic identification techniques such as DNA profiling, judges and juries are quite capable of proffering an opinion on whether two face images depict the same person, though as discussed previously they may not necessarily be correct. Therefore, forensic face matching procedures must provide probative information beyond what the jury can derive on their own. There is no legal requirement for forensic face matching experts to follow a particular methodology or use a certain technique. In fact, UK courts are quite prepared to accept novel techniques even if they have been largely untested. In the UK there is no statutory test for the admissibility of forensic expert and scientific procedures. Experts must demonstrate that they comply with the requirements of both common law and legislation, but it is up to the discretion of individual judges to determine whether a certain expert's evidence is admissible and their procedures sufficiently reliable. This approach has been criticised as being too lenient in allowing new and untested forensic techniques into the courtroom, with expert evidence being admitted "*without sufficient regard to whether or not it is sufficiently reliable to be presented to the jury*" (The Law Commission, 2011, para. 1.8).

Forensic face matching has been largely self-regulated since its initial use in court in 1993 and face examiners were left to their own devices to devise forensic methods and procedures to compare faces. This resulted in a lack of standardisation in techniques, with experts borrowing from other scientific fields to develop procedures (Bromby, 2006). These procedures were largely untested on the types of images that examiners were applying them to (often low resolution CCTV imagery captured under poor lighting conditions). As a result, the error rates of the techniques in a forensic context are unknown (Edmond et al., 2009; Mallett & Evison, 2013). The significance of this point cannot be understated.

The issue of a lack of scientific foundation is not isolated to forensic face matching, having been raised across many forensic pattern and object matching disciplines, such as bite mark comparison (Saks et al., 2016) and handwriting comparison (Sulner, 2017). The much cited US National Academy of Science report entitled *Strengthening Forensic Science* (2009) strongly

FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

criticised many subjective forensic comparison disciplines as having a dearth of peer-reviewed studies that establish the validity of their methods and procedures. And five years later the PCAST report again *raised the need to evaluate specific forensic methods to determine whether they have been scientifically established to be valid and reliable* (President's Committee of Advisors on Science and Technology, 2016, p. 1). In light of issues specific to the reliability of forensic face matching evidence in the UK, the Forensic Regulator, in collaboration with the Metropolitan Police Service, Crown Prosecution Service and National Crime Agency published a guidance document for prosecutors and investigators on how to commission work from reliable forensic face examiners. The guidance document included criteria that the examiner's chosen procedures and methodology and procedures must comply with (Forensic Science Regulator, 2016b, p. 3):

'The expert has followed an analytical process that has been documented and can be repeated by another suitably qualified expert.

The methods and processes used during the comparison process have been validated to such an extent that the limitations are known and that they are suitable for the purpose for which they are used.

Simply citing years of experience and stating that the type of evidence has been previously accepted by the courts is insufficient to ensure that the expert is competent and their analysis and conclusions are reliable.'

Despite these requirements for demonstrable scientific validity and reliability there is a long history of face matching evidence based on procedures demonstrated to have limited scientific basis being admitted in the courtroom. In recent years practitioner guidance has recommended that such procedures no longer be used in forensic face matching.

Face matching procedures

The procedures devised by forensic face examiners to compare faces can be broadly categorised into four types; morphological analysis, facial feature classification, photo anthropometry and superimposition (Facial Identification Scientific Working Group, 2019). How

the procedure is applied in practice may vary between different examiners and be referred to by a different title, but will follow a similar underlying process. For example, photo anthropometry may be referred to as proportional alignment or superimposition as overlaying, but they are in essence the same procedure (European Network of Forensic Science Institutes, 2018). Of these four procedures only morphological analysis is recommended by the two major practitioner working groups in the field; the European Network of Forensic Science Institutes and the Facial Identification Working Group (European Network of Forensic Science Institutes, 2018; Facial Identification Scientific Working Group, 2019). Although once used widely by forensic face examiners, the three procedures of photo anthropometry, superimposition and feature classification have all been found to have significant issues in terms of consistency, accuracy and validity in published peer-reviewed research. The following sections offer an overview of the four forensic face matching procedures and a critical overview of the scientific validity of each.

Photo anthropometry

Photo anthropometry in the context of forensic face matching is the comparison of facial proportions based on measurements between specific facial landmarks. The facial landmarks are derived from both soft tissue features of the face, such as the endocanthions (En) and ectocanthions (Ec) (inner and outer corners of the eye) and the bony structures of the skull, such as the zygoma (Zy) and Gonions (Gn) (the cheekbones and the angle of the jaw) (Iskan, 1993). When applying photo anthropometry the face examiner must first plot the location of the landmarks on the image. Figure 1 shows an example of some of the facial landmarks used in photo anthropometric comparison.

