# The subjectivity of consistency, an overview of manual facial photographic comparison in forensic science

*by Jim Hoerricks, PhD AVFA*


## Abstract

Facial photographic comparison for the purpose of identifying people has been present in the world's courts since at least the famous Tichborne case, heard in the English Court of Common Pleas in 1871-72. One hundred fifty years later, courts are still attempting to accurately interpret the presented results of facial identification examinations, with results and conclusions often offered in subjective language. In this paper, the current advice from several standards producing bodies, court rulings, and the body of literature are used to frame a discussion of the process of comparing images of faces and presenting findings, providing practitioners and evaluators a framework with which to assess presented evidence. An annotated case survey is provided in the references section for further information.


### Introduction

Woodruff (1957) and McWilliam (2007) document the entry of facial comparison into the world of jurisprudence in Tichborne v. Lushington (1871–72). McWilliam (2007) notes that the photographic evidence was not given weight at the time, in Tichborne and in other cases, because of the belief that such images could be manipulated. Since then, the legal record is mixed as to whether or not specific expertise is needed to compare images and form conclusions as to match/no match, (Bertillon (1893), Burton (1999), Carey (1992), Davis (2009), Edmond (2009, 2010), Hancock (2000)). In an oft-cited case

regarding a perceived need for an expert to present testimony as to photographic comparison, Steinberg v. Indemnity Insurance Co. of North America, 364 F. 2d 266 - Court of Appeals, 5th Circuit 1966, the court ruled "If the question is one which the layman is competent to determine for himself, the opinion is excluded; if he reasonably cannot form his own conclusion without the assistance of the expert, the testimony is admissible." In case after case, one side or the other will move to exclude the other side's experts testimony and work product; arguing either that it is needed and vital to the presentation of the case or that it is simply a demonstrative presentation related to a single theory of the case that the Trier of Fact can easily discern for themselves. The determination as to if or when an expert is needed in a trial tends to fall more towards gaining advantage than towards an understanding of the evidence or the underlying science.

Once admitted and permitted to offer testimony, experts should be able to offer more than just a visual or demonstrative presentation of photographic views. They should be able and ready to opine on the more technical aspects of the case (White, 2015a, 2017). In United States v. Sellers, 566 F. 2d 884 - Court of Appeals, 4th Circuit 1977, the court ruled that "Expert testimony in cases such as this may assist the jury's evaluation of photographs by explaining the effects of light, shadow, and reflections, and the distortion caused by the perspective of the picture, and other technical factors. The expert, using enlargements if needed, may also point out to the jury similarities or differences between the features of the defendant and those of the person shown in the photograph." But to do so, the analyst must have accurate information from the scene. The ground truth information about the complete capture path of the images in evidence are often lacking from the crime scene report (Hoerricks, 2020).

Compounding the problem is cognitive bias. Dror (2006) notes that a type of cognitive bias common to pattern matching disciplines is the tendency for conclusions to be affected by how a question is framed or how data are presented. Forensic scientists, they note, can be affected by this cognitive bias if, for example, they are asked to compare two particular items – one frame of surveillance footage from the crime scene and one government-controlled image (DMV, booking photo, etc.) of the person suspected to have committed the particular offense - rather than comparing the crime scene exemplar with an appropriate sample of random images. To be truly random, the sample may or may not contain an image of the suspect in the particular inquiry. Figure 1, from White (2017), illustrates what such a

random one-to-many matching exercise might look like. In Figure 1, examiners were asked if the subject (above) is contained within the sample of 10 (below).


Figure 1 - A typical example of a trial from a one-to-many face matching study showing the level of similarity between the faces in face matching studies (Bruce et al., 1999), from White (2017), Figure 1.

Elsewhere, Dror (2013) notes that "criticisms have emerged from highly visible erroneous identifications and research demonstrating the subjectivity and bias-ability of forensic judgments, culminating in a number of public and scientific inquiries that have been quite critical of forensic science." These include the USA's National Research Council (2009), President's Council of Advisors on Science and Technology (PCAST, 2016), and the National Commission on Forensic Science (2015); as well as the UK's Forensic Science Regulator (2015), the Fingerprint Inquiry (2011), and the House of Lords Inquiry (2019), all of which have reported serious concerns with regard to forensic expert decision making.

Dror (2013) goes on to recommend that strict and detailed scientific methods and protocols should be developed, blinding examiners to potentially biassing irrelevant contextual information. Almazrouei (2019), Haber (2009), Sunde (2019) also speak to the need for examiners to be blind to irrelevant contextual information, suggesting, like Dror, a process of providing examiners only task-relevant information. Problems may also arise when examiners perceive themselves to be working for one side or the other. Dror (2013) suggests that it is not an easy task to weigh a piece of forensic evidence when one is part of the investigative team; or when the examiner is brought in to help 'build a case against' the suspected offender. Nevertheless, forensic examiners must give a balanced opinion to the court and contribute to the administration of justice by explicitly stating the weaknesses and limitations of their conclusions as well as those of the forensic science domain itself.

**Standards and Definitions**

In *A framework for harmonizing forensic science practices and digital/multimedia evidence*, the US-based Organization of Scientific Area Committees for Forensic Science (OSAC) notes *"[t]he value of forensic science as a whole is that it uses scientific reasoning and processes within the framework articulated in this document to address questions – specific to an event or a case – for legal contexts, to provide decision-makers with trustworthy understanding of the traces in order to help them make decisions. (OSAC, pg. iii)."* Further to the point, the authors place forensic science in context, *"[the above referenced document] proposes a broad definition of forensic science, not limited to legal problems in civil and criminal justice systems (courtroom contexts), and describes the different types of reasoning that play a significant role in forensic science. Then it defines five core forensic processes, seven forensic activities, and three operational techniques. The formalization of forensic science reasoning processes and outcomes in this work leads to increased reliability, repeatability, and validation in forensic results. This, in turn, gives decision-makers increased confidence in and understanding of forensic results. (pg. iii)."* A broad definition of forensic science is then proposed by the authors: forensic science is "*the systematic and coherent study of traces to address questions of authentication, identification, classification, reconstruction, and evaluation for a legal context (OSAC, pg.1)."*

It is this *systematic and coherent study* that is often missing from inquiries, replaced instead with haste and expediency as well as fallacious appeals to authority. Citing Dror (2015), Howes (2015), Morgan (2017), and Saks (2005), Almazrouei (2019) speaks to this mix of science and law, noting that "forensic science is a multidisciplinary field in which science, practice, law and policy come together to support the legal process."

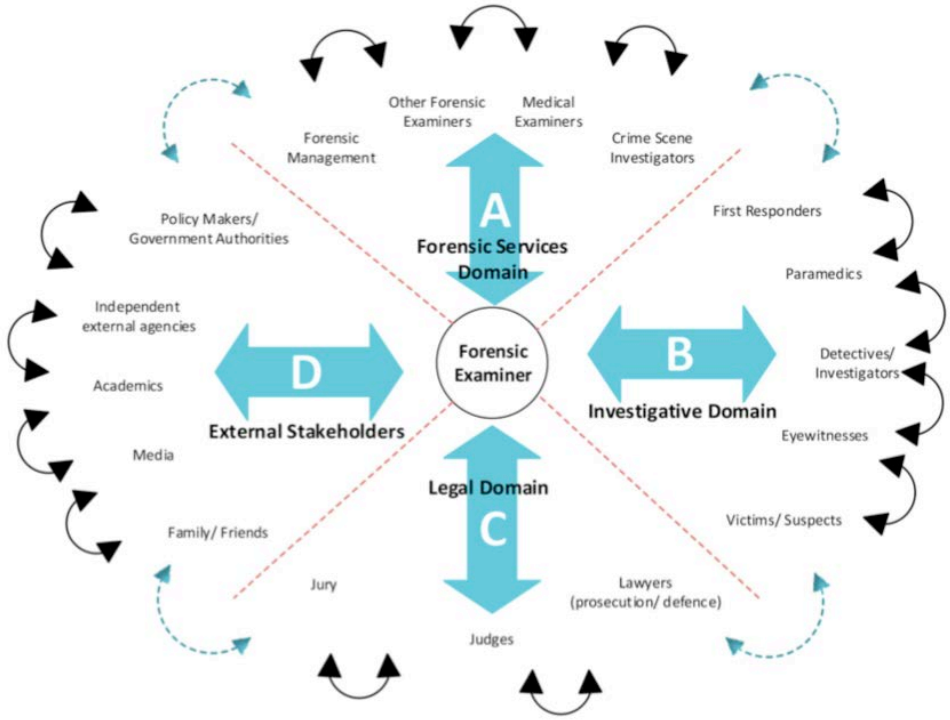


Figure 2 - from Almazrouei (2019). Interactions and decision-making pathways of different parties with the forensic examiners.

