Using Facial Creases for Identification

Helmi Hadi[a*]

[a] *Forensic Science Programme, School of Health Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia*

ABSTRACT: Facial creases have been long studied from a cosmetic point of view, but rarely utilised for facial identification. The first part of the paper focuses on growth and ageing of the skeletal structure, facial muscles and skin followed by the current trends of facial crease research by researchers. Face as an identification tool and the psychological aspects of internal and external features of the face useful for identification is classified in the second part. In conclusion, a new research area which combines facial creases and facial identification is suggested as facial creases are unique in structure and useful for identification. Facial creases should be categorised as an internal structure of the face and incorporated in facial identification research.

Keyword: Growth, Ageing, Facial Creases, Facial identification, Face Psychology,

The Ageing Mechanism and Facial Crease Formation

The ageing mechanism varies between individuals and it is hard to predict. Features which manifest on one person may not manifest on another person. What is ageing then?

Ageing needs to be universal in nature for a given species [1]. The onset of wrinkles is an example of a universal effect. Without external intervention (such as cosmetic surgery) everyone will eventually get face wrinkles. Second, the change should be intrinsic [1], extrinsic [2] or photoageing [3]. For example, exposure of skin to UV light (extrinsic and photoeageing in nature) will change the physical and chemical components of the skin (intrinsic in nature). Next, ageing is a progressive and irreversible event [1]. Individuals with forehead creases will have more pronounced creases as they get older. Finally, the change must be deleterious to the organism [1].

Facial Skeletal Growth and Ageing

Skeletal facial growth has been studied in detail by previous authors [4-6]. Formation of the face begins from the 3rd week of in-utero with the growth of the frontonasal prominence and the genesis of Branchial arches. The Branchial arches form the basic structural organs of the face and neck [4].

The human skeletal structure changes throughout the individual's life [7]. Visual example of the changes can be seen in the nose structure. At birth, the nostrils are similar with the lower margin of the eye orbits [8]. The nose will then steadily grow with age and other areas such as the nasal cavity will be enlarged by bone redeposition from the internal surface to the palate [8]. The bone redepostion method is also responsible for the air sinuses in the skull. The maxilla for example grows posteriorly and forward at the tuberosity with the apposition occurring anteriorly. The lateral surface of the maxilla will be deposited with bone and the alveolar process will widen inferior and anterior in direction [9]. Formation of the alveolar process will allow for the teeth to grow in place. Retrusion of the lower face is less pronounced with age as the mandible will grow more than the maxilla [8].

Research shows that the orbital, mandible, glabellar and maxillary region changes with age [10, 11]. Williams and Slice [11] also recorded changes in the zygomatic bone as a person ages. The Lambros theory on facial aging proposed by Pessa [12] suggests that the midface changed in a clockwise rotation when the skull is viewed on the right side of the sagittal plane. In order to verify the hypothesis, stereolithography was employed with the skull creation. Figure 1 shows the Lambros's theory as suggested by Pessa [12]:

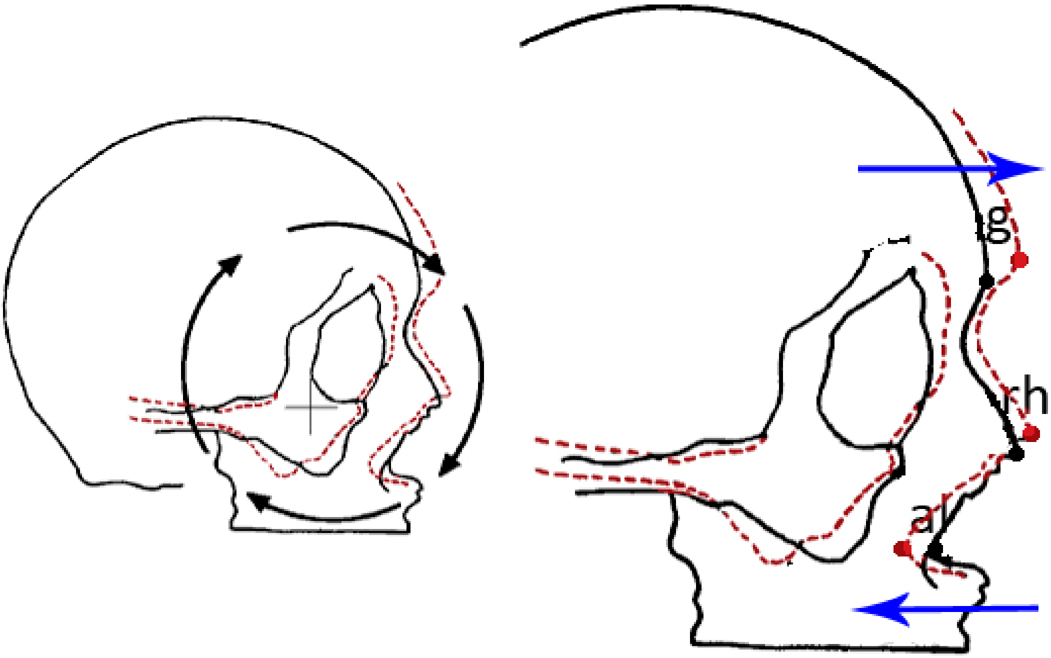

Figure 1: Ageing of the skull described by Lambros's theory. The skull shape after ageing is shown by the red-dotted line with the blue arrows indicating the direction of change. The rhinion (rhi) and glabella (g) moves forward while alare (al) regress back. Figure modified from Pessa [12].

It has to be recognised however that two studies contradict Lambros's theory. The results indicated by these studies suggested that there was no overall change in the fixed bony skeleton in the anteroposterior direction as seen in aged individuals [13, 14]. Changes could only be detected on the maxilla body without involving the orbital rims [14]. The different results of these studies may be due to different measurement methods. The Lambros's theory [12] and female Computed Tomography (CT) scan data [15] do suggest that the glabellar angle decreases as a person gets older. The glabella angle decreases the most with middle age males.

The orbital aperture width of both males and females increases significantly with age [13, 16, 17]. Changes could be seen on the superior and inferior orbital rim when the measurements were obtained medially [16]. The overall area of the orbits increases in size with the increase in size in the superior and inferior orbital margin [10]. The increase in orbital size is also supported by another research on orbital volume with the aid of CT scan on participants between 18 to 40 years old [18].

The maxilla and mandible are not excluded from remodeling throughout the person's lifetime. Coleman [19], stated that the maxilla and mandible reduced in height, but no timeframe was provided. The height of the mandible and maxilla bone in the Frankfurt horizontal (FH) plane increases between 22 and 33 years old [20] and between 30 and 40 years old age group [21]. A study on three different age groups (17, 47 and 57 years old subjects) showed that the maxilla and mandible increase in height between 2 and 3 mm [22]. The ageing process is greatly pronounced in edentulous individuals as the mandible and maxilla bones reabsorb due to the missing teeth. However, if teeth are present, the maxilla and the mandible will remain relatively the same morphology [9]. Studies on the maxilla and ageing have been conducted by numerous authors [10, 12-17, 19, 23-25]. The anterior portion of the zygomatic arch becomes slender with age as old age individuals exhibit a compressed arch [11].

Muscles of Facial Expression and Ageing of the Muscles

Renaissance artists such as Leonardo da Vinci, Michelangelo and Andrea del Verrochio were the first to record their studies on wax models [26]. Duchenne (late 19th century) studied the action and location of each muscle by stimulating muscles on test subjects faces with electricity [27]. From 30 years old onwards, there is a 1% muscle loss per year with increase in age which is mainly due to atrophy [1]. Muscles grow weaker due to death and the lower ability to contract the remaining muscle cells [1]. The finite amount of cell division is due to the length of the cell's telomere [28]. The specific amount of time a cell can divide before it stops dividing due to the telomere reaching its critical length is called the Hayflick limit [29]. Aesthetically, individuals will appear flabby in appearance due to muscle loss with the lack of muscle usage [30]. Bone joints will appear larger and areas between the joints will become thinner due to muscle loss [30].