Figure 1 - Diagram depicting facial landmarks used for photo anthropometry. Illustration by Jennifer Harris and reproduced with permission

Once positioned the landmarks are used to derive the distances between facial features. Facial proportions are then compared between images to determine if the faces are those of the same person or different people, however these assessments of similarity and dissimilarity are subjective. Figure 2 shows an example of photo anthropometry commonly seen in forensic face matching reports. The images depict the same individual but note that the facial proportions vary due to differences in pose, distance to camera and facial expression.

Figure 2 - An example of photo anthropometry between two images of the same individual. Lines denote vertical and horizontal proportions for comparison between the two images. Note how proportions vary due to extraneous factors such as pose and expression.

An appealing aspect of photo anthropometry is its apparent objective basis using the measurements and ratios between images, whereas other face matching procedures, such as morphological analysis, are subjective in nature and based on the knowledge, experience and interpretation of the observer. However, this apparent objectivity is a fallacy. Locating facial landmarks is a manual process, therefore open to interpretation by different observers. Photo anthropometry has been applied to high resolution images in controlled environments and in these contrived conditions has shown limited effectiveness in face matching (Yoshino, Matsuda,

Kubota, Imaizumi, & Miyasaka, 2000). In forensic casework, images are unconstrained and often poor quality. Factors such as low resolution imagery (Moreton & Morley, 2011), variation in camera angle (Kleinberg, Vanezis, & Burton, 2007) and distance of the subject from the camera (Edmond et al., 2009; Noyes & Jenkins, 2017) have all been demonstrated to alter facial proportions in images. Photo anthropometry has now been largely derided by much of the forensic facial comparison community as unreliable (European Network of Forensic Science Institutes, 2018; Facial Identification Scientific Working Group, 2019) but this was not always the case. This shift in perspective was only brought about after many examples of academic research demonstrating the fundamental flaws in this procedure.

Attempting to infer information about identity from facial measurements is not a new idea. Anthropologists have attempted to use facial proportions to measure latent characteristics of a face, such as age, gender and ethnicity (Zhuang, Landsittel, Benson, Roberge, & Shaffer, 2010). The application of facial measurements to the identification of suspects is also not novel. In the late 19th century a Parisian named Alphonse Bertillon created a system for recording facial and bodily measurements to identify recidivists in police custody (Bertillon, 1893). This approach was time consuming and quickly superseded by the comparison of fingerprint ridge detail (Prabhakar, Jain, & Ross, 2004).

An early semi-automated facial recognition system, designed by Woodrow Bledsoe in the 1960s, required human operators to annotate facial landmarks on images, the machine then calculated a set of facial measurements based on the distance between these landmarks. A set of measurements were stored for each face in a database, with the intention that the machine would be able to recall a previously stored face based on a set of measurements from a new image of that face. This approach proved to be time-consuming to process and inaccurate when faces varied in pose, camera or expression. Bledsoe himself was critical of the technique, explaining;

'This recognition problem is made difficult by the great variability in rotation and tilt, lighting intensity and angle, facial expression, aging, etc. Some other attempts at facial recognition by machine have allowed for little or no variability in these quantities. Yet the method of correlation (or pattern matching) of unprocessed optical data, which is often used by some researchers, is certain to fail in cases where the variability is great. In particular, the correlation is very low between two pictures of the same person with two different head rotations.' (Ballantyne, Boyer, & Hines, 1996, pp. 10–11)

FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

Despite the limitations of facial measurements being known 30 years previously, the rise of forensic face matching in the early 1990s saw a resurgence in the technique. Photo anthropometry became a common procedure for forensic face examiners and was readily accepted by the courts despite its inherent limitations. In *R v Hookway* (1999), the first stated case where a defendant was convicted solely on face matching evidence, discussions of facial proportions feature heavily, with the case summary stating that the expert said '*the proportions of the robber's face were totally consistent with the proportions of the appellant's face, both in relation to frontal and side views. He (the expert) said the findings were "very powerful support for the assertion that the offender was the appellant"*' Academic research had raised concerns about the use of facial proportions and measurements by forensic experts three years prior to the Hookway case, highlighting the necessity for an established database of facial proportions within the population (Mardia, Coombes, Kirkbride, Linney, & Bowie, 1996). Without such a database how could experts be able to state a level of certainty for the similarity between facial proportions? Such a database was not developed and, as is seen in Hookway, experts were still assigning levels of support to face matching examinations based on proportions with little or no empirical basis.