Within this context, the work product and testimony offered by forensic experts often carries significant weight in the criminal justice system as it is generally perceived to offer impartial and scientifically based evidence. Whilst there have been criticisms directed at the validity of some forensic science techniques and methods, as noted above, there have also been a number of challenges and concerns reported regarding the communication of expert testimony and overstatements of expertise, validity, and/or findings.

White (2017) investigated the issue of the error and validity in facial comparison for the purpose of identification. This investigation uncovered many cases in which expert evidence was proven to be wrong. The first of these cases illustrated by White involved evidence provided in a murder case in the UK. "In this case police asked four different facial mapping analysts to compare photographs of the suspect to surveillance images, and all four agreed that there was some support for a match. Sometime later, the investigators decided that they had arrested the wrong person and named a new suspect, whose image was sent to these same four analysts. Of the four, the first two now reached "inconclusive" findings, the third said there was support for the conclusion that the surveillance images did not depict the new suspect and the fourth concluded that there was 'powerful support' for the conclusion that they were the same person. Presumably troubled by the third expert's conclusions, the police asked this person to reconsider their evidence, making it apparent that they believed the new suspect was the person shown on the CCTV. This expert now reported that he could not exclude the possibility that it was the same person." Thus, this one piece of surveillance video had been linked to two different suspects with widely varying levels of identification confidence.

More importantly, what does "powerful support" mean? What does it mean when features observed in an image are "consistent with" features observed in another? How can specific levels of confidence be quantified? How can this quantification of confidence levels be standardized across an entire forensic science discipline? How should the Trier of Fact interpret a forensic expert's inability to exclude or include a subject or object from the inquiry?

**Essential Elements Within the Process of Manual Facial Comparison**

Across the justice system, images and video evidence items are analyzed every day. Perhaps contemporaneous notes were taken documenting the process employed and any other information relative to the facts of the case. Perhaps those notes were disclosed as part of the discovery process. I say perhaps, as there is no current requirement, at least in the US, that examiners take and disclose notes. Many agencies lack specific requirements about whether or not notes should be taken and kept, and what specifically must be included in those notes, or the eventual report.

Once a trial begins, the attorney that is seeking to qualify their forensic expert in order to provide expert (opinion) testimony will likely introduce the examiner, their qualifications, and what they've been

asked to do in the case. At that point, the judge may or may not declare them to be an expert in order that their opinion may be heard.

It is important to note at this point that titles and job descriptions can vary widely. Forensic experts that analyze images, videos, or multimedia files can be known as analysts, specialists, directors, police officers, etc. US FRE Rule 702 (2020), for example, governs the expert's testimonial experience. According to Rule 702, one is not an "expert" unless the judge confers such a status, and then only for the duration of one's testimony in that case. After one is dismissed, the expert will go back to their work as an analyst, examiner, specialist, etc. One may have specific subject matter expertise. But the assignment of the title of "expert" as relates to forensic science case work is generally done by the judge in a specific case, related to the type of testimony that will be offered, and only for the duration of the testimonial event.

Another class of testimony is available for those who will not offer an opinion, but rather will recount a series of events. A "technician" generally offers testimony about a procedure and the results of the procedure. No opinion is given. A typical example of such testimony would be, "I pushed the button and the DVR produced these files" (Hoerricks, 2018).

An "expert," qualified by education, knowledge, skills, and experience (Wilkinson, 2008), generally offers opinion-based testimony about the results of an experiment or test. A typical example of such testimony would be, "I've conducted a photographic comparison for the purposes of identification and, in my opinion, the unknown subject in the video at the aforementioned date/time is indeed the person depicted in the submitted booking photos."

As a vital part of the testimonial experience, the "expert" will be asked to explain the contents of the report that was prepared for the case. This requires a question be asked, what should be in such a report? Here, the "standard practices" or "standard guides" that are produced by standards-producing bodies, such as ASTM, can be of assistance in formatting and completing expert reports. Within the discipline of Forensic Multimedia Analysis, there are quite a few standards that govern our work. The relevant guidelines and standards are listed in the reference section below.

Following the guidance on report writing from the Scientific Working Group on Digital Evidence (2018), as well as the many ASTM guides and standard practices, a generalized structure for a forensic science report would contain the items shown below:

Administrative Information

- Examiner Information – ASTM E860
- Requestor Information – ASTM E860
- Unique Evidence Control Number(s) – ASTM E1459 – ASTM E1492
- Chain of Custody Information – ASTM E860 – ASTM E1188 – ASTM E1492

Summary of Request

- Service Requested (e.g. photographic comparison, photogrammetry, authentication, content analysis, etc.) (SWGDE Requirements for Report Writing – 5.2.3)

Methodology

- Equipment List (SWGDE Requirements for Report Writing – 5.4)
- Experimental Design/Workflow (SWGDE Requirements for Report Writing – 5.4)

Limitations/Delimitations

- Delimitations of the Experiment (SWGDE Requirements for Report Writing – 5.4)
- Limitations in the Data (SWGDE Requirements for Report Writing – 5.4)
- Personnel Delimitations/Limitations (SWGDE Requirements for Report Writing – 5.4)

Processing

- A description of the processing steps taken, settings, adjustments, etc., that would aid a similarly trained and equipped examiner to (1) reproduce the results and/or (2) validate the findings contained in the report. Both 1 and 2 would be necessary in supporting either a technical review or peer review of the work. ASTM 2825 (SWGDE Requirements for Report Writing – 5.4)

Results/Summary

- Problems/Errors Encountered (SWGDE Requirements for Report Writing – 5.4)
- Validation (SWGDE Requirements for Report Writing – 5.4)
- Conclusions/Findings (SWGDE Requirements for Report Writing – 5.5) – ASTM E620
- List of Output File(s)/Derivatives/Demonstratives (SWGDE Requirements for Report Writing – 5.6)

Approvals

- Examiner - ASTM E860
- Reviewer - ASTM E860
- Administrative Approval - ASTM E860

Within the processing section of the report, a similarly structured detailed overview of the processing of the files is necessary. Such a structure would look like the following (Hoerricks, 2008):

- Expanded Processing Workflow for Forensic Photographic Comparison
- Case Management (Assembling the evidence and the questions to be answered.)
- File Triage (can I view this file?)
- For Proprietary File Types, the creation of an appropriate proxy
- Import/Acquisition (load into software program)
- Content Triage (is an answer possible?)

Restoration

- Focus/Optical Correction/Stabilization/Noise Mitigation

Clarification

- Global Light/Colour Correction
- Local Light/Colour Correction

- Edge Sharpening

Presentation

- Interpolation
- Output Sharpening
- Analysis (Forensic Comparative Analysis)
- Redaction (when requested)
- Output (print/storage/archive)

An important note must be made at this point. Each evidence file will present unique problems to the examiner. For example, not all files will contain problematic noise or require optical correction. It's up to the examiner to document and justify the processing of each file. The above is offered as a generalized structure for the processing of files regardless of the tools employed.

**Content Triage – the most important step in forensic photographic comparison?**

In the image/video analysis workflow, the Content Triage step examines the file's contextual information from the standpoint of "can I answer the question or satisfy the request with this file?"

When considering video files as the source of the historic images for the eventual photographic comparison, the Content Triage step necessarily involves Frame Analysis. In answering questions about the quality and quantity of data present in the frame of interest, e.g. the level and type of compression employed in the creation of the frame, Frame Analysis necessarily considers the nominal resolution of the region of interest. The SWGDE Digital & Multimedia Evidence Glossary, Version: 3.0 (2016), defines nominal resolution as "the numerical value of pixels per inch (within the region of interest) as opposed to the achievable resolution of the imaging device." In other words, nominal resolution deals with the quantification of the pixels within the region of interest, not the capture system's capabilities. In this sense, the lens plays a key role. The farther away from the camera that the object is, given the lens and focal length, the lower the resulting nominal resolution will be (see Figure 3). The lower the nominal resolution, the lower the chance of successfully answering identification questions. Of the four classes of video views shown in Figure 3 (HOSDB, 2009), only the "Identify" view, with 100% of the image

height dedicated to the subject of interest, is fit for purpose in providing sufficient nominal resolution to support attempting a comparative analysis, though the "Recognise" view may occasionally yield a positive result.