Skin and Skin Ageing

The skin is the largest organ of the human body creating a barrier between internal organs and the outside world. It weighs six pounds, roughly 2 mm thick and made out of two layers (epidermis and dermis) with one layer of fat (hypodermis) [31]. The epidermis does not contain collagen fibres therefore has little tensile strength [32]. The dermis located inferior of the epidermis is a fibrous protein in nature and contains appendages which include eccrine glands, blood vessels and nerves [32].

The skin will eventually lose its elasticity and wrinkles will manifest with age. The change is shown with the slower cell division in the stratum germinativum and the flattening of the epidermal-dermal interface [33]. The loss of subcutaneous also contributes to the increased ageing process [33]. For menopausal women, the lack of oestrogen reduces the activity of the sweat and sebaceous glands which in turn makes the skin more susceptible to trauma and wounds heal slower [1]. Skin sagging is common for aged individuals with the diminishing of the skin collagen. The lack of collagen makes the skin coarser, less elastic and cross-link [30]. Sagging skin is one of the causes of facial wrinkles. The effects of skin ageing based on chronological age starting from 30 years onwards have been documented by several researchers [34-37].

Ageing and Face Analysis

Early research on ageing with lateral head plates of the same individuals from child to adulthood shows that the chin and nose become more pronounced in adult faces [38]. Sexual dimorphism could be detected in the nasal, chin and mouth area with females having smaller faces compared to males [39]. Correlation between the soft-tissue components and the skeletal structure was found in a study on lateral cephalograms of 170 orthodontic patients [40]. However, the findings from Halazonetis [40] were not replicable by another research utilising lateral cephalographs [41]. It is however possible to differentiate occlusion of Class I and Class III in facial profile but harder between Class I and Class II [41].

Research shows that people are better at estimating the age of unknown individuals when the individual is closer to the person's own age [42]. However, when skin texture is removed, people tend to underestimate the person's age [42]. In another research on 250 Chinese women aged between 25 and 70 years old in Shanghai, the authors found that large discrepancies of up to 29 years for women with the same chronological age [43]. The highest age association were found when hyperpigmentation and wrinkles were used as identification cues [43]. Skin hydration, colour and trans-epidermal water loss (TEWL) does not aid in age identification [43]. A study on Caucasian women yielded slightly different results, where participants noted that skin colour, lip border and eye area were the main indicators of a person's age with a clear advantage towards same sex identification [44]. The differences which exist among Asian and Caucasian population may be due to the different cues utilised to predict a person's age.

Wrinkles, Furrows, Folds and Creases

The use of wrinkles, furrows, folds and creases are mostly interchangeable and no accepted classification exists [45]. A wrinkle is "a slight ridge in the smoothness of a surface such as a crease in a skin as a result of age" [46]. Furrow is defined as "any deep groove, especially a deep wrinkle on the forehead" [47]. By anatomy definition, a fold is a "mark, crease, or hollow made by folding" [48]. A crease is "a wrinkle or furrow especially on the face" [49]. In order to differentiate the term wrinkles and folds, Lemperle and colleagues defined wrinkles as creases limited to the dermal layer which can be cosmetically treated while folds manifest from an intrinsic ageing laxity of the skin and sagging [45]. Figure 2 shows the difference between wrinkles and folds as described by Lemperle *et al.* [45].

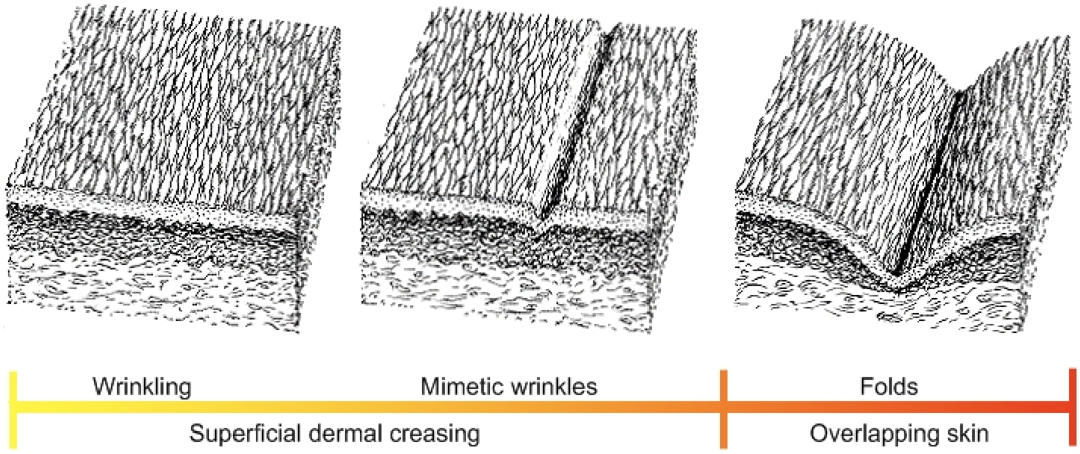

Figure 2: Textural changes of facial skin. Figure modified from [45]

Wrinkling pattern differs between racial groups [50, 51]. However, wrinkles has a multifactorial cause of origin and subject recruitment in the research may play a factor in wrinkle pattern observed [50, 51].

There are two common methods for face wrinkle categorisation. The first and most utilised method is carried out with skin casts or skin replicas [45, 51-53] and rate the wrinkles based on photos or images [45, 51, 54-60]. Biopsies [54, 61, 62], direct 3D in-vivo measurements [63] and measurement of elasticity utilising a cutometer [51, 52, 64] have also been conducted. As skin replicas and scales are qualitative analysis (dependent on the researcher), there does not seem to be a consensus on the scale utilised for skin wrinkle measurement. Most researches use "0 to 5" scale where no wrinkles are indicated by a zero score and severe wrinkling by a five score [45, 51, 58, 59]. The scales however vary from a 3-point [55, 56, 60] to a 14-point scale [56]. The scale preference is researcher dependent. While it is possible to categorise images based on photographs of facial wrinkles, it is impossible for a standardisation which could be utilised across different researches. Another problem with relying on a specific face angle photograph for crease detection is that the creases are not visualised as a whole. Angle of lighting and shadow of which results from the lighting may make a fine crease appear deep. As qualitative analysis is researcher dependent, researchers may change rating scales while conducting the test. For instance, if a severe wrinkling face photograph is obtained from the data pool, there is a tendency to reclassify images seen prior to the severe wrinkled face [65].

Quantifiable analysis studying the depth, number or length of wrinkles have been conducted by several researchers [55, 57, 62, 66]. However, the 3D measurement of the skin replicas still needs to be assessed qualitatively if wrinkles were to be classified based on severity [45, 53]. Categorisation of face wrinkles with computer algorithms has also been carried out [66]. The software categorises the age based on the number of creases which is detected on the face and limited to few parts of the face, rather than analysing the face as a whole [66]. Table 1 summarises the researches categorising facial wrinkles. Figure 3 shows the location of the creases analysed in Table 1 except for the neck fold. The orbital shape in Figure 3 is not a specific crease, but an overall crease which is manifested in old aged individuals with severe skin laxity.

