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Morphological Classification of Facial Features in Adult Caucasian Males Based on an Assessment of Photographs of 50 Subjects

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ABSTRACT: Fifty sets of photographs showing facial features of Caucasian males aged 18 to 60 years were examined to establish a morphological classification of the face. It is suggested that such a classification could assist facial identification by photocomparison. The selection criteria stress the importance of interassessor agreement and discrimination among feature subset units in formulating the proposed classification.

KEYWORDS: forensic science, physical anthropology, facial identification, facial morphology, photocomparison, facial classification

The increasing use of security camera systems, coupled with the rising level of crime, has increased the need for facial image comparison to identify possible offenders. When security camera images are clear, the identification is often a matter of recognition by lay witnesses and expert opinion is not usually necessary. Such identifications frequently go unchallenged.

The use of an expert for facial identification evidence is appropriate when:

- Images, particularly from security cameras, are of variable quality.
- Images are taken from viewpoints that do not make recognition of the offender immediately obvious.
- The image in question may show only part, or none, of the facial features because the suspect is covering his face in some way.

New techniques are needed, as well as improvement in existing procedures such as video superimposition (1–3), to enable image comparisons that are based on scientific principles that are acceptable in courts of law. One such approach within the area of facial image comparison relies on assessments of morphological characteristics of facial features and the frequencies of occurrences of combinations of subsets in individuals.

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Objective

The study aims to explore the feasibility of establishing a practical morphological classification of the face to facilitate identification of crime suspects by image comparison.

Methods

Fifty sets of photographs of adult Caucasian males were assessed by seven persons. The majority of photograph sets consisted of a full frontal, left and right lateral, and left and right three-fourths profile views. In two cases, no frontal view was available. All the photographs selected depicted faces with a neutral expression. The clarity of each photograph allowed ease of discrimination of facial characteristics according to the classification used.

We revised and adapted the classification that had been, in turn, modified by İşcan (4), originally from J. Lawrence Angel's unpublished anthropometry and morphology data collection form and from Hammer (5) (see Table 1).

Each person then evaluated each set of photographs independently, examining 39 different types of facial feature categories and selecting the appropriate feature from the subset.

The aim was to ascertain:

- The number of times each feature from the subset was selected by each assessor in the 50 different cases and the mean incidence among the seven assessors.
- The degree of agreement of facial subset features chosen among assessors in each case (agreement was deemed to be satisfactory when five or more assessors chose a particular feature subset; less than five was regarded as unsatisfactory).

Results

The results were evaluated and tabulated as shown in Table 1. From our results, we found that there are a number of features, initially included in the 39 categories, that are of little value as discriminators in enabling us to produce a workable classification. The discriminatory value of each feature subset depended on whether agreement was good among the assessors (5+) and on its inherent reliability as a discriminator. The most unreliable and

Subject Identifier_____ ☐ - **Not applicable**

Checked by_____

1. Facial form ☐

1	1.		Undecided
2	2.		Round
3	3.		Oval
4	4.		Angular up
5	5.		Angular down
6	6.		Square
7	7.		Asymmetrical

2. Facial fatness ☐

8	1.		Undecided
9	2.		Fat
10	3.		Medium
11	4.		Thin

3. Chin feature ☐

12	1.		Undecided
13	2.		Dimple
14	3.		Cleft
15	4.		Double
16	5.		Featureless

4. Chin shape from front ☐

17	1.		Undecided
18	2.		Round
19	3.		Pointed
20	4.		Square

5. Malars ☐

21	1.		Undecided
22	2.		Not noticeable
23	3.		Noticeable
24	4.		Asymmetrical

6. Eyebrow shape ☐

25	1.		Undecided
26	2.		Straight
27	3.		Curved
28	4.		Asymmetrical

7. External eyebrow ends ☐

29	1.		Undecided
30	2.		Up
31	3.		Horizontal
32	4.		Down
33	5.		Asymmetrical

8. Eyebrow density ☐

34	1.		Undecided
35	2.		Sparse
36	3.		Normal
37	4.		Thick / Bushy
38	5.		Asymmetrical

9. Eye shape ☐

39	1.		Undecided
40	2.		Round
41	3.		Oval
42	4.		Narrow
43	5.		Asymmetrical

10. Palpebral slit ☐

44	1.		Undecided
45	2.		Down
46	3.		Horizontal
47	4.		Up
48	5.		Asymmetrical

11. Eye bag ☐

49	1.		Undecided
50	2.		Absent
51	3.		Present
52	4.		Asymmetrical

12. Nose tip shape

53	1.		Undecided
54	2.		Pointed
55	3.		Bilobed
56	4.		Hooked
57	5.		Rounded
58	6.		Bulbous
59	7.		Snub