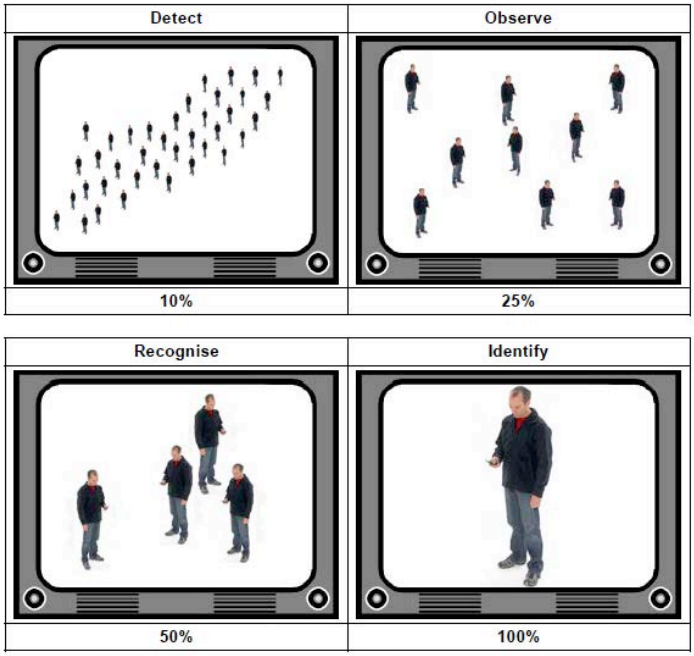


Figure 3 - camera type illustration (HOSDB, 2009).

In cases such as the attempt to identify an unknown object or subject by comparing it/them to an exemplar, the nominal resolution of the region of interest in the historic image is not known. In these cases, reverse projection photogrammetry is often employed whereby a contemporary recording is created and serves as an overlay to the historic recording. A calibrated measurement chart is placed in the contemporary recording in order to provide the measurement reference (Fig 4). If such an exercise is not possible, examiners often base their work on a normal distribution of values of the measure of relevant and nearby reference objects, representing results as a range rather than a specific measure.

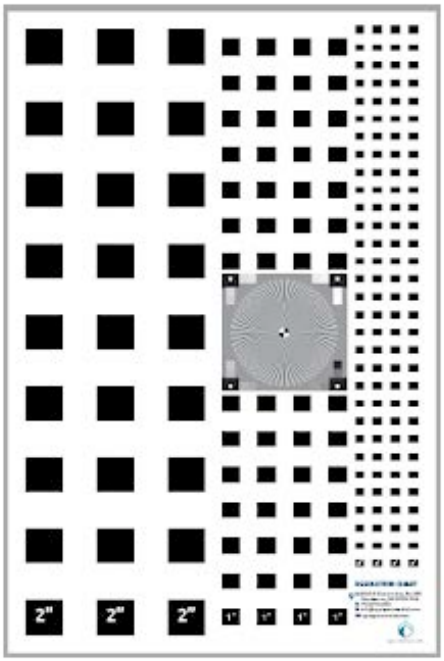


Figure 4 - Resolution chart used for reverse projection photogrammetry with 2", 1" and ½" squares. Specific design template available from the author.

Towler (2017) suggests that a "feature comparison" strategy is the most accurate method for conducting facial identification exams. With this in mind, a helpful guide for the Content Triage step is FISWG's Facial Image Comparison Feature List for Morphological Analysis, Version 2.0 (Feature List). The Feature List defines morphological analysis as "the method of facial comparison in which the features and components of the face are compared. Conclusions in relation to similarity or difference are based on subjective assessment, evaluation, and interpretation of observations." This list contains nineteen facial components (grouped in "tables"), each of which is further divided into levels of detail. The guidance goes on to note that the facial components are gross features to be considered in virtually all comparisons. The listed Tables, 1 through 19, further expands each facial component into a set of component characteristics and their associated characteristic descriptors.

Considering the complexity of human anatomy, any standard procedure using facial comparison analysis should consider all of the following facial components: Skin, Face/Head Outline, Face/Head Composition, Hair, Forehead, Eyebrows, Eyes, Cheeks, Nose, Ears, Mouth, Chin/Jawline, Neck, Facial Hair, Facial Lines, Scars, Facial Marks, and Alterations (FISWG, 2018). ASTM's E3149, "Standard Guide for Facial Image Comparison Feature List for Morphological Analysis," also provides a standard list of facial components and component characteristics to be assessed and evaluated during a morphological analysis.

In section 6.2.5, the FISWG Feature List makes an important point, "Morphological analysis is highly dependent on the quality and quantity of the facial features and characteristics that can be compared, which is in turn dependent on the quality of the image. Image quality can be affected by factors such as image resolution, lighting, focus, pose, angle, orientation, obstructions of facial features, etc. (FISWG, 2018). This brings us back to the concept of nominal resolution. How many rows or columns of pixels does it take to accurately depict the nasal tip and ala (Table 9 – Nose), or the helix and tragus (Table 10 – Ears), features that are very small in real life. What about the nose's overall length and angle? What nominal resolution is sufficient to perform a comparison?

Considering the question of the quantification of features, size, shape, etc., there is wide variation within the human species. At what nominal resolution does the nose become discernible in images in videos? At what nominal resolution does the alar base or nasal tip become distinct from the rest of the face? The features of the ear can be rather distinct when observed up close, or within high resolution photography. But, how do distance from the camera and compression conspire to confound an analysis by obscuring these details?

These questions are raised both to further the conversation and to point out that many of the studies cited by examiners when questioned about the general acceptance and validity of facial comparisons are studies related to biometrics, which utilize higher resolution images than are typically found in the world's CCTV systems (White, 2014, 2015, 2017). For those studies that consider medium to low resolution CCTV images, the authors note the functional distance at which recognition ceases to be possible. But, again, these relate to "recognition" by algorithms, not "identification" by examiners (Hurley, 2008; Kapil, 2014; Purkait, 2008). Additionally, some examiners cite the results of studies like

the Glasgow Face Matching Test (GFMT) (Burton, 2010) as proof of the validity of facial comparison, failing to inform the Trier of Fact that the GFMT's methodology bears no resemblance to the methodology commonly employed in the forensic sciences.

Finally here, as in the studies noted above, having clear, higher resolution images is surely important to the task of Content Triage. So too is knowing what one is looking for. Spaun (2009) notes, "A facial image comparison expert must be versed in many subjects including: comparative science, image science and processing, bones of the head, muscles of the face, properties of the skin, aging and alteration, legal issues and case law, and the history of facial identifications and photographic comparisons."

**Fairly Presenting One's Findings**

Once the examination is complete, the results noted on a copy of FISWG Feature List's tables can act like a "tally sheet," allowing the examiner to "total up" the number of features that are either in common or exclusive. This total can be used to justify a conclusion. The question here becomes, how to state one's conclusions in a fair and justifiable way?

To that point, many agencies adopted the Continuum of Conclusions Examples For Photographic Comparative Analysis that was found in version 1 of SWGIT's Section 16 – Best Practices for Forensic Photographic Comparison when it was published in 2009. The main issue with the Continuum is the subjectivity of the way it's been employed. For example, if an examiner finds similarity in two of the 36 characteristic descriptors of the nose of a subject of interest, are the noses "similar," are the results "inconclusive," or would such results "eliminate" the subject from consideration? Given that the nose table is only one of nineteen tables, if no other similarities are found across the face and head, does the result move to "eliminated?" The same question could be posed of the ears. Given the work done on the biometrics of the ear, finding "similarity" in what percentage of the characteristic descriptors moves the conclusion up the continuum? To the point of content triage, what percentage of the descriptors must be present/visible for the examination to even commence with any sort of validity? Given the quote attributed to Albert Einstein, "no amount of experimentation can ever prove me right; a single experiment can prove me wrong," as well as the burden of proof placed on the prosecution, should the number of visible descriptors needed to proceed at least exceed 50% of the items within the Feature

List? With that, for "identification," shouldn't the number of descriptors found to have matched between the historic image and the exemplar at least exceed 90% of the available descriptors? For images of faces where features are either obscured (clothing/accessories/make-up), or partially out of view, should the number needed remain the same or be reduced? For example, how should the Trier of Fact weigh the available data vs. the black swan that may be lurking beneath the subject's hoodie or behind their glasses?

| Continuum of Conclusions Examples For Photographic Comparative Analysis | | | |
|---|---|---|---|
| Identification<br>No conclusion<br>Elimination | Identification | Identification | Identification |
| | Similar | | Powerful support same |
| | | Similarities noted | Strong support same |
| | No conclusion, but with similarities | | Moderate support same |
| | | Neither/Nor – with explanation | Limited support same |
| | No conclusion | | Inconclusive |
| | | | Limited support different |
| | No conclusion, but with dissimilarities | | Moderate support different |
| | | | Strong support different |
| | Dissimilar | | Powerful support different |
| | Elimination | Elimination | Elimination |
| | No comparison Possible | Not suitable – with explanation | No comparison Possible |

Figure 5 - from SWGIT Section 16, Best Practices for Forensic Photographic Comparison, page 6.