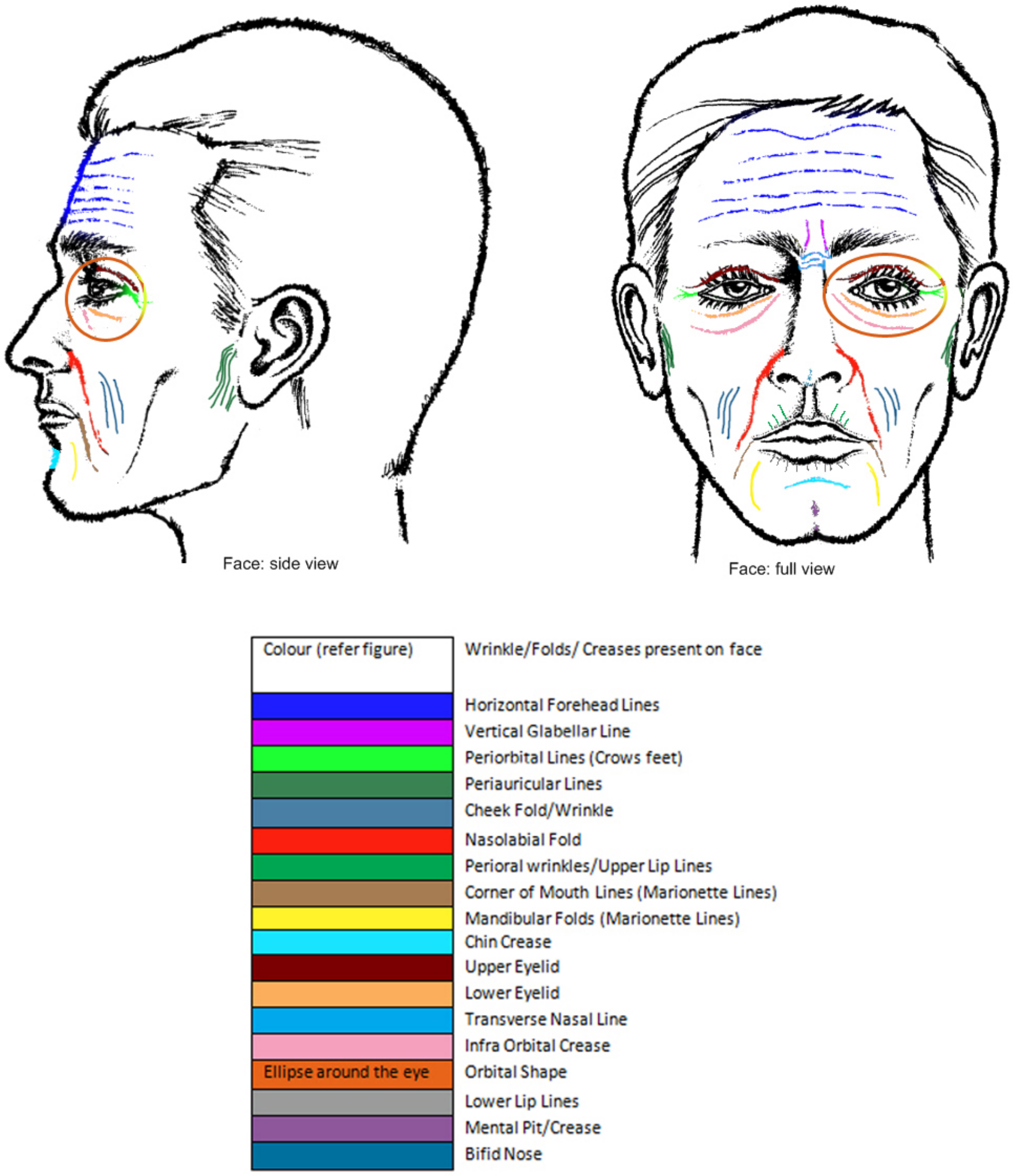

Figure 3: Location of folds and wrinkles on the human face based on Table 1. Figure modified from [140] with additional creases added based on the information in Table 1.

From Table 1, it could be said that no uniformity exists among the grading scales among different researchers even though analysing the same crease of interest. The difference could be seen in the grading of the horizontal forehead lines by two research groups [67, 68]. In 2004, "Rated Numeric Kinetic Line Scale" was invented [68]. However, in 2008, a different scale, called the "Forehead Lines Grading Scale" was utilised [67]. Both scales have the same five-grade rating system and dermatologists were required to visually score the creases into each group. The latter study does include the earlier research in their paper, even though some similarities between the experiment methodologies exist.

Facial creases have never been studied from an identification perspective and most research focuses on categorisation of wrinkles based on severity as shown in Table 1. It may be possible to utilised facial creases as an identification tool, given the availability of the creases on the face.

The following paragraphs will concentrate on the usage of the face in general from an identification and psychological perspective. Topics which will be discussed include photogrammetry, recognition of unfamiliar individuals and the psychology of facial identification.

Table 1: Research conducted on facial wrinkles

Author	Type of Crease/Wrinkle/Folds: Horizontal Forehead Lines	Vertical Glabella Line	Periorbital Lines (Crows Feet)	Periauricular Lines	Cheek fold / wrinkle	Nasolabial Fold	Perioral wrinkles / Upper Lip Lines	Corner of Mouth Lines (Marionette Lines)	Mandibular Folds (Marionette Lines)	Chin Crease	Upper Eyelid	Lower Eyelid	**Experiment, No of researchers making assessments, methods & notes (gd = photo wrinkle grade scale; res/r.p = no. of researchers/ set of reference photographs; ? = unknown)** ****All test carried out on female participants unless mentioned***
[55]	●		●		●			●					Smoking & wrinkling. Number of wrinkles, depth, length of wrinkles. 3-gd. ? res/r.p. Male & Female subjects
[60]	●		●										Overall face assessment - 3 res/r.p. Fitzpatrick skin assessment. 4-gd. Facial elasticity assessment. 3-gd
[58]	●		●		○	○		○			●	●	Chronological grading of onset of wrinkling. 5 & 9-gd. 5 res/r.p. assessment. 9-gd scale less accurate. Previous research results combined.
[56]		●	●				●						Pigmented disorder & wrinkle assessment. Chinese vs. European populations. 14-gd (crows feet), 9-gd (perioral wrinkle), 3-gd (glabella wrinkle)
[45]	●	●	●	●	●	●	●	●	●	●			Wrinkle Assessment Scale. 6-gd.Skin replicas. Skin surface depth scanner. Included wrinkle: Neck fold; ? res/r.p. Live wrinkle assessment on subjects.
[57]	●		●			●							Tracings on transparent paper on top of face photograph. Skin replicas of peri orbital area. Length and number of creases in test area quantified.
[51]	●	●			●	●		●			●	●	Survey of Tokyo, Shanghai and Bangkok. Comparison of 10 year age group. 5-gd. 1 res/r.p.
[59]					●								Cheek sagging study. NLF included as part of study but not measured directly. 6-gd. 7 res/r.p.
[53]	●	●	●		●	●		●			●	●	Skin replicas of crease areas. Chronological grading of onset of wrinkling. Effects of UV on various areas of the face.
[63]			●										Direct 3D in-vivo measuring system. 9-gd. ? res/r.p. Test repeated on male participants as well to measure accuracy of 3D measuring equipment.
[141]			●									●	Skin roughness analysis as secondary criterion to visual assessment. Subjects- Japanese, Chinese & German females. 9-gd. ? res/r.p.
[66]	○		○		○	○						○	Computer algorithms used to analyse the forehead, cheeks, infraorbitals, and periorbital region. No qualitative assessment of the type of crease analysed.
[52]			●										Measured elastic properties of the skin. Measure roughness & elasticity using skin replica & cutometer.
[54]		○	○	○	○	○	○	○	○		○	○	Korean women; UV aging with skin biopsy at buttock & face; 8-gd. ? res/r.p

Table 1 (cont.)