Not all experts were unanimous on the use of photo anthropometry and facial proportions, reflecting the fragmented and self-regulatory nature of forensic face matching at the time. In a 2003 case at Winchester Crown Court, four face matching experts were asked their opinion of photo anthropometry as a comparison technique. Photo anthropometry was '*condemned by two experts as being without scientific foundation and impossible in any event to apply since the angle of the facial or bodily feature could never be aligned exactly as between the known and disputed images.*' (Campbell-Tiech, 2005, p. 4). Even the condemnation of the technique by practicing experts was insufficient for the courts to deem photo anthropometry unreliable.

In 2007, Kleinberg, Vanezis, and Burton published a research paper with the unequivocal title 'Failure of Anthropometry as a Facial Identification Technique Using High-Quality Photographs', concluding that for the landmarks tested in the study photo anthropometry '*does not generate the consistent results necessary for use in a court of law*' (Kleinberg et al., 2007, p. 779). However, in the 2009 Facial Identification Guidance, issued by the UK National Police Improvement Agency two years after the publication of Kleinberg et al. (2007), facial proportions were still listed as a procedure for forensic face matching (National Police

Improvement Agency, 2009). In an academic paper published the same year Wilkinson and Evans (2009) stated that the majority of face matching experts in the UK used a combination of morphological analysis and photo anthropometry.

Possibly due to the overwhelming scientific evidence that photo anthropometry is unreliable for identification many forensic face matching experts stated the technique would only be used for elimination purposes (i.e. determining that two faces do not show the same person). Research from the Metropolitan Police in 2011 echoed the findings of Kleinberg et al. as to the inconsistency of photo anthropometric results and went further to conclude that *‘photoanthropometric facial comparison, as it is currently practiced, is unsuitable for elimination purposes’* due to the variability of proportions of the same face caused by changes in pose and camera angle exceeding the variability in facial proportions of different individual’s faces (R. Moreton & Morley, 2011, p. 1). McNeill, Suchomska, and Strathie (2015) found that simply overlaying a grid of facial proportions on two face images increased the chance that untrained observers would decide that two non-matching faces were the same person, debunking the notion that photo anthropometry and the comparison of facial proportions are an effective elimination tool. McNeill et al. went as far as referring to the technique and others used by face matching experts as *pseudoscience* in the title of their paper.

Guidance from the Facial Identification Scientific Working Group is unambiguous in stating that *‘photo anthropometry should NOT be used’* for forensic face matching, citing many of the academic studies above as grounds for this decision (Facial Identification Scientific Working Group, 2019, p. 7). In 2013, the UK Forensic Science Regulator stated there is *‘paucity of scientific underpinning and validation on the analysis of facial characteristics and proportions from photographs using anthropometric landmarks, dimensions and angles’* (Forensic Science Regulator, 2013, p. 3) and the 2018 European Network of Forensic Science Institute’s Facial Image Comparison Best Practice Manual further recommended against the use of measurements and proportions in forensic face matching (European Network of Forensic Science Institutes, 2018).

The use of photo anthropometry has decreased in recent years and internationally forensic face examiners are no longer using the technique (for example Houlton & Steyn, 2018). But, at the time of writing, a simple internet search reveals several UK face matching experts that do still use the technique, despite there being over 40 years of empirical evidence demonstrating the

lack of reliability of photo anthropometry, practitioner guidance stating that it should not be used, and criticism that the technique lacks scientific underpinning by the Forensic Science Regulator.

As can be seen in the case of photo anthropometry, UK courts seldom go so far to exclude a specific technique as unreliable, even with a substantial body of scientific research supporting such a decision. Therefore it is the onus of practitioners and researchers to work together to ensure that forensic procedures, including those used for forensic face matching, have been sufficiently validated and give consistent and reliable results in the courtroom.

Facial feature classification

The concept of assigning an individual's features to certain categories in order to identify them is not new, having its roots in late 19th century physical anthropology. Head shape has long been used by anthropologists to determine the '*racial affinity*' of humans both living and deceased (Ripley, 1897). Forensic face examiners have taken this concept and developed categories with which to assign different shapes of facial features (Iskan, 1993; Vanezis et al., 1996).

In principle this sounds like an objective and systematic way of comparing faces, but in practice this is not the case. Facial features are not discrete variables that can be simply assigned to one category or another as there is continuous variability in facial feature shape and form derived from complex genetic, hormonal and environmental interactions (Claes et al., 2014; Guyuron et al., 2009). Extraneous factors such as image quality, pose and camera angle may also impact on the appearance of facial features. Ritz-Timme et al, (2011) evaluated the reproducibility of facial feature categorisation between different observers and by the same observer on different days. The categories were devised from a dataset of 900 adult males forming an atlas of 43 different features, with multiple categories of shape and form per feature (Ohlrogge et al., 2008). The list of features used in the atlas is given in Table 1. Each feature is then sub-divided into discrete categories based upon shape, e.g. the nose bridge breadth (frontal) may be classified as 'narrow', 'average' or 'broad'.