13. Nostril visibility ☐

60	1.		Undecided
61	2.		Not visible
62	3.		Visible
63	4.		Pronounced
64	5.		Asymmetrical

14. Nasal alae ☐

65	1.		Undecided
66	2.		Compressed
67	3.		Normal
68	4.		Flaring
69	5.		Extended
70	6.		Asymmetrical

15. Philtrum depth ☐

71	1.		Undecided
72	2.		Shallow
73	3.		Deep

16. Philtrum shape ☐

74	1.		Undecided
75	2.		Sides parallel
76	3.		Sides divergent

17. Upper lip notch ☐

77	1.		Undecided
78	2.		Absent
79	3.		Wavy
80	4.		Angular

18. Upper lip thickness ☐

81.	1.		Undecided
82.	2.		Thin
83.	3.		Average
84.	4.		Thick

19. Lower lip thickness ☐

85.	1.		Undecided
86.	2.		Thin
87.	3.		Average
88.	4.		Thick

20. Ear projection ☐

89	1.		Undecided
90.	2.		Slight
91.	3.		Average
92.	4.		Pronounced
93.	5		Asymmetrical

21. Ear lobe(anatomic left) ☐

94.	1.		Undecided
95.	2.		None
96.	3.		Attached
97.	4.		Free
98.	5.		Long and free

22. Ear lobe(anatomic right) ☐

99	1.		Undecided
100	2.		None
101	3.		Attached
102	4.		Free
103	5.		Long and free

23. Nose profile ☐

104	1.		Undecided
105	2.		Convex
106	3.		Concave
107	4.		Straight
108	5.		Humped

24. Chin projection ☐

109	1.		Undecided
110	2.		Slight
111.	3.		Normal
112.	4.		Pronounced

25. Septum tilt ☐

113.	1.		Undecided
114.	2.		Up
115.	3.		Up slight
116.	4.		Horizontal
117.	5.		Down slight
118.	6.		Down

FIG. 1—*Proposed facial morphological classification in Caucasian males and investigation form.*

TABLE 1

Incidence and frequency distribution of facial features in 50 Caucasian males using the classification form adapted from Işcan (see text). where: A = *all observations;* q = *incidence (in a number of categories the total is less than 50 because of inability to assess and select a subset feature by the assessor);* f = *frequency distribution;* B = *interassessor agreement of five or higher;* q' = *incidence; and* f' = *frequency distribution.*

Features				A		B	
	Category (1)		Sub-set (2)	q (3)	f (%) (4)	q' (5)	f' (%) (6)
1.	Facial form	1	Round	3.4	6.8	0	0
		2	Oval	19.7	39.4	14	28
		3	Angular up	1	2	0	0
		4	Angular down	13.4	26.8	13	26
		5	Square	10	20	5	10
		6	Asymmetrical	0.3	0.6	0	0
2.	Forehead height	1	Low	2	4	0	0
		2	Medium	27.6	55.2	23	46
		3	High	19.6	39.2	12	24
3.	Forehead width	1	Narrow	2	4	0	0
		2	Medium	33.3	66.6	32	64
		3	Broad	12.7	25.4	5	10
4.	Chin shape	1	Dimple	5.1	10.2	1	2
		2	Cleft	16.7	33.4	16	32
		3	Double chin	10.6	21.2	8	16
5.	Facial profiles	1	Jutting	1.9	3.8	0	0
		2	Forward curving	17.7	25.4	9	18
		3	Vertical	26.1	52.2	18	36
		4	Concave	0.1	0.2	0	0
		5	Lower jutting	1.6	3.2	0	0
		6	Upper jutting	2.0	4.0	0	0
6.	Malars	1	Absent	4.9	9.8	1	2
		2	Noticeable	39.9	79.8	44	88
		3	Pronounced	3.9	7.8	0	0
7.	Hair length	1	Long	3.7	7.4	1	2
		2	Medium	18.3	36.6	8	16
		3	Short	25.4	50.8	24	48
		4	Partially bald	1.3	2.6	0	0
		5	Bald	0.9	1.8	0	0
8.	Chin from front	1	Small and round	12	24	5	10
		2	Wide and round	18	36	11	22
		3	Pointed	6.6	13.2	0	0
		4	Square	14.6	29.2	9	18
9.	Hair colour	1	Dark	33	66	29	58
		2	Fair	11.7	23.4	9	18
		3	Greying	4.3	8.6	4	8
		4	White	0.9	1.8	1	2
10.	Hair form	1	Straight	32.6	65.2	32	64
		2	Wavy	10	20	3	6
		3	Curly	7.1	14.2	4	8
		4	Frizzy	0.3	0.6	0	0
11.	Eyebrow shape	1	Straight	7.9	15.8	3	6
		2	Curved	31	62	27	54
		3	Arched	11.1	22.2	3	6
12.	Eyebrow density	1	Sparse	15.9	31.8	16	32
		2	Thick	24.6	49.2	24	48
		3	Bushy	4.3	8.6	4	8