Author	**Type of Crease/Wrinkle/Folds** Horizontal Forehead Lines	Vertical Glabella Line	Periorbital Lines (Crows Feet)	Periauricular Lines	Cheek fold / wrinkle	Nasolabial Fold	Perioral wrinkles / Upper Lip Lines	Corner of Mouth Lines (Marionette Lines)	Mandibular Folds (Marionette Lines)	Chin Crease	Upper Eyelid	Lower Eyelid	**Experiment, No of researchers making assessments, methods & notes (gd = photo wrinkle grade scale; res/r.p = no. of researchers/ set of reference photographs; ? = unknown)** ****All test carried out on female participants unless mentioned***
[142]	●	●	●			●		●					Wrinkle, hyperpigmentation & yellowing observed. 10 gd; 7 res/25 r.p.
[67]	●												Forehead Lines Grading scale created from frontal face photograph; 5-gd 9 res/35 r.p.
[68]	●												Rated Numeric Kinetic Line Scale developed. Ability to assess during rest and muscle contraction. 5-gd; 11 res/20 r.p.
[62]							●						Skin surface replicas of 10 male & 10 female cadavers analysed digitally at 3 sites. Histology tests of wrinkles made as well.
[143]			●										Predicting renal function based on crow's feet wrinkles. 5-gd. 1 res/? r.p. 178 subjects
[144]		●											Infraorbital crease classified. four different 6-gd 4 res/253 r.p.
[145]						●							Modified Fitzpatrick Wrinkle Scale (MFWS) 7-gd. 5 res/r.p.
[146]						●							Wrinkle Severity Rating Scale (WSRS); 5-gd.; 5 res/30 r.p.
[147]			●										Smoking and crow's feet. 5-gd.; 1 res/25 r. p.
[148]	●												Forehead wrinkles based on facial expression. 6-gd; 3 res/50 r. p.
[65]	●		●					●	●				Research includes brow scale for brow positioning; scales based on photographs 5.g.d; ? res./35 r. p.. No amount of validators obtained from conference stated
[149]						●							The Genzyme 6-point Grading Scale; 6-gd; 13 res/46 r.p.
[43]		●	●				●					●	RW Johnson Pharmaceutical Research Institute scale; 10-gd; 2 res/250 r.p.
[150]	●		●					●	●			●	Includes neck folds. Skin aging atlas, Asian type 7-gd; ? res/354 r.p.

● Area tests were conducted ○ Data included but no direct test conducted

Photogrammetry

Photogrammetry is a technique utilised to compare the proportional relationships between two photographs. The common problem facing practitioners when employing this method include the differences between the control and the target image. Differences include the lighting conditions, angle of the face, age of the photograph may not be recent and the differences in facial expression [69]. Lens distortion between the target image and the control image too may distort the shape of the face [69, 70]. However, it is possible to carry out facial mapping from a similar viewing angle even though exact angle is unobtainable [71]. Vanezis and Brierley [71] have suggested that poor quality images may be useful than higher quality images if the face angle of the poor quality image is similar with the target image. However, if possible, obtaining the best image quality is better when carrying out facial mapping as more minute features could be compared between the questioned and the supplied images.

Life-size photograph is needed for skull-to-photo superimposition [72]. The technique has been studied in depth by numerous authors [69, 71, 73-89]. In order to obtain good skull-to-photograph superimposition, it is vital to have a common reference point between the skull and the ante-mortem photograph. Whenever possible, the teeth should be utilised as reference points as they are robust to the elements and detectable on both ante-mortem photograph and skull. In a smile or laughing pose, the incisors and canines could be detected on an ante-mortem photograph [81]. Teeth as reference points have been detailed in previous literature [79, 81, 84]. The face and skull have to be similar in angle in order for successful superimposition [72, 80, 89].

Recognition of Unfamiliar Individuals

Familiar faced individuals could be identified faster compared to unfamiliar individuals [90]. Bruce *et al.* [91] first documented that people are poor at identifying unfamiliar faces. The findings have been replicated by other researchers trying to probe why humans are unsuccessful at identifying unfamiliar faces [92-101]. People could only identify unfamiliar neutral face in frontal view around 70% of the time and the identification performance rate drops when facial expression and different face angles were introduced as the target images [91]. As faces become more familiar, the eye shifts from viewing external to internal features of the face [102, 103]. Eyes are the most viewed internal part of the face [104-106] regardless of familiarity [102]. A research conducted with a 30 second video clip and static face images shows that the viewing shifted from the external to the internal features of the face after three days of face familiarisation [104]. Conditioning in noticing internal features could also be seen in communities where external features appeared similar. Research on Egyptian adults showed that they were better at recognising internal features of people within their own community [107]. External features could not be utilised as an identifying features as Egyptian girls generally wore headscarves [107].

There are several studies comparing experts and laypeople in identifying unfamiliar faces [98, 108, 109]. The lack of more studies in this area may be due to the small amount of experts available for meaningful comparison research to be carried out. In a study comparing the identification performance of 50 professionals and 50 laymen, no difference was noted in performance between the two groups in identifying faces [108]. Other studies which do show an advantage towards the expert have low number of experts recruited for the experiment (less than five individuals) compared to the high amount of layperson (more than 20) [98, 109]. There is also no consensus favouring one sex group identification based on the internal features of the face [110].

Psychology of Face Identification

Reviews on the recognition of unfamiliar faces have been carried out by several authors [111-113]. Hancock *et al.* [111] has classified factors which affect face recognition under lighting and negation, configuration and distinctiveness and viewpoint and orientation. Johnston and Edmonds [112] added factors such as inversion, internal and external features of the face while Sinha *et al.* [113] mentions face recognition from a computer vision perspective. Factors affect face recognition include other-race effect [114, 115], face movement [116-121] and quality of the image [122].

A face which is more distinctive is more likely to be remembered [111, 112]. However, it is known that repeated viewings of the face will make it more easily remembered [101, 123]. People pay more attention to the internal features of the face for familiar faces [124] and rely on external features (such as hair, beard ears and shape of the face) when recognising unfamiliar faces [91, 105]. Hair style is the highest mentioned verbal feature mentioned by participants when viewing unfamiliar faces, followed by eyes and nose [125, 126]. Summary of the features mentioned by participants utilised as an identifying feature could be seen in Figure 4.

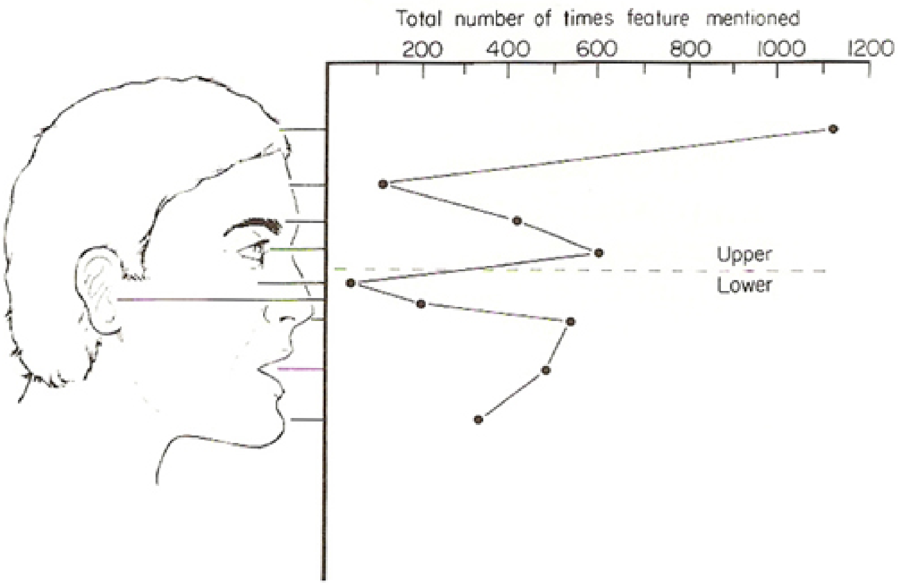

Figure 4: Relative frequencies which the principal facial features mentioned in face description ([126] in [125]).

A study on frontal view of famous individuals showed that the internal features were recognised better than external feature of the face [127]. In a study on celebrity faces, internal features were recognised better as a whole or segmented into pieces compared to the external features as a whole [127]. Results of this research could be seen in Figure 5. An unfamiliar face becomes a familiar face following repeated viewings of the face and repeated viewings from different angles [128]. Own-race identification has been shown to be superior compared to different race identification as people are more familiar with faces from their own race [114, 115, 129-137].