Table 1 - List of features from the facial feature atlas (Ohlrogge et al., 2008)

No.	Feature	22	Nose protrusion (lateral)
01	Head shape (frontal)	23	Nasal breadth (frontal)

FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

02	Frontal height (frontal)	24	Alar wing length (lateral)
03	Frontal breadth (frontal)	25	Alar wing height (lateral)
04	Frontal hairline (frontal)	26	Nostrils (lateral)
05	Forehead bias (lateral)	27	Philtrum height (frontal)
06	Eyebrow height (frontal)	28	Philtrum depth (frontal)
07	Eyebrow density (frontal)	29	Philtrum shape (frontal)
08	Eyebrow shape (frontal)	30	Upper lip notch (frontal)
09	Mono-brow (frontal)	31	Labial breadth (frontal)
10	Distance upper eyelid-eye brow (frontal)	32	Orientation of mouth corner (frontal)
11	Upper eyelid (frontal)	33	Chin shape (frontal)
12	Lid axis (frontal)	34	Chin transition (frontal)
13	Lower eyelid fold (frontal)	35	Chin protrusion (lateral)
14	Nasal root (frontal)	36	Chin dimple (frontal)
15	Nose bridge length (frontal)	37	Ear height (lateral)
16	Nose bridge breadth (frontal)	38	Ear breadth (lateral)
17	Nose bridge process (frontal)	39	Ear lobe size (lateral)
18	Nose profile (lateral)	40	Ear lobe attachment (lateral)
19	Inclination of the columella (lateral)	41	Ear protrusion (frontal)
20	Nose tip shape (frontal)	42	Transition head-neck (frontal)
21	Nose tip incisure (frontal)	43	Pronunciation of cheek bones (frontal)

Observer consistency was evaluated by two pairs of observers categorising a subset of images used to develop the atlas. Both of the observers in the first pair had received training in human identification from an expert and categorised the facial features of 60 randomly chosen faces from a larger sample of 270 faces. In the second pair only one observer was trained in face matching from photographs. This pair categorised a different subset of 25 face images. The same images were categorised again one month after the initial study.

Disagreement between observers was found to occur approximately 40% of the time and disagreements from the same observer categorising the same images on different days ranged from 19% to 30%. Interestingly 30% of disagreements were from an observer who had received

training in feature classification, meaning that even with training this observer changed their opinion on face categories in almost one third of observations.

Figure 3 - Examples of face shape diagrams similar to those used by Iscan, (1993) and Towler, White, & Kemp, (2014). Illustrations by Jennifer Harris and reproduced with permission

More recently, Towler et al., (2014) evaluated observer rating consistency in the categorisation of only face shape, using categories similar to those shown in Figure 3. Inter-observer (different person) consistency in face shape classification was found to be low, with each individual face image being classified, on average, as having three different shapes by different observers. Of most concern, intra-observer (same person) agreement was also low, with only 56% of repeat classifications being consistent. Instruction in face shape classification had no impact on accuracy on a laboratory test of face matching (the Glasgow Face Matching Test; see Burton et al., 2010) given after the face shape categorisation task.

Despite earlier studies advocating the use of facial feature categorisation (Iscan, 1993; Vanezis et al., 1996), and considerable effort put into developing classification schemes (Ohlrogge, Arent, Huckenbeck, Gabriel, & Ritz-Timme, 2009; Ohlrogge et al., 2008), research has demonstrated poor consistency in categorisations and no observable benefit in face matching accuracy from this approach. Facial feature classification has been largely superseded by morphological analysis and is not recommended for use by both the FISWG (Facial

Identification Scientific Working Group, 2019) and ENFSI (European Network of Forensic Science Institutes, 2018).

Superimposition

Superimposition is the process of merging two or more face images using various image processing techniques to create a single composite image. The intention is that the composite image will highlight any apparent similarities or differences between the two faces and assist in determining whether the images depict the same person. Superimposition, in various guises, has been widely used by forensic face matching experts since the introduction of this type of evidence in UK courts. Vanezis and Brierley (1996) reviewed 46 forensic face matching cases of superimposition from a two year period. They found the technique to be useful in some cases but of limited applicability in others due to differences in pose of the subjects and angle of the camera. This study only reviewed past cases and therefore the ground truth of the images used are unknown, which greatly limits the scientific validity of the conclusion. The paper also overlooked a major factor, the impact of superimposition on face matching decisions made by untrained 'lay' observers, such as a jury.