The main problem with the Continuum is its resemblance to a Likert scale. Likert scales are used to measure attitudes and are employed in a wide variety of studies. Likert scales work best when assessing "agreement," "likelihood," "satisfaction," and "importance" (Likert, 1932). Used in a forensic setting, the Continuum would be a reflection of strength of the examiner's opinions or beliefs, not an objective measure of the strength of the association between features found in the historic and contemporary images. This is one of the likely reasons that the Continuum was dropped from SWGDE's current offerings on photographic comparison.

To this point, the FISWG Feature List does not define the comparison process itself, just the feature set to be used during such comparisons. Nor does it define a classification system to constrain how those descriptors shall be articulated as applied to samples. SWGDE's Technical Overview for Forensic Image Comparison (2019) notes that "multiple methodologies exist for image comparison," but does not enumerate them. SWGDE's Best Practices for Photographic Comparison for All Disciplines (2018) agrees with the Overview document that "there is no one specific methodology for photographic comparisons." Additionally, both make liberal use of the word "should," giving examiners and their agencies wide latitude to accept or reject the recommendations contained therein. As a result, there is wide variability in the way examinations are conducted and the workflow/conclusions reported.

FISWG's Facial Comparison Overview and Methodology Guidelines (2019) lists the three comparison methodologies (morphological analysis, superimposition, and photo-anthropometry) currently recognized in facial comparison and provides a brief overview of each, indicating that morphological analysis is best suited for forensic science work. FISWG's Forensic Face Note Taking and Reporting Requirements (2019) offers a bit of structure for one's report that largely mirrors the guidance on report writing from SWGDE. Yet, in the document, the only guidance provided to practitioners is to "compare and document features of the face visible in each image, as defined in the E3149 Facial Image Comparison Feature List for Morphological Analysis (FISWG, 2019)."

**Conclusion**

An analysis of the listed case files, the available literature, and guidance provided in the relatively few courses on offer for training on facial identification finds that examiners report their findings in deliberately ambiguous ways, often offer only a limited report that withholds the specific details and data needed by the Trier of Fact in evaluating their opinions, and often answer questions about validity and general acceptance by citing studies that have little bearing on their work or their methodology. This paper has explored the many ways in which these issues have presented themselves since the introduction of photographic comparison evidence 150 years ago.

To be fair and accurate, examiners must correctly assess the suitability of their evidence for use in a photographic comparison. They must ascertain and report the nominal resolution in the region of interest. That nominal resolution must be capable of resolving the details under consideration.

Examiners must report their findings in a way that is clear, accurately stating the results of their work. When some feature or another is a match, it is a match in its entirety. If such is not the case, then there is no match. The use of language that indicates the strength of the support of one's opinion must be avoided. The subjectivity of phrases like "consistent with" and "cannot include/exclude" pervert the course of justice when they are used to deliberately confuse the Trier of Fact. Often, when those that use such obfuscations within their report are questioned directly as to their conclusion – match or no match – they respond that they can't determine match… thus there is no match. Why waste the Court's time? Why not just say so in one's report? If a conclusion is possible, then appropriate phrases are "match" and "no-match." If no conclusion is possible, then the only available conclusion is that "no conclusion is possible." If the data supports no conclusion, then it should be reported as such.

In evaluating the work of others, either for technical reviews, peer reviews, or reviewing the work of the opposing counsel's examiner, the outlines found in the many consensus standards documents listed herein can provide guidance. The outline of the report's format above can help build a checklist of what must be included in a formal report. Something resembling FSWG's Feature List must be a part of that reportage. The word "must" is used, as opposed to the word "should," as these items are absolutely necessary when attempting to reproduce another person's work product or to test the validity of their claims/conclusions. Thus, this paper serves as a guide for such endeavors.

The claims/conclusions of examiners must be subject to scrutiny. Fallacious appeals to the authorities of college degrees and/or certifications are not enough. The work presented is either reproducible or it's not. The conclusions are either supportable, valid, or they're not. If the work is not reproducible, it must be rejected by the Trier of Fact. Likewise, if the conclusions aren't valid, they must be not simply discounted in weight but ignored completely, barred from the trial.

In light of Natural Law, where people have inalienable rights and are presumed innocent (Tadros, 2004), it is the prosecution's burden to prove their case beyond a reasonable doubt. When presenting forensic science work product and opinion, these must not be twisted by artful rhetoric, but plainly and simply presented. The unknown subject/object is either a match, or it isn't. It's really that simple.

**References:**

**Standards and Guidelines**


- ASTM E860 Standard Practice for Examining And Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation
- ASTM E1188 Standard Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator
- ASTM E1459 Standard Guide for Physical Evidence Labeling and Related Documentation
- ASTM E1492 Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory
- ASTM E2825 Standard Guide for Forensic Digital Image Processing
- ASTM E2916 Terminology for Digital and Multimedia Evidence Examination.
- ASTM E3149 Standard Guide for Facial Image Comparison Feature List for Morphological Analysis.
- ANZFSS The Australian and New Zealand Forensic Science Society Code of Professional Practice. Version 1, 11 August 2014.
- FISWG Facial Comparison Overview and Methodology Guidelines. Version 1.0 2019.10.25.
- FISWG Facial Identification Practitioner Code of Ethics. Version 2.0 2018.09.19.
- FISWG Facial Image Comparison Feature List for Morphological Analysis. Version 2.0 2018.09.11.
- FISWG Forensic Face Note Taking and Reporting Requirements. Version 1.0 2019.05.10.
- FISWG Glossary. Version 2.0 2019.10.25.
- FISWG Guide for Facial Comparison Training of Examiners to Competency (Draft). Version 1.0 2019.10.25.
- FISWG Guidelines and Recommendations for Facial Comparison Training to Competency. Version 1.1 2010.11.18.

- SWGDE Best Practices for Digital Forensic Video Analysis. Version: 1.0 (November 20, 2018)
- SWGDE Best Practices for the Forensic Use of Photogrammetry. Version: 1.0 (September 29, 2015)
- SWGDE Best Practices for Image Content Analysis. Version: 1.0 (February 21, 2017)
- SWGDE Best Practices for Photographic Comparison for All Disciplines. Version: 1.1 (July 18, 2017)
- SWGDE Digital & Multimedia Evidence Glossary. Version: 3.0 (June 23, 2016)
- SWGDE Guidelines for Forensic Image Analysis. Version: 1.0 (February 21, 2017)
- SWGDE Requirements for Report Writing in Digital and Multimedia Forensics. Version: 1.0
- (November 20, 2018)
- SWGDE Technical Overview for Forensic Image Comparison. Version: 1.0 (July 16, 2019)
- SWGDE Vehicle Make/Model Comparison Form: Version 1.0 (July 11, 2018)
- SWGIT Section 7 - Best Practices for Forensic Video Analysis. Version 1.0. 2009.01.6.
- SWGIT Section 11 - Best Practices for Documenting Image Enhancement. Version 1.3. 2010.01.15.
- SWGIT Section 12 - Best Practices for Forensic Image Analysis. Version 1.6. 2007.01.11.
- SWGIT Section 16 - Best Practices for Forensic Photographic Comparison. Version 1.0. 2009.01.16.


**Case Citations (USA)**


Ibar v. State, 190 So. 3d 1012 - Fla: Supreme Court 2016 https://scholar.google.com/scholar_case?case=8375007357416186543&q=%22facial+identification%22+experts&hl=en&as_sdt=2006

"Facial identification expert Raymond Evans testified at the evidentiary hearing that his work in facial identification is based upon scientific principles and is accepted as a valid and reliable scientific discipline within the scientific community — and was so recognized in 2000. Evans explained that because poor images have some resemblances to a referenced image, lay persons — who are generally unable to factor in discoloration, distortion, or other factors — may be lulled into believing that the images have to be depicting the same person."