TABLE 1—*Continued.*

Features				A		B	
	Category (1)		Sub-set (2)	q (3)	f (%) (4)	q' (5)	f' (%) (6)
13.	Eye setting	1	Low	9.7	19.4	5	10
		2	Medium	30.1	60.2	25	50
		3	High	10	20	3	6
14.	Eyebrow colour	1	Light	19.1	38.2	13	26
		2	Dark	29.6	59.2	21	42
15.	External eyebrow ends	1	Up	0.7	1.4	0	0
		2	Horizontal	6.1	12.2	1	2
		3	Down	42.6	85.2	42	84
		4	Asymmetrical	0.3	0.6	0	0
16.	Eye shape	1	Round	1.3	2.6	0	0
		2	Oval	39.4	79.8	39	78
		3	Narrow(slit)	13.6	27.2	5	10
		4	Triangular	0.86	1.8	0	0
17.	Palpebral slit	1	Down	14.7	29.4	9	18
		2	Horizontal	31.1	62.2	23	46
		3	Up slight	6.7	13.4	0	0
		4	Up extreme	0	0	0	0
18	Opening height	1	Small	10.7	21.4	7	14
		2	Medium	34.7	69.4	33	66
		3	Large	4.4	8.8	0	0
19.	Eyefolds	1	Absent	29.3	58.6	21	42
		2	Present	20.4	40.8	5	10
20.	Eye bag	1	Absent	26.6	53.2	24	48
		2	Slight	18.4	36.8	6	12
		3	Pronounced	5	10	2	4
21.	Nose length	1	Short	6	12	0	0
		2	Average	37.1	74.2	31	62
		3	Long	6.7	13.4	2	4
22.	Nose breadth	1	Narrow	2.9	5.8	0	0
		2	Average	36.1	72.2	33	66
		3	Wide	8.4	16.8	3	6
23.	Nose tip shape	1	Pointed	8.4	16.8	3	6
		2	Bilobed	3.6	7.2	2	4
		3	Hooked	1.3	2.6	0	0
		4	Rounded	33	66	35	70
		5	Bulbous	2.4	4.8	0	0
		6	Snub	1	2	0	0
24.	Nose profile	1	Convex	4.1	8.1	1	2
		2	Concave	12.3	24.6	11	22
		3	Straight	25.7	51.4	23	46
		4	Humped	8	16	8	16
25.	Nostril visibility	1	None	1.6	3.2	0	0
		2	Slight	37.4	74.8	37	74
		3	Pronounced	9.6	19.2	7	14
26.	Nose alignment	1	Straight	40.6	81.2	41	82
		2	Deviated	6.1	12.2	2	4