Superimposition has not only been used by forensic experts but also criminals attempting to commit identity fraud. Face morphing is a risk for identification verification, such as at the border, where criminals will attempt to create morphed face images in passports that bear sufficient resemblance to multiple individuals, thwarting human passport reviewers and automated facial recognition systems. The passport can then be used illegally by two or more different individuals. Robertson, Kramer, and Burton (2017) found that when lay participants were presented with morphed face images they commonly accepted that the image was of a single face, failing to detect the morph. Even when participants were told that some images were morphs a number were still accepted. The fact that observers can be so easily deceived into thinking a morph of two different faces depicts a single individual is a major concern for forensic use. In a forensic face matching case it is likely that the defendant will share some degree of similarity with the offender to end up being arrested for the crime, even if they did not actually commit it. The fact that morphs of two different faces can appear so convincing is a significant risk when presenting superimposition evidence to a jury, with its potential to mislead an observer into believing two different faces are the same.

The courts have raised issues in the past as to the reliability of the technique (*R v Clarke*, 1995) but not enough to prevent its use in future cases. Strathie, McNeill, and White (2012) evaluated the impact of presenting a single image formed from two faces on matching accuracy. The technique to impaired observer accuracy and introduced a biasing effect, where observers were more likely to respond that a superimposed image was the same individual when the two face halves were from different individuals. A biasing effect and accuracy impairment was also observed by Strathie & McNeill, (2016) when the superimposition was performed using ‘facial wipes’ where a video clip gradually alternates from one face to another, a technique also used by forensic face examiners.

In light of the biasing effect of superimposition and the significant risk this poses in the court room, the European Network of Forensic Science Institutes, (2018) recommend the technique not be used in forensic face matching. Confusingly, the Facial Identification Scientific Working Group (2012) acknowledge the limitations of superimposition, including the potential biasing effect, but have not gone as far as stating it should not be used. Instead, the recommendation is that superimposition should be used only in conjunction with morphological analysis, as a visual aid. But given that multiple studies have demonstrated the false positive bias caused by superimposition, this recommendation appears counter to the findings of peer-reviewed academic research.

Morphological analysis

The final comparison procedure used by forensic face matching experts is morphological analysis, where the individual features of the face are systematically analysed and compared. Examiners focus on individual features, such as the nose or ears and compare the shape and form of these features between face images. If there is sufficient detail, facial feature components are further broken down into sub-components (also known as characteristics descriptors), such as the shape of the nostrils or the size and adherence of the ear lobes. Fine feature detail, such as wrinkles or facial marks will also be described and compared. Often a set list of features will be used by the examiner as an *aide memoir*, such as the Standard Guide for Facial Image Comparison Feature List for Morphological Analysis E3149 – 18, published by the American Society for Testing and Materials (ASTM) in 2018 and based on the earlier FISWG feature list (Facial Identification Scientific Working Group, 2018).

Table 2 gives an example of the characteristic descriptors of the nose from the FISWG checklist, with a supporting diagram from the document shown in Figure 4.

Table 2 - Characteristic descriptors of the nose from the facial image comparison feature list for morphological analysis (Facial Identification Scientific Working Group, 2018)

9 - Nose	
Component Characteristics	Characteristic Descriptors
9.1 Nasal outline (profile and front view)	<ul style="list-style-type: none"> • Overall shape • Length and/or width relative to rest of face • Prominence • Symmetry
9.2 Nasal root (bridge)	<ul style="list-style-type: none"> • Front view: width, length, shape, depth • Profile view: length, depth, angle
9.3 Nasal body	<ul style="list-style-type: none"> • Front view: width, length, shape, angle • Profile view: length, angle, contour
9.4 Nasal tip	<ul style="list-style-type: none"> • Shape (in front and profile view) • Angle (e.g., up , down) • Symmetry
9.5 Nasal base	<ul style="list-style-type: none"> • Width • Height • Deviation to the right or left
9.6 Nasal base: alae (wings of nose)	<ul style="list-style-type: none"> • Thickness • Symmetry • Shape
9.7 Nasal base: nostrils (nasal openings)	<ul style="list-style-type: none"> • Shape and size of opening • Symmetry • Hair
9.8 Nasal base: columella (soft tissue between nostrils)	<ul style="list-style-type: none"> • Width and length • Relative position • Symmetry

Figure 4- Diagram of the characteristic descriptors of the nose from the facial image comparison feature list for morphological analysis (Facial Identification Scientific Working Group, 2018). Illustrations by Jane Wankmiller and reproduced with permission.