"Evans found the crime scene images distilled from the surveillance videotape had very poor quality and lighting and very low resolution. Evans maintained that the images were not adequate to make a reliable identification. In comparing the facial proportions of Ibar with the perpetrator alleged to have been him, Evans found discrepancies with their respective jaw lines, right eyebrows, the width of the mouths, and dorsal ridge shape. Although he was not able to completely exclude Ibar because of general similarities, Evans opined that it is not possible to conclude that the perpetrator and Ibar are the same person because of the noted differences."

Commentary from the author (JH): This case is often cited in current cases. Its applicability is limited now as the case's multimedia evidence was analogue. The images used in current cases often come from predicted encoded frames. In the best of cases, the majority of the macroblocks in the region of interest utilize 8x8 or 16x16 Intra Prediction (FFMPEG, 2018). It's important to know that SWGDE has been informed of the error in their FFMPEG document as relates to these block types (Hoerricks, 2019d). Nevertheless, quality and quantity of data remains at issue.

People v. Dawkins, Cal: Court of Appeal, 2nd Appellate Dist., 6th Div. 2017 https://scholar.google.com/scholar_case?case=12640603706938852774&q=%22facial+identification%22+experts&hl=en&as_sdt=2006

"In speaking of the work of FISWG, Nadelle testified that the whole face identification method had a 30 percent error rate."

Commentary from the author (JH): Most testimony offered by experts do not offer error rates for their disciplines, error rate given the nominal resolution in comparisons, or error rate when using predictive encoded frames from digital video.

People v. Hernandez, Cal: Court of Appeal, 2nd Appellate Dist., 2nd Div. 2017 https://scholar.google.com/scholar_case?case=14991640428465668774&q=%22facial+comparison%22+experts&hl=en&as_sdt=2006

"Prior to trial, the trial court excluded that testimony of defense video expert [name omitted] regarding facial comparison of a frontal photo and profile photo taken of appellant just prior to trial with, respectively, Exhibit 8 and a still taken from Perez's iPhone video of the shooter. Appellant contends that the trial court abused its discretion under Sargon Enterprises, Inc. v. University of Southern California (2012) 55 Cal.4th 747 (Sargon). The People contend the trial court properly barred [name

omitted] testimony under People v. Kelly (1976) 17 Cal.3d 24 (Kelly) because it was based on a new scientific technique that was unreliable."

"Upon review, we conclude [name omitted] proffered comparisons were based on matter of a type on which an expert may not reasonably rely, and they were speculative. The trial court acted well within its authority as a gatekeeper in essentially determining that [name omitted] was not employing the same level of intellectual rigor of an expert in the relevant field. Notably, the theories relied upon by [name omitted] were new to science as well as the law, and he did not establish that his theories had gained general acceptance in the relevant scientific community or were reliable."

"Asked how he would compare the images, [name omitted] explained he would use, in part, Euclidean geometry. He admitted this was a technique that other people did not use. Also, he used what he called Michelangelo theory—[name omitted]'s technique of taking away portions of a distorted and/or blurred digital image to reveal the true features of the person in the iPhone video still and Exhibit 8—and an unnamed and unexplained technique for looking at bad images. [name omitted] thought his margin of error was five-to-eight percent."

"On cross-examination, [name omitted] agreed he was "somewhat unique" in using Euclidean geometry in image analysis and comparison. He did not have a scientific degree or a degree in Euclidean geometry. When asked if his use of Euclidean geometry had been subjected to scientific and peer view, he stated, "Sometimes, but not in this case because it's a theorem to understand my logic. I'm not drawing lines. . . . [¶] . . . [¶] I'm using a theory. . . . I'm defending my logic with a theory in geometry[.]" On an as-needed basis, [name omitted] used a member of his staff for peer review. The prosecutor inquired if [name omitted] was aware of anyone using Euclidean geometry in the forensic analysis of photographs like him, and he replied, "By name? No.""

"[name omitted] was asked if he had made any effort "to distinguish between artifacts and properties of the individuals depicted" in Exhibit 8. He replied, "No. Not in the report." He was then asked if he tried to make a distinction in his analysis. He said, "As best as . . . one could possibly do, but there's quite a bit of pixilation on that image.""

Commentary from the author (JH): This famous case illustrates the hazard of allowing untrained people into the proceeding. The examiner had no protocols for determining what was object and what was artefact or disturb. The examiner made up their own procedure, drawing from ancillary disciplines, but did not test their assumptions via peer review.

Romaine v. State, Fla: Dist. Court of Appeals, 2nd Dist. 2019 https://scholar.google.com/scholar_case?case=7927787708673898365&q=%22facial+identification%22+experts&hl=en&as_sdt=2006

"If an expert had been able to enhance the surveillance and had defense counsel presented that enhanced video to the jury through the expert's testimony, there is a reasonable probability that the jury would have placed more weight on the video evidence than the eyewitness identifications and that the result of the proceeding would have been different. See Ibar v. State, 190 So. 3d 1012, 1022-23 (Fla. 2016) (holding that trial counsel's deficiency in failing to procure a facial identification expert to challenge identification of defendant in videotape as one of the perpetrators of murders prejudiced the defendant and undermined the Court's confidence in his trial)."

Commentary from the author (JH): This case illustrates the importance of having a properly trained and equipped examiner clarify/enhance images used for identification. It also speaks to the potential of mistaken identifications/recognitions when using poor quality imagery.

United States v. Alexander, 816 F. 2d 164 - Court of Appeals, 5th Circuit 1987. https://scholar.google.com/scholar_case?case=15838778797911800203&q=%22photographic+comparison%22&hl=en&as_sdt=2006

"The court, relying upon United States v. Johnson, 575 F.2d 1347 (5th Cir.1978), cert. denied, 440 U.S. 907, 99 S.Ct. 1213, 59 L.Ed.2d 454 (1979), determined that the jury was able to make the necessary photographic comparisons without the aid of expert witnesses. Johnson held that "[i]f the question is one which the layman is competent to determine for himself, the opinion is excluded; if he reasonably cannot form his own conclusion without the assistance of the expert, the testimony is admissible." Id. at 1361 (citation omitted)."

Commentary from the author (JH): If the party is only offering a demonstrative comparison, then expertise is not necessary in "explaining" what they will see. If the party will offer a detailed explanation as to how it made its determination of "match" or "identification," then expertise can be offered. But, if the conclusion on offer is "consistent with," or "cannot include/exclude," these are observational judgements (qualitative, categorical, lacking specific quantitative/scientific basis), and thus no expertise is needed.

United States v. Sellers, 566 F. 2d 884 - Court of Appeals, 4th Circuit 1977 https://scholar.google.com/scholar_case?case=14174818174942779119&q=%22photographic+comparison%22&hl=en&as_sdt=2006

"The court permitted the defendant's expert in photo comparison to express his opinion about the differences between Sellers' features and those of the person in the surveillance photographs. It, however, excluded from the jury the expert's conclusion that Sellers was not the person shown in the photographs."

"On rebuttal, the court permitted the government's expert to explain the difficulties of making photographic comparisons because of variations in lenses, perspective, light, and development paper. Far more importantly, it also allowed him to express his conclusion that identification of the bandit by these particular photographs was impossible."

"Expert testimony in cases such as this may assist the jury's evaluation of photographs by explaining the effects of light, shadow, and reflections, and the distortion caused by the perspective of the picture, and other technical factors. The expert, using enlargements if needed, may also point out to the jury similarities or differences between the features of the defendant and those of the person shown in the photograph. This testimony may be admissible. Fed.R.Evid. 702, 703; see United States v. Green, 525 F. 2d 386, 391 (8th Cir. 1975)."

Commentary from the author (JH): It is quite rare to find the collection/field notes in the discovery package. Such notes would detail the surveillance system that recorded the evidence items (e.g. camera/lens/recorder make & model). Similarly, it is rare to find notes about the systems that capture the controlled images issued from government agencies (e.g. motor vehicle licenses, jail booking photos, and etc.).

United States v. Trejo, 501 F. 2d 138 - Court of Appeals, 9th Circuit 1974. https://scholar.google.com/scholar_case?case=11304209089792537647&q=%22facial+comparison%22+experts&hl=en&as_sdt=2006

"A photographic expert then testified for the government that in his "expert opinion," the individual in the surveillance camera photographs could be the defendant. Simmons v. United States, 390 U.S. 377, 88 S.Ct. 967, 19 L.Ed.2d 1247 141*141 (1968), established that when the photographic identification procedures followed is attacked on appeal, the verdict must be set aside if that procedure was so impermissibly suggestive as to give rise to a very substantial likelihood of irreparable misidentification."