TABLE 1—*Continued.*

Features				A		B	
	Category (1)		Sub-set (2)	q (3)	f (%) (4)	q' (5)	f (%) (6)
27.	Nasal alae	1	Compressed	4.1	8.2	0	0
		2	Slight	28.3	56.6	19	38
		3	Flaring	12.4	24.8	4	8
		4	Extended	0	0	0	0
28.	Mouth width	1	Narrow	5.9	11.8	3	6
		2	Average	37.1	74.2	39	78
		3	Wide	5.6	11.2	3	6
29	Upper lip thickness	1	Thin	11.1	22.2	3	6
		2	Average	32.6	65.2	31	62
		3	Thick	6.3	12.6	3	6
30.	Lower lip thickness	1	Thin	4	8	1	2
		2	Average	29.4	58.8	28	56
		3	Thick	16.6	33.2	10	20
31.	Philtrum depth	1	Flat	17.4	34.8	7	14
		2	Deep	30.9	61.8	23	46
32.	Upper lip notch	1	Absent	2.7	5.4	1	2
		2	Wavy	26.9	53.8	22	44
		3	V-shape	20	40	13	26
33.	Philtrum shape	1	Sides parallel	28.6	57.2	24	48
		2	Sides divergent	19.4	38.8	14	28
34.	Ear size	1	Small	8.3	16.6	3	6
		2	Medium	36.3	72.6	36	72
		3	Large	5.1	10.2	1	2
35.	Ear projection	1	Slight	15.1	30.2	9	18
		2	Medium	26	52	18	36
		3	Large	6.7	13.4	5	10
36.	Lobe	1	None	1.7	3.4	0	0
		2	Attached	16	32	10	20
		3	Free	31	62	29	58
		4	Long and free	1.4	2.8	0	0
37.	Facial fatness	1	Fat	8.3	16.6	5	10
		2	Medium	30.7	61.4	26	52
		3	Thin	10.4	20.8	6	12
38	Chin projection	1	Absent	2.9	5.8	2	4
		2	Average	44.1	88.2	45	90
		3	Pronounced	2.3	4.6	0	0
39.	Septum tilt	1	Up	10.7	21.4	9	18
		2	Up slight	22.1	44.2	17	34
		3	Horizontal	14.1	28.2	13	26
		4	Down slight	2.6	5.2	0	0
		5	Down	0.1	0.2	0	0

unpredictable feature subsets were those that required the assessor to make a judgment of height or breadth, for example, forehead height or breadth and length of head hair. On the other hand, there were a number of features in which agreement among assessors was consistently good. Furthermore, the best discriminators were those features in which agreement was high and features occurrences in the 50 sets of photographs were relatively low. For example, it is relatively easy to agree on what an oval face is, but its frequency in the population studied is about 40%. On the other hand, large (pronounced) ear projection has a frequency of 13.4% coupled with good agreement, thus making this feature a powerful discriminator. No further attempt was made to weigh the results because of the small sample studied.

Based on these results, recommendations are made for morphological classification of adult Caucasian males and are shown in Fig. 1.

Discussion

Despite the limited number of sets of photographs examined, we were able to demonstrate which facial features were likely to be of practical use for the formulation of a classification (compare Fig. 1 with Fig. 2). These subset features could be reliably chosen as similar by at least five out of seven assessors.

Although 50 Caucasian males are a limited database for statistical purposes, the survey has enabled us to select feature parameters for inclusion in the new classification.

As a result of our findings, we eliminated a number of features from subsets from the initial classification used in Table 1 for the following reasons:

- Difficulty was experienced in consistently discriminating between them e.g., between arched and curved eyebrows. The subset feature "arched" is omitted, preferring the use of the term "curved" for both.
- Features could not be described as permanent because they could be easily changed (other than surgically), e.g., color of head hair and growth of facial hair.
- Evaluation was based on a subjective assessment of linear measurement, e.g., length of nose.
- Features regarded as acquired anomalies resulting in many cases as a result of injury (e.g., deviated nose), rather than as part of general morphological developmental variation of facial anatomy.

Hence, our criteria for inclusion into the new classification were:

- ease of discrimination among subset features,
- good agreement among assessors,
- nonreliance on anthropometric data (linear measurements and proportion indices),
- permanence of feature, and
- feature, part of normal morphological anatomical variation.

There have been a number of studies carried out to assess facial features to improve the reliability of identifications based on image comparison. These have been based on a consideration of anthropometric and morphometric parameter assessment or a combination of both (5–7).

A number of workers are also developing databases of facial characteristics to establish uniqueness of feature combinations (8,9). Neave and Wilcox (9) in their feasibility study using 200 anteroposterior and lateral photographs of Caucasian males have emphasized the need for consistency and also found considerable variation in the manner in which different individuals interpret facial features.

Techniques that rely on measurements rather than strictly morphological parameters need to be based on standardized photographs for assessment. Any classification that is based solely on absolute measurement comparisons, particularly, when comparing images taken by different types of cameras, is of little practical value. The only situation in which an anthropometric comparison should be attempted, (the latter uses absolute measurements between facial landmarks or proportion indices derived from such measurements), is where both images are at the same angle in relation to the camera lens and conform to the standardized position on which the classification is based.

From our study, we were able to produce a morphological facial classification for future use (Fig. 1) comprising 25 feature categories. There are two cautionary points that need to be emphasized. First, the categories and subsets selected for our proposed classification apply only to adult Caucasian males. It will be necessary to assess other ethnic groupings, as well as sex and age, to develop modified classifications for these groups. Second, small sample size precludes drawing any reliable inferences with respect to identification; a much larger database is necessary for this purpose.

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