Although morphological analysis is the recommended method for forensic face matching, there has been limited published research validating its use. Towler et al. (2017) found that when using a simplified list of facial features similar to those given in the ASTM standard guide, untrained students were more accurate at matching the same face but the list gave no discernible benefit for non-matching faces. When trained face examiners were tested using the same list of features, they not only outperformed untrained participants but their facial feature similarity ratings were more diagnostic of identity than those of novices. This finding implies that examiners with training and experience in morphological analysis have greater understanding of the discriminatory power of different facial features and are more proficient in the procedure. For examiners, the ears and scars-and-marks were found to be the most diagnostic facial features used, which reinforces anecdotal evidence from examiners that the ears are the most useful

features for comparison (Towler et al., 2017) and the fact that scars and facial marks can distinguish between identical twins (Biswas, Bowyer, & Flynn, 2011).

A study of forensic facial examiners undertaking quick-decision face matching tasks showed that, although more accurate than control participants at the group level, the examiners suffered greater impairment to accuracy when the task was constrained to two seconds duration (White, Phillips, et al., 2015). These findings, and those of Towler et al., (2017), indicate that facial examiners trained in morphological analysis are using a qualitatively different approach to matching faces that is based more on individual feature detail than the face as a whole .

The initial findings of Towler et al. (2017) are promising signs that morphological analysis can give accurate forensic face matching results when conducted by trained face examiners. But the findings of this one study alone are insufficient to justify the use of a procedure in court. Only seven forensic face examiners from the same agency were tested, analysing images captured in similar conditions. It is currently unknown how applicable morphological analysis is to matching different sources of imagery, such as low quality CCTV footage to high quality police mugshots, a common scenario in forensic casework. Examiners must conduct validation studies of their procedures using the types of images they will encounter in casework. Validation studies should investigate the accuracy, precision, range, repeatability, reproducibility and robustness of the procedure to ensure it meets the requirements of its intended use (European Network of Forensic Science Institutes, 2018).

Example of a forensic morphological analysis

When used in forensic face matching casework a full morphological analysis may take a face examiner hours or even days depending upon the complexity of the material. To give a clearer understanding of how morphological analysis is used in practice, this section will outline an example case based on current practitioner guidance (European Network of Forensic Science Institutes, 2018; Facial Identification Scientific Working Group, 2019) and the author's own experiences working as a forensic face examiner in the UK for seven years from 2011 to 2018.

Case scenario

Investigators have requested for a forensic face examiner to compare the two images and provide an evidential report on whether the images depict the same or different persons. In this simulated case investigators have recovered an image from social media linked to a potential suspect via

intelligence, this is the questioned image. Investigators have access to a known image of the offender from an identity document database, this is the reference image. The investigation team know there are at least two years' time difference between the questioned and reference images.

Managing contextual information

When a forensic face examiner receives a request from an investigator the request often contains contextual information that is irrelevant to the morphological analysis but could cognitively bias the outcome. Examples of such information include if the suspect has a previous criminal record or other forensic evidence linking them to the offence. Cognitive bias caused by extraneous contextual information is a phenomenon that has been repeatedly demonstrated across a range of forensic disciplines, including fingerprint comparison (Dror, Charlton, & Péron, 2006) and the interpretation of DNA profiles (Dror & Hampikian, 2011). It is an issue that all forensic examiners should be aware of and take steps to mitigate. One way to mitigate this risk is to give examiners the bare minimum of information required to conduct their analyses and, if further details are needed, to reveal them as required by sequential unmasking (Krane et al., 2008). Forensic face matching departments should implement a procedure for context management, where an individual who will not undertake the examination strips a case of all but the most essential contextual information before it is passed to the examiner (Found & Ganas, 2013). In the current example, such essential information would be the two year time difference between the questioned image and the reference image.