"As part of its case, the government called as an expert witness [name omitted], an FBI photographic identification expert. He compared four photographs taken by the bank's surveillance camera at the time of the robbery with four police photographs of appellant and one photograph of appellant obtained from the California Driver's License Bureau. All the photographs had been enlarged so that the head size would be the same to facilitate comparison. [name omitted]pointed out that in all the photographs, the shape of the face, nose, mouth, and hair were similar. He admitted that the surveillance photographs were not clear enough to allow a positive identification, but stated that the features of the appellant were not inconsistent with the general facial characteristics discernible in the surveillance photographs. He concluded that all the photographs could possibly be of the same individual."

Commentary from the author (JH): the problem with this style of examination is the lack of quantification of "could possibly be." This is the same problem with the lack of scientific validity of the conclusion, "consistent with." This is rhetorical, categorical, and not scientific. Additionally, the way in which the case was presented to the examiner does not track with the current research in mitigating bias.

**State v. Kunze, 988 P. 2d 977 - Wash: Court of Appeals, 2nd Div. 1999.** https://scholar.google.com/scholar_case?case=15795224135794616261&q=STATE+v.+David+Wayne+KUNZE,+Court+of+Appeals+of+Washington,+Division+2.+97+Wash.+App.+832,+988+P.2d+977,+1999&hl=en&as_sdt=2006

"Alfred V. Iannarelli testified to extensive qualifications as a law enforcement officer. For 30 years, he had worked as a deputy sheriff in Alameda County, California, as the chief of campus police at California State University at Hayward, and in several other law enforcement positions. Thereafter, he had worked as a consultant on ear identification. He became interested in ears in 1948, and over the next 14 years classified perhaps 7,000 ears from photographs (but not from latent prints). In 1964, he published a book describing his system, which he calls "earology" or the "science of ear identification."[26] In 1989, he published a second edition through a different publisher. He had been prohibited from testifying in a 1985 Florida case called State v. Polite[27] on the ground that his system of ear identification was not generally accepted in the scientific community.[28] He had testified without objection in a 1984 California murder case called People v. Anzillotti.[29] He did not know of any

published scientific studies confirming his theory that individuals can be identified using earprints, and he did not claim that his system was generally accepted in the scientific community. On the contrary, he testified: Q: Are you aware of any scientific research at all that would confirm your theory that ears are so unique that individuals can be positively identified by comparing known earprints with latent ear impressions? A. Ear photographs, not earprints. Counsel, this is relatively a new science.[30]" "Dr. Ellis Kerley testified to extensive qualifications as a physical anthropologist. He has a doctorate in anthropology from the University of Michigan and was for many years a professor of that subject. He has taught the anatomy of the human ear. He formerly was President of the American Academy of Forensic Sciences, and President and First Diplomate of the American Board of Forensic Anthropology. He has worked on cases such as the assassination of President John F. Kennedy.[32] He thought that the human ear is probably different for each person, but he had "no information" indicating whether one ear can be differentiated from another by observing the ear's gross external anatomy.[33] He did not "consider Mr. Iannarelli's work scientific;" on the contrary, it was "narrative," not "reported in a scientific manner," and "not subjected to any statistical analysis."[34]"

Commentary from the author (JH): Ears are often used in facial comparisons. There is scant research on the uniqueness of the appearance of ears as depicted in surveillance footage or the nominal resolution necessary to quantitatively compare features or determine uniqueness.

**References**

1. Aitken, C., Roberts, P., & Jackson, G. (2010). Fundamentals of Probability and Statistical Evidence in Criminal Proceedings. London, UK: Royal Statistical Society.

2. Attwood, A. S., Penton-Voak, I. S., Burton, A. M., & Munafò, M. R. (2013). Acute anxiety impairs accuracy in identifying photographed faces. Psychological Science, 24, 591-1594.

3. Australia New Zealand Forensic Science Society. (2016). ANZFSS Council Response to President's Council of Advisors on Science and Technology Report. Retrieved from http://anzfss.org/anzfss-council-response-to-presidents-council-of-advisors-on-science-and-technology-report/

4. Almazrouei, M. A., Dror, I. E., & Morgan, R. M. (2019). The forensic disclosure model: What should be disclosed to, and by, forensic experts? International Journal of Law, Crime and Justice, 59, 100330. doi:10.1016/j.ijlcj.2019.05.003

5. Beattie, L., Walsh, D., McLaren, J., Biello, S. M., & White, D. (2016). Perceptual impairment in face identification with poor sleep. Royal Society Open Science, 3, 160321.

6. Bertillon, A. (1893). Identification anthropométrique: instructions signalétiques (Vol. 1). Impr. administrative.

7. Bruce, V., Henderson, Z., Greenwood, K., Hancock, P. J. B., Burton, A. M., & Miller, P. (1999). Verification of face identities from images captured on video. Journal of Experimental Psychology: Applied, 5, 339-360.

8. Brace, N., Pike, G., Kemp, R., Turner, J., & Bennett, P. (2006). Does the presentation of multiple facial composites improve suspect identification? Applied Cognitive Psychology, 20, 213-226.

9. Burton, A. M., Wilson, S., Cowan, M., & Bruce, V. (1999). Face recognition in poor-quality video: Evidence from security surveillance. Psychological Science, 10,243-248.

10. Burton, A. M., Schweinberger, S. R., Jenkins, R., & Kaufmann, J. M. (2015). Arguments against a configural processing account of familiar face recognition. Perspectives on Psychological Science, 10, 482-496.

11. Burton, A.M., White, D., McNeill, A. (2010). The Glasgow face matching test. Behav. Res. Methods 42, 286–291. (doi:10.3758/BRM.42.1.286)

12. Campbell-Tiech, A. (2005). "Stockwell" revisited: The unhappy state of facial mapping. Archbold News, 6, 4-6.

13. Carey, S., De Schonen, S., & Ellis, H. D. (1992). Becoming a face expert. Philosophical Transactions of the Royal Society B: Biological Sciences, 335, 95-103.

14. Chambers, D., & Reisberg, D. (1992). What an image depicts depends on what an image means. Cognitive Psychology, 24(2), 145.

15.Champod, et al. (2016). ENFSI Guideline for Evaluative Reporting in Forensic Science, A Primer for Legal Practitioners. Retrieved from https://www.researchgate.net/publication/298214747_ENFSI_Guideline_for_Evaluative_Reporting_in_Forensic_Science_A_Primer_for_Legal_Practitioners

16.Davis, J. P., & Valentine, T. (2009). CCTV on trial: Matching video images with the defendant in the dock. Applied Cognitive Psychology, 23, 482-505.

17.Dror, I., Charlton, D. (2006). Why experts make errors. Journal of Forensic Identification 56(4): 600-616.

18.Dror, I. (2013). The ambition to be scientific: Human expert performance and objectivity. Science and Justice, 53(2), 81-82. doi:10.1016/j.scijus.2013.03.002

19.Dror, I.E., McCormack, B.M., Epstein, J. (2015). Cognitive bias and its impact on expert witnesses and the court. Judges' J. 54 (4), 8–14.

20.Edmond, G., Biber, K., Kemp, R. I., & Porter, G. (2009). Law's looking glass: expert identification evidence derived from photographic and video images. Current Issues in Criminal Justice, 20, 337.

21.Edmond, G., Kemp, R., Porter, G., Hamer, D., Burton, M., Biber, K., & Roque, M. S. (2010). Atkins v The Emperor: the 'cautious' use of unreliable 'expert' opinion. The International Journal of Evidence & Proof, 14, 146-166.

22.Edmond, G., & Wortley, N. (2016). Interpreting Image Evidence: Facial Mapping, Police Familiars and Super-Recognisers in England and Australia. Journal of International and Comparative Law, 3, 473-522.

23.Executive Office of the President, President's Council of Advisors on Science and Technology. (2019). Report to the President, Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf

24.Fingerprint Inquiry. (2011). https://www.webarchive.org.uk/wayback/archive/20170104175208/http://www.webarchive.org.uk/wayback/archive/

25.20150428160012/http:/www.thefingerprintinquiryscotland.org.uk/inquiry/21.html

26.Fysh, M. C., & Bindemann, M. (2017). Effects of time pressure and time passage on face-matching accuracy. Royal Society Open Science, 4, 170249.