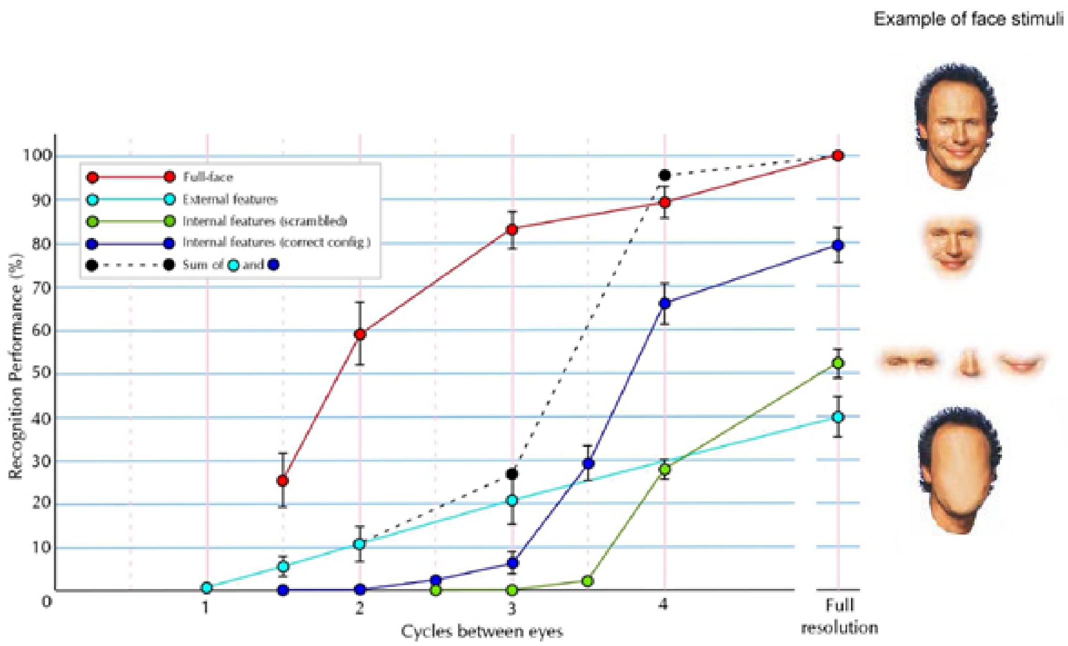

Figure 5: Recognition performance across different image resolution. The dash lines show the sum between internal and external features. Figure modified from [127].

Limitations of utilising facial creases from an identification perspective

One of the reasons why facial creases have never been studied from an identification perspective may be due to the fact that creases are mobile in nature. Unlike other internal organs of the face such as the nose, eyes and mouth, facial creases change with expression of the face. Also, categorisation of facial creases such as in Table 1 is not a practical solution as creases are unique in morphology. A study on Black South African male population which classifies the nasolabial fold based on length [138] shows the problems of having a scale. In the research, the nasolabial fold was categorised as long, short and fold absence. While it is possible to categorise the crease, it does not explain the morphology of the crease. The second challenge is the fact that in order to obtain meaningful comparison, the target crease image must be of high quality as the captured image. Images obtained from CCTV footage captured from a distance away and at high locations [139] will not provide any meaningful data for comparison.

Conclusion

Facial creases are mostly researched from a severity perspective and not from an identification perspective. Human identification remains largely a subset of psychology. However, no research from the psychology perspective has included facial creases as an identification feature. Identification based on internal features of the face tends to concentrate more on organs such as eyes, nose and mouth rather than facial creases. Facial creases are not a specific organ but results from the folding of the skin. Facial creases are themselves fine in structure and may not be detectable if the target image is of poor quality. Creases such as the nasolabial fold and the forehead creases are large structures which could be utilised in identification. A crease, when distinct enough could be utilised in unfamiliar face recognition to evoke memory recall by subjects who are viewing the face. Facial creases are considered internal features of the face hence should be incorporated in future research where internal features are utilised as part of the identification cue. It is hoped that with this article, more emphasis is placed upon the usage of facial creases as an identification tool.

References

1. Case RM, Waterhouse JM. *Human physiology: Age, stress, and the environment*: OUP Oxford; 1994.
2. Baumann L. Skin ageing and its treatment. *Journal of Pathology*. 2007;211:241-51.
3. Scharffetter-Kochanek K, Brenneisen P, Wenk J, Herrmann G, Ma W, Kuhr L, *et al.* Photoaging of the skin from phenotype to mechanisms. *Experimental Gerontology*. 2000;35:307-16.
4. Beatty E. Embryology of the head and neck. In: Georgiade GS, Reifkohl R, Levin LS, editors. *Georgiade Plastic, Maxillofacial, and Reconstructive Surgery*: Williams & Wilkins; 1997. p. 215-9.
5. Scheuer L, Black S. *The juvenile skeleton*: Academic Press; 2004.
6. Scheuer L, Black S, Christie AI. *Developmental juvenile osteology*: Academic Press; 2000.
7. Sharabi SE, Hatef DA, Koshy JC, Hollier LH, Jr., Yaremchuk MJ. Mechanotransduction: the missing link in the facial aging puzzle? *Aesthetic Plastic Surgery*. 2010;34:603-11.
8. Clement J, Ranson DL. *Craniofacial identification in forensic medicine*: Hodder Arnold; 1998.
9. Rosen CJ, Glowacki J, Bilezikuan JP. *The aging skeleton*: Academic Press; 1999.
10. Shaw RB, Jr., Katzel EB, Koltz PF, Yaremchuk MJ, Girotto JA, Kahn DM, *et al.* Aging of the facial skeleton: Aesthetic implications and rejuvenation strategies. *Plastic and Reconstructive Surgery*. 2011;127:374-83.
11. Williams SE, Slice DE. Regional shape change in adult facial bone curvature with age. *American Journal of Physical Anthropology*. 2010;143:437-47.
12. Pessa JE. An algorithm of facial aging: verification of Lambros's theory by three-dimensional stereolithography, with reference to the pathogenesis of midfacial aging, scleral show, and the lateral suborbital trough deformity. *Plastic and Reconstructive Surgery*. 2000;106:479-88; discussion 89-90.
13. Bartlett SP, Grossman R, Whitaker LA. Age-related changes of the craniofacial skeleton: an anthropometric and histologic analysis. *Plastic and Reconstructive Surgery*. 1992;90:592-600.