During the management of contextual information the propositions for evaluation may also be established. The proposition for evaluation are the different scenarios against which the examiner must assess the evidential strength of their observations. The propositions must be mutually-exclusive (i.e. only one can be true). The aim of having at least two propositions to evaluate the evidence is to help ensure the findings are balanced and not biased towards one particular outcome (European Network of Forensic Science Institutes, 2015). In this case example two such propositions may be:

Proposition A: The questioned image and reference image depict the same adult male

Proposition B: The questioned image and reference image depict different adult males

Analysis

FORENSIC FACE MATCHING: PROCEDURES AND APPLICATION

It is currently recommended that the morphological analysis of faces be conducted within an ACE-V framework (European Network of Forensic Science Institutes, 2018). ACE-V is a linear workflow of four different phases, comprising of Analysis, Comparison, Evaluation and Verification. ACE-V is used across many forensic pattern matching disciplines to provide robustness and transparency in comparison procedures. In the analysis phase, the examiner analyses the questioned image (Figure 5) in isolation of the reference image. The rationale for this procedure is to reduce the risk of confirmation bias, whereby observation of the target or reference image at the same time as the questioned image may alter the examiners observations (Dror et al., 2011). Throughout the ACE-V process the examiner will keep thorough contemporaneous notes, including the parameters of the image, any processing steps applied to the image (e.g. resizing, rotating or brightness adjustments) and their observations of facial feature detail.

Figure 5 – Questioned image

During the analysis phase the examiner will note down the parameters of the image file, such as the file type and resolution of the image, and any conditions in the image that will impact on the comparison phase. Examples of such conditions may arise from the file itself (e.g., a low resolution or heavily compressed image), the subject in the image (e.g., pose and facial

expression), the image capture device (e.g., exposure settings and focal distance) and the environment the image was taken (e.g., light source and intensity). The examiner should be competent in understanding how these complex and interacting conditions impact on the observations made in the comparison phase.

The examiner may also comment on the level of facial detail present in the questioned image using a standardised facial feature checklist (e.g., ASTM, 2018). Facial feature observations may include which features are visible and how well resolved they are. For instance, such observations should capture if only the basic outline of the feature can be discerned, or if sub-components of the feature are visible. The examiner will also note the presence of fine feature detail, such as scars or facial marks.

In this example the questioned image (Figure 5) is fairly low resolution, causing a loss of facial feature detail and captured with a non-neutral expression. The examiner will make a note of these factors as they may impact upon the subsequent comparison.

Comparison

Once the examiner has completed the analysis of the questioned image they can then view the reference or target image. An analysis of the reference image may be conducted, making note of the conditions of the image and the visibility of features. In this example, the subject in the reference image is too close to the camera, causing perspective distortion and the apparent enlargement of medial facial features, such as the nose (see Figure 6). This type of distortion has been shown to impair face matching accuracy (Noyes & Jenkins, 2017) and is a factor the examiner must consider when comparing facial feature detail.

Figure 6 – Reference image

The examiner will then systematically compare the questioned and reference images on a feature-by-feature basis, noting any apparent similarities or differences in facial feature detail. The examiner may annotate their observations onto the images. In the example in Figure 7, similarities are annotated in blue, such as the shape and curve of the eyebrows (blue arrows 2 and 3), and differences are annotated in pink. The examiner should also note possible explanations for their observations based on the image conditions noted in the analysis phase. For example, the difference in the visibility of a mark by the left eyebrow may be caused by the mark being a transient feature (pink arrow 1), and the difference in the size of the chin may be attributable to perspective distortion in the reference image (pink arrow 4).

Figure 7 – Side-by-side comparison of the questioned image and reference image, annotated with similarities (blue arrows) and differences (pink arrows).

Evaluation

During the evaluation phase the examiner will assess the strength of their observations under the competing propositions established at the start of the examination. This will then be presented as a level of support on a conclusion scale, which represents the strength of the evidence rather than a measure of the examiners confidence. There is currently no standardised conclusion scale for evidence evaluation in forensic face matching. Table 3 – Example conclusion scale for face matching examinations an example conclusion scale that could be used by forensic face matching examiners.

Table 3 – Example conclusion scale for face matching examinations

Level	Description
+4	The evidence provides extremely strong support for the proposition that the images depict the same adult male
+3	The evidence provides strong support for the proposition that the images depict the same adult male
+2	The evidence provides moderate support for the proposition that the images depict the same adult male
+1	The evidence provides limited support for the proposition that the images depict the same adult male
0	The evidence does not support either proposition/The evidence is inconclusive
-1	The evidence provides limited support for the proposition that the images depict different adult males
-2	The evidence provides moderate support for the proposition that the images depict different adult males
-3	The evidence provides strong support for the proposition that the images depict different adult males
-4	The evidence provides extremely support for the proposition that the images depict different adult males

Evidence evaluation and conclusion scales are a contested topic across forensic science, with many advocating a logical approach to evaluation based on Bayes theorem over more traditional frequentist approaches or categorical identity judgements (e.g. match or non-match) (Jackson, Jones, Booth, Champod, & Evett, 2006; Meuwly, Ramos, & Haraksim, 2015; Redmayne, Roberts, Aitken, & Jackson, 2011). Such a discussion is beyond the scope of this chapter. Regardless of the conclusion scale and evaluation model in use, the face examiner should consider as a minimum the types of features compared, the level of detail observed for those features, and the impact of conditions in the images on their observations (European Network of Forensic Science Institutes, 2018).