27.Garvie, C., Bedoya, A. M., & Frankle, J. (2016). The perpetual line-up: Unregulated police face recognition in America. Georgetown Law Center on Privacy & Technology. Retrieved from: www.perpetuallineup.org

28.Grother, P., Ngan, M., Hanaoka, K. (2020).Ongoing Face Recognition Vendor Test (FRVT) Part 1: Verification. NIST. https://www.nist.gov/programs-projects/face-recognition-vendor-test-frvt-ongoing

29.Grother, P., Ngan, M., Hanaoka, K. (2019).Face Recognition Vendor Test (FRVT) Part 2: Identification. NIST. https://doi.org/10.6028/NIST.IR.8271

30.Grother, P., Ngan, M., Hanaoka, K. (2019). Face Recognition Vendor Test (FRVT) Part 3: Demographic Effects. NIST. https://doi.org/10.6028/NIST.IR.8280

31.Haber, L.; Haber, R. N. (2009). Challenges to Fingerprints. Tucson, Az: Lawyers & Judges.

32.Hahn, C. A., O'Toole, A.J. & Phillips, P. J. (2016). Dissecting the time course of person recognition in natural viewing environments. British Journal of Psychology, 107, 117-135.

33.Hancock, P. J. (2000). Evolving faces from principal components. Behavior Research Methods, 32, 327-333.

34.Hancock, P. J., Bruce, V., & Burton, A. M. (2000). Recognition of unfamiliar faces. Trends in Cognitive Sciences, 4, 330-337.

35.Hancock, P. J. (2015). A decade of evolving composites: regression-and meta-analysis. Journal of Forensic Practice, 17, 319-334.

36.Henderson, Z., Bruce, V., & Burton, A. M. (2001). Matching the faces of robbers captured on video. Applied Cognitive Psychology, 15, 445-464.

37.Hoerricks, J. (2008). Forensic Photoshop. Blurb Publishing. San Francisco, CA.

38.Hoerricks, J. (2009). Author's invitation to the first meeting of FISWG. Retrieved from http://hoerricks.com/images/FISWG_invite_letter.pdf

39. Hoerricks, J. (2018). Report writing in forensic multimedia analysis. Retrieved from https://forensicphotoshop.blogspot.com/2018/05/report-writing-in-forensic-multimedia.html

40. Hoerricks, J. (2019a). Calculating nominal resolution during content triage. Retrieved from https://forensicphotoshop.blogspot.com/2019/03/calculating-nominal-resolution-during.html

41. Hoerricks, J. (2019b). First, do no harm. Retrieved from https://forensicphotoshop.blogspot.com/2019/08/first-do-no-harm.html

42. Hoerricks, J. (2019c). Review: Forensic science. the importance of identity in theory and practice. Retrieved from https://forensicphotoshop.blogspot.com/2019/09/review-forensic-science-importance-of.html

43. Hoerricks, J. (2020). Ground Truth – the missing link in digital/multimedia forensic science. eForensics Magazine. Vol. 09 No. 01. Issue 01/2020, (97) January ISSN 2300 6986

44. House of Lords Science and Technology Select Committee. (2019). Forensic Science and the Criminal Justice System: A Blueprint for Change. Available at: https://publications.parliament.uk/pa/ld201719/ldselect/ldsctech/333/33302.htm

45. Howes, L.M., 2015. The communication of forensic science in the criminal justice system: a review of theory and proposed directions for research. Sci. Justice 55 (2), 145–154.

46. Hurley, D., Arbab-Zavar, B., Nixon, M. (2008). The Ear as a Biometric. In: Jain, A.K., Flynn, P., Ross, A.A. (eds) Handbook of Biometrics. Springer, Boston, MA

47. Jenkins, R., & Burton, A. M. (2011). Stable face representations. Philosophical Transactions of the Royal Society of London B: Biological Sciences, 366, 1671- 1683.

48. Jenkins, R., White, D., van Montfort, X., Burton, A. M. (2011). Variability in photos of the same face. Cognition, 121, 313–323.

49. Kapil, V., Bhawana, J., & Vikas, K. (2014). Morphological variation of ear for individual identification in forensic cases: A study of an Indian population. Res J Forensic Sci, 2(1), 1-8.

50.Kemp, R. I., Towell, N., & Pike, G. (1997). When seeing should not be believing: Photographs, credit cards and fraud. Applied Cognitive Psychology, 11, 211-222.

51.Kleinberg, K. F., Vanezis, P., & Burton, A. M. (2007). Failure of anthropometry as a facial identification technique using high quality photographs. Journal of forensic sciences, 52, 779-783.

52.Lee, W. J., Wilkinson, C., Memon, A., & Houston, K. (2009). Matching unfamiliar faces from poor quality closed-circuit television (CCTV) footage. Axis: The Online Journal of CAHId, 1, 19-28.

53.Legal Information Institute. (2020). Federal Rules of Evidence. Rule 702. Testimony by Expert Witnesses. Retrieved from https://www.law.cornell.edu/rules/fre/rule_702

54.Likert, Rensis (1932). "A Technique for the Measurement of Attitudes". Archives of Psychology. 140: 1–55.

55.Lucas, T., Kumaratilake, J., & Henneberg, M. (2016). Metric identification of the same people from images: How reliable is it? Journal of Anthropology, 2016

56.McWilliam, R. (2007). The Tichborne Claimant: A Victorian Sensation. London: Hambledon Continuum.

57.Megreya, A, & Burton, A. M. (2006). Unfamiliar faces are not faces: Evidence from a matching task. Memory & Cognition, 34, 865-876.

58.Megreya, A. M., & Burton, A. M. (2007). Hits and false positives in face matching: A familiarity-based dissociation. Perception & Psychophysics, 69, 1175-1184.

59.Megreya, A., & Burton, A. (2008). Matching faces to photographs: Poor performance in eyewitness memory (without the memory). Journal of Experimental Psychology: Applied, 14, 364–372.

60.Megreya, A. M., Sandford, A., & Burton, A. M. (2013). Matching face images taken on the same day or months apart: The limitations of photo ID. Applied Cognitive Psychology, 27, 700-706.

61.Megreya, A., White, D., & Burton, A. M. (2011). The other race effect does not rely on memory: Evidence from a matching task. Quarterly Journal of Experimental Psychology, 64, 1473-1483.

62.Meissner, C.A., & Brigham, J.C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. Psychology Public Policy and Law 7(1):3-35.

63.Morgan, R.M. (2017a). Conceptualising forensic science and forensic reconstruction. Part I: a conceptual model. Sci. Justice 57 (6), 455–459.

64.Morgan, R.M. (2017b). Conceptualising forensic science and forensic reconstruction. Part II: the critical interaction between research, policy/law and practice. Sci. Justice 57 (6), 460–467.

65.Morgan, R.M. (2018). Forensic science needs the 'hedgehog' and the 'fox'. Forensic Sci. Int. 292, e10–e12.

66.Morgan, R.M., Nakhaeizadeh, S., Earwaker, H., Rando, C., Harris, A.J.L., Dror, I.E. (2018). Interpretation of evidence: cognitive decision making under uncertainty (at every step of the forensic science process). In: Wortley, R., Sidebottom, A., Laycock, G., Tilley, N. (Eds.), Handbook of Crime Science. Routledge, Abingdon, pp. 408–420.

67.National Commission on Forensic Science. (2015). Ensuring that Forensic Analysis Is Based upon Task-Relevant Information. Retrieved from. https://www.justice.gov/archives/ncfs/file/818196/download

68.National Research Council. (2009). Strengthening Forensic Science in the United States: A Path Forward. The National Academies Press, Washington DC

69.Norell, K., Läthén, K. B., Bergström, P., Rice, A., Natu, V., & O'Toole, A. (2015). The effect of image quality and forensic expertise in facial image comparisons. Journal of Forensic Sciences, 60, 331-340.

70.Noyes, E., & Jenkins, R. (2016). Deliberate disguise in facial image comparison. Journal of Vision, 16, 924-924.

71.Noyes, E., & Jenkins, R. (2017). Camera-to-subject distance affects face configuration and perceived identity. Cognition, 165, 97-104.

72.Organization of Scientific Area Committees for Forensic Science. (2019). A framework for harmonizing forensic Science practices and digital/multimedia evidence [PDF]. Gaithersburg: The

Organization of Scientific Area Committees for Forensic Science, OSAC Task Group on Digital/ Multimedia Science. http://dx.doi.org/10.29325/OSAC.TS.0002

73.Palermo, R., Willis, M., Rivolta, D., McKone, E., Wilson, C.E., Calder, A.J. (2011). Impaired holistic coding of facial expression and facial identity in congenital prosopagnosia. Neuropsychologia Volume 49, Issue 5, April 2011, Pages 1226-1235. ps://doi.org/10.1016/j.neuropsychologia. 2011.02.021

74.Phillips, P. J., Jiang, F., Narvekar, A., Ayyad, J., & O'Toole, A. J. (2011). Another-race effect for face recognition algorithms. ACM Transactions on Applied Perception, 8, 14.