14. Mendelson BC, Hartley W, Scott M, McNab A, Granzow JW. Age-related changes of the orbit and midcheek and the implications for facial rejuvenation. *Aesthetic Plastic Surgery*. 2007;31:419-23.
15. Shaw RB, Jr., Kahn DM. Aging of the midface bony elements: A three-dimensional computed tomographic study. *Plastic and Reconstructive Surgery*. 2007;119:675-81; discussion 82-3.
16. Kahn DM, Shaw RB, Jr. Aging of the bony orbit: a three-dimensional computed tomographic study. *Aesthetic Surgery Journal*. 2008;28:258-64.
17. Pessa JE, Chen Y. Curve analysis of the aging orbital aperture. *Plastic and Reconstructive Surgery*. 2002;109:751-5; discussion 6-60.
18. Furuta M. Measurement of orbital volume by computed tomography: especially on the growth of the orbit. Japanese *Journal of Ophthalmology*. 2001;45:600-6.
19. Coleman SR. The anatomy of the aging face: Volume loss and changes in 3-dimensional topography. *Aesthetic Surgery Journal*. 2006;26:S4-9.
20. Bondevik O. Growth changes in the cranial base and the face: a longitudinal cephalometric study of linear and angular changes in adult Norwegians. *European Journal of Orthodontics*. 1995;17:525-32.
21. West KS, McNamara JA, Jr. Changes in the craniofacial complex from adolescence to midadulthood: a cephalometric study. *American journal of orthodontics and dentofacial orthopedics* : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 1999;115:521-32.
22. Pecora NG, Baccetti T, McNamara JA, Jr. The aging craniofacial complex: a longitudinal cephalometric study from late adolescence to late adulthood. *American journal of orthodontics and dentofacial orthopedics* : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 2008;134:496-505.
23. Pessa JE, Zadoo VP, Mutimer KL, Haffner C, Yuan C, DeWitt AI, *et al.* Relative maxillary retrusion as a natural consequence of aging: combining skeletal and soft-tissue changes into an integrated model of midfacial aging. *Plastic and Reconstructive Surgery*. 1998;102:205-12.
24. Pessa JE, Desvigne LD, Lambros VS, Nimerick J, Sugunan B, Zadoo VP. Changes in ocular globe-to-orbital rim position with age: implications for aesthetic blepharoplasty of the lower eyelids. *Aesthetic Plastic Surgery*. 1999;23:337-42.
25. Zadoo VP, Pessa JE. Biological arches and changes to the curvilinear form of the aging maxilla. *Plastic and Reconstructive Surgery*. 2000;106:460-6; discussion 7-8.
26. Wilkinson C. *Forensic facial reconstruction.* First ed: Cambridge University Press; 2004.
27. Duchenne De Boulogne GBA. *The mechanism of human facial expression*: Cambridge University Press 1990.
28. Austad SN. *Why we age: What science is discovering about the body's journey through life*: John Wiley & Sons; 1999.
29. De Magalhães JP. *Cellular senescence: Hayflick's limit and aging cells*. Integrative Genomics of Ageing Group; 1997. p. Hayflick limit.
30. Christiansen JL, Grzybowski JM. *Biology of aging:* William C. Brown; 1993.
31. Young JL, Fritz A, Adamo M, Liu G, Thoburn K, Kres J, *et al. Anatomy of the skin*. National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program; 2009.
32. Krizek TJ, Harries RHC, Robson MC. Biology of tissue injury and repair. In: Georgiade GS, Reifkohl R, Levin LS, editors. *Georgiade Plastic, Maxillofacial, and Reconstructive Surgery*: Williams & Wilkins; 1997. p. 3-4.
33. Sadick N, Karcher C, Laura P. Cosmetic dermatology of the aging face. *Clinics in Dermatology*. 2009;27:S3-S12.
34. Albert AM, Ricanek K, Jr., Patterson E. A review of the literature on the aging adult skull and face: implications for forensic science research and applications. *Forensic Science International*. 2007;172:1-9.
35. Gonzalez-Ulloa M. *The aging face*: Piccin Nuova Libraria S.p.A.; 1987.
36. Gonzalez-Ulloa M, Flores ES. Senility of the face--basic study to understand its causes and effects. *Plastic and Reconstructive Surgery*. 1965;36:239-46.

37. Neave R. Age changes to the face in adulthood. In: Clement J, Ranson DL, editors. *The Craniofacial Identification in Forensic Medicine*: Hodder Arnold; 1998. p. 306.
38. Subtelny JD, Rochester MS. A longitudinal study of soft tissue facial structures and their profile characteristics, defined in relation to underlying skeletal structures. *American Journal of Orthodontics*. 1959;45:481-507.
39. Fernandez-Riveiro P, Suarez-Quintanilla D, Smyth-Chamosa E, Suarez-Cunqueiro M. Linear photogrammetric analysis of the soft tissue facial profile. American *Journal of Orthodontics and Dentofacial Orthopedics*. 2002;122:59-66.
40. Halazonetis DJ. Morphometric correlation between facial soft-tissue profile shape and skeletal pattern in children and adolescents. American *Journal of Orthodontics and Dentofacial Orthopedics*. 2007;132:450-7.
41. Godt A, Muller A, Kalwitzki M, Goz G. Angles of facial convexity in different skeletal classes. *European Journal of Orthodontics*. 2007;29:648-53.
42. George PA, Hole GJ. Factors influencing the accuracy of age estimates of unfamiliar faces. *Perception*. 1995;24:1059-73.
43. Mayes A, Murray P, Gunn D, Tomlin C, Catt S, Wen Y, *et al.* Ageing appearance in China: biophysical profile of facial skin and its relationship to perceived age. *Journal of the European Academy of Dermatology and Venereology*. 2009.
44. Nkengne A, Bertin C, Stamatas GN, Giron A, Rossi A, Issachar N, *et al.* Influence of facial skin attributes on the perceived age of Caucasian women. *Journal of the European Academy of Dermatology and Venereology*. 2008;22:982-91.
45. Lemperle G, Holmes RE, Cohen SR, Lemperle SM. A classification of facial wrinkles. *Plastic and Reconstructive Surgery*. 2001;108:1735-50.
46. Language TAHDotE. Wrinkle. The American Heritage® Dictionary of the English Language, Fourth Edition. 4th ed: Houghton Mifflin Company http://www.thefreedictionary.com/wrinkle Accessed On: 17 May 2013; 2009.
47. Collins. Furrow. *Collins English Dictionary*. 2nd ed: HarperCollins Publishers http://www.thefreedictionary.com/furrow Accessed On: 9 May 2009; 2006.
48. Collins. Fold. *Collins English Dictionary*. 2nd ed: HarperCollins Publishers http://www.thefreedictionary.com/fold Accessed On: 9 May 2009; 2006.
49. Collins. Crease. *Collins English Dictionary*. 2nd ed: HarperCollins Publishers http://www.thefreedictionary.com/crease Accessed On: 9 May 2009; 2006.
50. Chung JH. Characteristics of skin aging in Korean men and women. International *Journal of Cosmetic Science*. 2005;27:37-79.
51. Tsukahara K, Sugata K, Osanai O, Ohuchi A, Miyauchi Y, Takizawa M, *et al.* Comparison of age-related changes in facial wrinkles and sagging in the skin of Japanese, Chinese and Thai women. *Journal of Dermatological Science*. 2007;47:19-28.
52. Fujimura T, Haketa K, Hotta M, Kitahara T. Loss of skin elasticity precedes to rapid increase of wrinkle levels. *Journal of Dermatological Science*. 2007;47:233-9.
53. Takema Y, Tsukahara K, Fujimura T, Hattori M. Age-related Changes in the Three-dimensional Morphological Stucture of Human Facial Skin. *Skin Research and Technology*. 1997;3:95-100.
54. Chung JH. Photoaging in Asians. *Photodermatol Photoimmunol Photomed*. 2003;19:109-21.
55. Ernster VL, Grady D, Miike R, Black D, Selby J, Kerlikowske K. Facial wrinkling in men and women, by smoking status. *American Journal of Public Health*. 1995;85:78-82.
56. Nouveau-Richard S, Yang Z, Mac-Mary S, Li L, Bastien P, Tardy I, *et al.* Skin ageing: a comparison between Chinese and European populations. A pilot study. *Journal of Dermatological Science.* 2005;40:187-93.
57. Tsukahara K, Takema Y, Fujimura T, Moriwaki S, Hattori M. Quantitative two-dimensional analysis of facial wrinkles of Japanese women at various ages. *International Journal of Cosmetic Science*. 2002;24:71-80.
58. Tsukahara K, Takema Y, Kazama H, Yorimoto Y, Fujimura T, Moriwaki S, *et al.* A photographic scale for the assessment of human facial wrinkles.

Journal of Cosmetic Science. 2000;51:127-39.