There is no database of facial features available to allow a quantitative, statistical evaluation of face matching evidence. Evaluations are therefore based on the subjective knowledge and experience of the examiner. Subjective opinions are accepted by UK courts for forensic face matching but juries are advised to treat them with caution. Face examiners must make clear when giving evidence that there is no empirical basis to their conclusion (*R v Atkins & another*, 2009).

Verification

Because morphological analysis is a subjective process and open to interpretation, it is recommended that all examinations are independently verified by another examiner (Facial Identification Scientific Working Group, 2019). During the verification another face examiner will repeat all or part of the ACE-V process. If the two examiners' findings agree, the conclusion can be given to the investigator. If the examiners do not agree, there will need to be some form of resolution procedure, such as review by a third examiner. Verification may be conducted blind, where the second examiner does not know the first examiner's findings or non-blind where the findings are known. To reduce the risk of biasing the second examiner, blind verification is the preferred approach (European Network of Forensic Science Institutes, 2018).

Discussion

Despite being readily accepted by the courts, the procedures used by forensic face matching experts have been subject to extensive and justified criticism in the academic literature and, previously, forensic face examiners made little effort to validate face matching procedures. In more recent years, international practitioner-led working groups have begun to produce standards, guidelines and best practice documents to address these criticisms and bring greater accountability and rigour to the field^{4 5 6}. In the UK specifically, the Forensic Science Regulator's Codes of Practice and Conduct require forensic examiners to demonstrate that they are both competent as experts to carry out a certain procedure and that the procedure has been validated to the extent that any limitations are known (Forensic Science Regulator, 2016a). The Regulator's Codes cover a range of forensic disciplines, which includes forensic face matching. Coupled with existing legislative requirements, the work of practitioner working groups, the

⁴ www.fiswg.org

⁵ <http://enfsi.eu/about-enfsi/structure/working-groups/digital-imaging/>

⁶ <https://www.nist.gov/topics/organization-scientific-area-committees-forensic-science/facial-identification-subcommittee>

forensic regulator's codes and empirical research will help to ensure that forensic face matching procedures are of a sufficiently reliable standard to be used as expert evidence in a court of law, where life changing decisions may be made on the basis of that evidence.

There is a consensus amongst much of the forensic face examiner community that morphological analysis is the recommended procedure for face matching, with a standardised list of features available now available (ASTM, 2018). This move towards standardisation is a promising step but further work is required to validate morphological analysis as a reliable procedure across various image types and establish known error rates. To establish the error rates of subjective feature-comparison methods, such as morphological analysis, the PCAST report advocates 'black-box' testing of examiners undertaking many test comparisons (President's Committee of Advisors on Science and Technology, 2016). From these repeated tests the error rates of a procedure can be calculated and the validity and reliability of the method established. In 2018, the first large scale study of forensic face examiner accuracy was published, testing 57 examiners from five continents. The aim of the study was to be the first to compare the accuracy of trained face examiners against untrained observers and automated facial recognition algorithms on a challenging face matching task (Phillips et al., 2018). The face examiners were requested to complete the task using their forensic face matching procedures with no time limit.

As a group the forensic face examiners were found to outperform both untrained 'lay' participants and fingerprint examiners. However, there was considerable overlap in the range of accuracy for individual participants in all groups, including face examiners and untrained participants. Several face examiners even performed more poorly than the average score of the untrained group. This is highly alarming. That there could be such a range in accuracy for different face examiners using forensic procedures has major ramifications for the use of face matching evidence in court. The forensic face matching community must take urgent action to address and produce validated procedures that give consistent results when used by different trained examiners.

Complying with the regulatory requirements of forensic accreditation should eventually lead to validated procedures that can be safely used to provide evidence in the courtroom, but forensic face matching is on a long journey to get there. Greater collaboration between the practitioner and relevant academic communities will help to make the journey shorter. Cognitive scientists and psychologists have extensive experience in human performance testing for

perceptual tasks, and much of this is translatable to the testing and validation of forensic face matching procedures (for particularly useful examples, see Edmond et al., 2017; Martire & Kemp, 2016). By working together, the forensic face matching community and researchers can develop suitable tests to validate procedures, quantify error rates and establish the limitations of forensic face matching procedures. This will lead to safe and reliable forensic evidence in the court and prevent potential miscarriages of justice that can have catastrophic effects on people's lives.

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