75.Phillips, P. J., Beveridge, J. R., Draper, B. A., Givens, G., O'Toole, A. J., Bolme, D. S., ... & Weimer, S. (2011). An introduction to the good, the bad, & the ugly face recognition challenge problem (pp. 346-353). IEEE.

76.Phillips, P. J., Hill, M. Q., Swindle, J. A., & O'Toole, A. J. (2015). Human and algorithm performance on the PaSC face recognition challenge. In: IEEE 7th International Conference on Biometrics: Theory, Applications and Systems (BTAS 2015).

77.Porter, G., Doran, G. (2000). An anatomical and photographic technique for forensic facial identification. Forensic Science International, 114 (2000) 97-105

78.PCAST, 2016. Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods. President's Council of Advisors on Science and Technology, Executive Office of the President of the United States, Washington, DC.

79.Purkait, R., Singh, P. (2008). A test of individuality of human external ear pattern: Its application in the field of personal identification. Forensic Science International. Volume 178, Issues 2–3, 4 July 2008, Pages 112-118

80.Reisberg, D., Pearson, D.G., Kosslyn, S.M. (2003). Intuitions and introspections about imagery: the role of imagery experience in shaping an investigator's theoretical views. Applied Cognitive Psychology. Appl. Cognit. Psychol. 17: 147–160 (2003) doi: 10.1002/acp.858

81.Ritchie, K. L., Smith, F. G., Jenkins, R., Bindemann, M., White, D., & Burton, A. M. (2015). Viewers base estimates of face matching accuracy on their own familiarity: Explaining the photo-ID paradox. Cognition, 141, 161-169.

82.Saks, M.J., Koehler, J., 2005. The coming paradigm shift in forensic identification science. Science 309 (5736), 892–895.

83.Saks, M.J., Risinger, D.M., Rosenthal, R., Thompson, W.C., 2003. Context effects in forensic science: a review and application of the science of science to crime laboratory practice in the United States. Sci. Justice 43 (2), 77–90.

84.Scobie, C., C. Semmler & M. Proeve (2019) Considering forensic science: individual differences, opposing expert testimony and juror decision making, Psychology, Crime & Law, 25:1, 23-49, DOI: 10.1080/1068316X.2018.1488976

85.Shakeshaft, N. G., & Plomin, R. (2015). Genetic specificity of face recognition. Proceedings of the National Academy of Sciences, 112, 12887-12892.

86.Shapiro, P.N., Penrod, S. (1986). Meta-Analysis of Facial Identification Studies. Psychological Bulletin 1986, Vol. I 00, No. 2, 139-156

87.Spaun N.A. (2009) Facial Comparisons by Subject Matter Experts: Their Role in Biometrics and Their Training. In: Tistarelli M., Nixon M.S. (eds) Advances in Biometrics. ICB 2009. Lecture Notes in Computer Science, vol 5558. Springer, Berlin, Heidelberg.

88.Spiteri, V. R., Porter, G., & Kemp, R. (2015). Variation of craniofacial representation in passport photographs, Journal of Criminological Research, Policy and Practice, 1, 239-250.

89.Strathie, A., McNeill, A., & White, D. (2012). In the dock: Chimeric image composites reduce identification accuracy. Applied Cognitive Psychology, 26, 140-148.

90.Strathie, A., & McNeill, A. (2016). Facial Wipes don't Wash: Facial Image Comparison by Video Superimposition Reduces the Accuracy of Face Matching Decisions. Applied Cognitive Psychology, 30, 504-513.

91. Sunde, N., & Dror, I. E. (2019). Cognitive and human factors in digital forensics: Problems, challenges, and the way forward. Digital Investigation, 29, 101-108. doi:10.1016/j.diin.2019.03.011

92. Tadros, V., & Tierney, S. (2004). The Presumption of Innocence and the Human Rights Act. The Modern Law Review, 67(3), 402-434.

93. The Forensic Science Regulator. (2015). Cognitive Bias Effects Relevant to Forensic Science Examinations. Retrieved from. https://www.gov.uk/government/publications/cognitive-bias-effects-relevant-to-forensic-science-examinations

94. Tistarelli, M. & Champod, C. (Eds.), Springer-Verlag., Wilkinson, C., & Evans, R. (2009). Are facial image analysis experts any better than the general public at identifying individuals from CCTV images? Science & Justice, 49, 191-196.

95. Towler, A. (2017) Match me if you can: Evaluating professional training for facial image comparison (unpublished PhD thesis). UNSW Sydney, Sydney, Australia

96. Towler, A., Kemp, R. I., & White, D. (2017). Unfamiliar face matching systems in applied settings. In M. Bindemann & A. M. Megreya (Eds.), Face Processing: Systems, Disorders and Cultural Difference. Nova Science.

97. Towler, A., White, D., & Kemp, R. I. (2014). Evaluating training methods for facial image comparison: The face shape strategy does not work. Perception, 43, 214-218.

98. Towler, A., White, D., & Kemp, R. I. (2017). Evaluating the feature comparison strategy for forensic face identification. Journal of Experimental Psychology: Applied, 23, 47-58.

99. Wang, Z, et al. (2004). Image quality assessment: From error visibility to structural similarity. In IEEE Transactions on Image Processing, Vol. 13, No. 4, pp. 600–612, Apr. 2004. http://dx.doi. org/10.1109/TIP.2003.819861

100. White, D., Burton, A. M., Kemp, R. I., & Jenkins, R. (2013). Crowd effects in unfamiliar face matching. Applied Cognitive Psychology, 27, 769-777.

101.White, D., Phillips, P. J., Hahn, C. A., Hill, M., & O'Toole, A.J. (2015a). Perceptual expertise in forensic facial image comparison. Proceedings of the Royal Society of London B: Biological Sciences, 282, 1814-1822.

102.White, D., Burton, A. M., Jenkins, R. & Kemp, R. I. (2014). Redesigning photo-ID to improve unfamiliar face matching. Journal of Experimental Psychology: Applied, 20, 166-173.

103.White, D., Dunn, J. D., Schmid, A. C. & Kemp, R. I. (2015). Error rates in users of automatic face recognition software. Plos One 10: e0139827.

104.White, D., Kemp, R. I., Jenkins, R., Matheson, M., & Burton, A. M. (2014). Passport officers' errors in face matching. PloS One, 9, e103510.

105.White, D., Norrell, K., Phillips, J. P., O'Toole, A. J. (2017). Human factors in forensic face identification. In Springer Handbook of Biometrics in Forensic Science,

106.Wilmer, J. B., Germine, L., Chabris, C. F., Chatterjee, G., Williams, M., Loken, E., ... & Duchaine, B. (2010). Human face recognition ability is specific and highly heritable. Proceedings of the National Academy of sciences, 107, 5238-5241.

107.Wirth, B. E., & Carbon, C. C. (2017). An easy game for frauds? Effects of professional experience and time pressure on passport-matching performance. Journal of Experimental Psychology: Applied, 23, 138.

108.Woodhead, A. D. Baddeley & D. C. V. Simmonds (1979). On Training People to Recognize Faces, Ergonomics, 22, 333-343.

109.Woodruff, D. (1957). The Tichborne Claimant: A Victorian Mystery. London: Hollis & Carter.

110.Yovel, G., & O'Toole, A. J. (2016). Recognizing People in Motion, Trends in Cognitive Sciences, 20, 383-395.

111.Zaidi, A.A., Mattern, B.C., Claes, P., McEvoy, B., Hughes, C., et al. (2018). Investigating the case of human nose shape and climate adaptation. PLOS Genetics 14(1): e1007207. https://doi.org/10.1371/journal.pgen.1007207

**About the Author**

**Jim Hoerricks, PhD AVFA**, is a Certified Audio/Video Forensic Analyst (AVFA) in private practice, is the author of the best-selling book Forensic Photoshop (available on Amazon.com), is a co-author of Best Practices for the Retrieval of Video Evidence from Digital CCTV Systems (DCCTV Guide), published by the Combating Terrorism Technical Support Office (CTTSO), is retired from police service where his unit (LAPD's Electronics Unit) was responsible for the collection and analysis of multimedia evidence (audio, video, images, and metadata from digital CCTV systems and mobile devices), and currently serves the Organization of Scientific Area Committees on Forensic Science (OSAC) as the Video/Image Technology and Analysis (VITAL), Video Task Group lead.