59. Tsukahara K, Takema Y, Fujimura T, Moriwaki S, Kitahara T, Imokawa G. Determination of age-related changes in the morphological structure (sagging) of the human cheek using a photonumeric scale and three-dimensional surface parameters. *International Journal of Cosmetic Science*. 2000;22:247-58.
60. Wang YN, Fang H, Zhu WF. Survey on skin aging status and related influential factors in Southeast China. *Journal of Zhejiang University Science*. 2009;10:57-66.
61. Contet-Audonneau JL, Jeanmaire C, Pauly G. A histological study of human wrinkle structures: comparison between sun-exposed areas of the face, with or without wrinkles, and sun-protected areas. *The British Journal of Dermatology*. 1999;140:1038-47.
62. Paes EC, Teepen HJ, Koop WA, Kon M. Perioral wrinkles: histologic differences between men and women. *Aesthetic Surgery Journal*. 2009;29:467-72.
63. Fujimura T, Haketa K, Hotta M, Kitahara T. Global and systematic demonstration for the practical usage of a direct in vivo measurement system to evaluate wrinkles. *International Journal of Cosmetic Science*. 2007;29:423-36.
64. Takema Y, Yorimoto Y, Kawai M, Imokawa G. Age-related changes in the elastic properties and thickness of human facial skin. *The British Journal of Dermatology*. 1994;131:641-8.
65. Carruthers A, Carruthers J. A validated facial grading scale: the future of facial ageing measurement tools? *Journal of Cosmetic and Laser Therapy*. 2010;12:235-41.
66. Kwon YH, Da Vitoria Lobo N. Age classifification from facial images. *Computer Vision and Image Understanding*. 1999;74:1-21.
67. Carruthers A, Carruthers J, Hardas B, Kaur M, Goertelmeyer R, Jones D, *et al.* A validated grading scale for forehead lines. *Dermatologic Surgery*. 2008;34 Suppl 2:S155-60.
68. Kim EJ, Reeck JB, Maas CS. A validated rating scale for hyperkinetic facial lines. *Archives of Facial Plastic Surgery*. 2004;6:253-6.
69. Işcan MY. Introduction of techniques for photographic comparison: Potential and problems In: Işcan MY, Helmer RP, editors. *Forensic Analysis of the Skull*: John Wiley & Sons; 1993. p. 57-70.
70. Eliasova H, Krsek P. Superimposition and projective transformation of 3D object. *Forensic Science International*. 2007;167:146-53.
71. Vanezis P, Brierley C. Facial image comparison of crime suspects using video superimposition *Science & Justice*. 1996;36:27-33.
72. Grϋner O. Identifications of skulls: A historical review and practical applications. In: Işcan MY, Helmer RP, editors. *Forensic Analysis of the Skull*: John Wiley & Sons; 1993. p. 29-45.
73. Bastiaan RJ, Dalitz GD, Woodward C. Video superimposition of skulls and photographic portraits - A new aid to identification. *Journal of Forensic Sciences*. 1986;31:1373-9.
74. Bilge Y, Kedici PS, Alakoc YD, Ulkuer KU, Ilkyaz YY. The identification of a dismembered human body: a multidisciplinary approach. *Forensic Science International*. 2003;137:141-6.
75. Blundell RH, Wilson GH. *Trial of Buck Ruxton. (Notable British trials.)*: William Hodge & Company Ltd (1937); 1937.
76. Chee LF, Cheng CT. Skull and photographic superimposition: a new approach using a second party's interpupil distance to extrapolate the magnification factor. *Journal of Forensic Sciences*. 1989;34:708-13.
77. Dorion RB. Photographic superimposition. *Journal of Forensic Sciences*. 1983;28:724-34.
78. Iten PX. Identification of skulls by video superimposition. *Journal of Forensic Sciences*. 1987;32:173-88.
79. Klonaris NS, Furue T. Photographic superimposition in dental identification. Is a picture worth a thousand words? *Journal of Forensic Sciences*. 1980;25:859-65.
80. Maat GJ. The positioning and magnification of faces and skulls for photographic superimposition. *Forensic Science International*. 1989;41:225-35.
81. McKenna JJ, Jablonski NG, Fearnhead RW. A method of matching skulls with photographic portraits using landmarks and measurements of the dentition. *Journal of Forensic Sciences*. 1984;29:787-97.
82. Nickerson BA, Fitzhorn PA, Koch SK, Charney M. A methodology for near-optimal computational superimposition of two-dimensional digital facial

photographs and three-dimensional cranial surface meshes. *Journal of Forensic Sciences*. 1991;36:480-500.
83. Shahrom AW, Vanezis P, Chapman RC, Gonzales A, Blenkinsop C, Rossi ML. Techniques in facial identification: computer-aided facial reconstruction using a laser scanner and video superimposition. *International Journal of Legal Medicine*. 1996;108:194-200.
84. Solla HE, Iscan MY. Skeletal remains of Dr. Eugenio Antonio Berrios Sagredo. *Forensic Science International*. 2001;116:201-11.
85. Ubelaker DH, Bubniak E, O'Donnell G. Computer-assisted photographic superimposition. *Journal of Forensic Sciences*. 1992;37:750-62.
86. Yoshino M. Craniofacial superimposition. In: Wilkinson C, Rynn C, editors. *Craniofacial Identification*: Cambridge University Press; 2012. p. 238-53.
87. Yoshino M, Kubota S, Matsuda H, Imaizumi K, Miyasaka S, Seta S. Face-toface video superimposition using three dimensional physiognomic analysis. *Japanese Journal of Science and Technology for Identification*. 1996;1:11-20.
88. Jayaprakash PT, Srinivasan GJ, Amravaneswaran MG. Cranio-facial morphanalysis: a new method for enhancing reliability while identifying skulls by photo superimposition. *Forensic Science International*. 2001;117:121-43.
89. Sekharan PC. Positioning the skull for superimposition. In: Işcan MY, Helmer RP, editors. *Forensic Analysis of the Skull*: John Wiley & Sons; 1993. p. 105-18.
90. Young AW, Hay DC, McWeeny KH, Flude BM, Ellis AW. Matching familiar and unfamiliar faces on internal and external features. *Perception*. 1985;14:737-46.
91. Bruce V, Henderson Z, Greenwood K, Hancock PJB, Burton AM, Miller P. Verification of face identities from images captured on video. *Journal of Experimental Psychology: Applied*. 1999;5:339-60.
92. Andrews TJ, Davies-Thompson J, Kingstone A, Young AW. Internal and external features of the face are represented holistically in face-selective regions of visual cortex. *Journal of Neuroscience*. 2010;30:3544-52.
93. Bergersen EO. The male adolescent facial growth spurt: its prediction and relation to skeletal maturation. *The Angle Orthodontist*. 1972;42:319-38.
94. Bruce V, Henderson Z, Newman C, Burton AM. Matching identities of familiar and unfamiliar faces caught on CCTV images. *Journal of Experimental Psychology: Applied*. 2001;7:207-18.
95. Burton AM, Wilson S, Cowan M, Bruce V. Face recognition in poor-quality video: Evidence from security surveillance. *Psychological Science*. 1999;10:243-8.
96. Davies G, Thasen S. Closed-circuit television: How effective an identification aid? *British Journal of Psychology*. 2000;91 (Pt 3):411-26.
97. Henderson Z, Bruce V, Burton AM. Matching the faces of robbers captured on video. *Applied Cognitive Psychology* 2001;15:445-64.
98. Lee W-J. *Matching unfamiliar faces from poor-quality closed-circuit television (CCTV) footage: An investigation about the matching ability between trained or experienced status of people in facial identification*. Dundee: University of Dundee; 2007.
99. Megreya AM, Burton AM. Unfamiliar faces are not faces: Evidence from a matching task. *Memory & Cognition*. 2006;34:865-76.
100. Megreya AM, Burton AM. Recognising faces seen alone or with others: When two heads are worse than one. *Applied Cognitive Psychology*. 2006;20:957-72.
101. Megreya AM, Burton AM. Hits and false positives in face matching: A familiarity-based dissociation. P*erception & Psychophysics*. 2007;69:1175-84.
102. Heisz JJ, Shore DI. More efficient scanning for familiar faces. *Journal of Vision*. 2008;8:9 1-10.
103. Russell R, Sinha P. Real-world face recognition: The importance of surface reflectance properties. *Perception*. 2007;36:1368-74.
104. Bonner L, Burton AM. Getting to know you: How we learn new faces. *Visual Cognition*. 2003;10:527-36.
105. O'Donnell C, Bruce V. Familiarisation with faces selectively enhances sensitivity to changes made to the eyes. *Perception*. 2001;30:755-64.
106. Althoff RR, Cohen NJ. Eye-movement-based memory effect: A reprocessing effect in face perception. *Journal of Experimental Psychology Learning,*

Memory, and Cognition. 1999;25:997-1010.
107. Megreya AM, Bindemann M. Revisiting the processing of internal and external features of unfamiliar faces: The headscarf effect. *Perception*. 2009;38:1831-48.
108. Troscianko T, Holmes A, Stillman J, Mirmehdi M, Wright D, Wilson A. What happens next? The predictability of natural behaviour viewed through CCTV cameras. *Perception*. 2004;33:87-101.
109. Wilkinson C, Evans R. Are facial imge analysis experts any better than the general public at identifying individuals from CCTV images? *Science and Justice* 49. 2009;49:191-6.
110. Bruce V, Burton AM, Hanna E, Healey P, Mason O, Coombes A, *et al.* Sex discrimination: How do we tell the difference between male and female faces? *Perception*. 1993;22:131-52.
111. Hancock PJ, Bruce VV, Burton AM. Recognition of unfamiliar faces. *Trends in Cognitive Sciences*. 2000;4:330-7.
112. Johnston RA, Edmonds AJ. Familiar and unfamiliar face recognition: A review. *Memory*. 2009;17:577-96.
113. Sinha P, Balas B, Ostrovsky Y, Russell R. Face recognition by humans: Nineteen results all computer vision reasechers should know about. *Proceedings of the IEEE*. 2006;94:1948-61.
114. McKone E, Brewer JL, MacPherson S, Rhodes G, Hayward WG. Familiar other-race faces show normal holistic processing and are robust to perceptual stress. *Perception*. 2007;36:224-48.
115. Michel C, Rossion B, Han J, Chung CS, Caldara R. Holistic processing is finely tuned for faces of one's own race. *Psychological Science*. 2006;17:608-15.
116. Christie F, Bruce V. The Role of dynamic information in the recognition of unfamiliar faces. *Memory & Cognition*. 1998;26:780-90.
117. Lander K, Bruce V. The role of motion in learning new faces. *Visual Cognition*. 2003;10:897-912.
118. Lander K, Christie F, Bruce V. The role of movement in the recognition of famous faces. *Memory & Cognition*. 1999;27:974-85.
119. Pike G, Kemp R, Towell NA, Phillips KC. Recognizing moving faces: The relative contribution of motion and perspective view information. *Visual Cognition*. 1997;4.
120. Pilz KS, Thornton IM, Bulthoff HH. A search advantage for faces learned in motion. *Experimental Brain Research*. 2006;171:436-47.
121. Valentine T, Darling S, Memon A. Do strict rules and moving images increase the reliability of sequential identification procedures? *Applied Cognitive Psychology*. 2006;21:933-49.
122. Liu CH, Burton AM, Chaudhuri A. Face recognition is robust with incongruent image resolution: relationship to security video images. *Journal of Experimental Psychology: Applied*. 2003;9:33-41.
123. Bruce V, Dench N, Burton M. Effects of distinctiveness, repetition and semantic priming on the recognition of face familiarity. *Canadian Journal of Experimental Psychology*. 1993;47:38-60.
124. Ellis H, Shepherd JW, Davies GM. Identification of familiar and unfamiliar faces from internal and external features: Some implications for theories of face recognition. *Perception*. 1979;8:431-9.
125. Davies G, Ellis H, Shepherd J. *Perceiving and remembering faces*. New York: Academic Press; 1981.
126. Shepherd JW, Ellis HD, Davies GM. *Perceiving and remembering faces. Technical report to the Home Office under contract POL/73/1675/24/1*. 1977.
127. Jarudi IN, Sinha P. *Relative contributions of internal and external features to face recognition* Cambridge: Massachusetts Institute of Technology; 2003. p. 12.
128. Longmore CA, Liu CH, Young AW. Learning faces from photographs. *Journal of Experimental Psychology: Human Perception and Performance*. 2008;34:77-100.
129. O'Toole AJ. Psychological and Neural Perspectives on Human Face Recognition. In: Li SZ, Jain AK, editors. *Handbook of Face Recognition*. New York: Springer Science & Business; 2005. p. 349-69.
130. Valentine T. A unified account of the effects of distinctiveness, inversion, and race in face recognition. Quarterly *Journal of Experimental Psychology A, Human Experimental Psychology*. 1991;43:161-204.
131. Valentine T, Bruce V. The effect of race, inversion and encoding activity upon face recognition. *ACTA Psychologica* (Amsterdam). 1986;61:259-73.

132. Ellis HD, Deregowski JB, Shepherd JW. Descriptions of white and black faces by white and black subjects. *International Journal of Psychology*. 1975;10:119-23.
133. [133] Lindsay DS, Jack PC, Jr., Christian MA. Other-race face perception. *Journal of Applied Psychology*. 1991;76:587-9.
134. Wright DB, Boyd CE, Tredoux CG. Inter-racial contact and the own-race bias for face recognition in South Africa and England. *Applied Cognitive Psychology*. 2003;17:365-73.
135. Dehon H, Bredart S. An 'other-race' effect in age estimation from faces. *Perception*. 2001;30:1107-13.
136. Evans JR, Marcon JL, Meissner CA. Cross-racial lineup Identification: Assessing the potential benefits of context reinstatement. *Psychology, Crime & Law*. 2009;15:19-28.
137. Zhao L, Bentin S. Own- and other-race categorization of faces by race, gender, and age. *Psychonomic Bulletin & Review*. 2008;15:1093-9.
138. Roeslofse MM. *An analysis of the metrical and morphological features* [Thesis]. Pretoria: University of Pretoria; 2006.
139. Cohen N, Gattuso J, MacLennan-Brown K. CCTV operational requirements manual: Is your CCTV system fit for purpose? In: *Branch HOSD*, editor.: Crown; 2007. p. 42.
140. Dunn KW, Harrison RK. Naming of parts: a presentation of facial surface anatomical terms. *British Journal of Plastic Surgery*. 1997;50:584-9.
141. Fujimura T, Sugata K, Haketa K, Hotta M. Roughness analysis of the skin as a secondary evaluation criterion in addition to visual scoring is sufficient to evaluate ethnic differences in wrinkles. *International Journal of Cosmetic Science*. 2009;31:361-7.
142. Griffiths CE, Wang TS, Hamilton TA, Voorhees JJ, Ellis CN. A photonumeric scale for the assessment of cutaneous photodamage. *Archives of Dermatology*. 1992;128:347-51.
143. Park BH, Lee S, Park JW, Kim KA, Kim HU, Lee JH, *et al.* Facial wrinkles as a predictor of decreased renal function. *Nephrology* (Carlton). 2008;13:522-7.
144. Valet F, Ezzedine K, Malvy D, Mary JY, Guinot C. Assessing the reliability of four severity scales depicting skin ageing features. *British Journal of Dermatology*. 2009;161:153-8.
145. Shoshani D, Markovitz E, Monstrey SJ, Narins DJ. The modified Fitzpatrick Wrinkle Scale: a clinical validated measurement tool for nasolabial wrinkle severity assessment. *Dermatologic Surgery*. 2008;34 Suppl 1:S85-91; discussion S.
146. Day DJ, Littler CM, Swift RW, Gottlieb S. The wrinkle severity rating scale: a validation study. *American Journal of Clinical Dermatology*. 2004;5:49-52.
147. Kadunce DP, Burr R, Gress R, Kanner R, Lyon JL, Zone JJ. Cigarette smoking: risk factor for premature facial wrinkling. *Annals of Internal Medicine*. 1991;114:840-4.
148. Ezure T, Amano S. The severity of the wrinkling at the forehead is related to the degree of ptosis of the upper eyelid. *Skin Research and Technology*. 2010;16:202-9.
149. Monheit GD, Gendler EC, Poff B, Fleming L, Bachtell N, Garcia E, *et al.* Development and validation of a 6-point grading scale in patients undergoing correction of nasolabial folds with a collagen implant. *Dermatologic Surgery*. 2010;36 Suppl 3:1809-16.
150. Qiu H, Long X, Ye JC, Hou J, Senee J, Laurent A, *et al.* Influence of season on some skin properties: winter vs. summer, as experienced by 354 Shanghaiese women of various ages. International *Journal of Cosmetic Science*. 2011;33:377-83.

Additional information and reprint requests:
Helmi Hadi,
Email: 4journals@outlook.com
Forensic Science Programme,
School of Health Sciences,
Universiti Sains Malaysia,
16150 Kubang Kerian,
Kelantan, Malaysia