

Reconstruction of Facial Features from the Skull: An Evaluation of its Usefulness in Forensic Anthropology

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ABSTRACT Although facial reconstructions from the skull have been widely used in forensic anthropology, their effectiveness has not been objectively assessed. Photographs of two reconstructions produced in this laboratory were shown to FAA employees and local policemen who were asked to select the subject's *in vivo* photograph when included with those of six other randomly-selected individuals of the same sex, race, and general age. While in both tests the reconstruction subject was chosen with significantly greater frequency than the controls, the results ranged from 26% correct (N = 104) on the first subject, a 67-year-old female, to 67% correct (N = 200) on the second, a 36-year-old male. In both tests policemen and civilian females performed better than civilian males.

The restoration of living facial features of skulls of the dead has long intrigued physical anthropologists. Such restorations have been used to flesh out our conceptions of fossil men long extinct, to verify the accuracy of disputed portraits of historic personages, and to confirm the identity of skeletons in cases of forensic interest. Various technical approaches have been applied. Some comparisons have relied on craniostatic tracings of the skull overlaid on portraits (Tildesley, '23; Pearson, '26, '28), photographs (Claister and Brash, '37), or x-rays (Cornwell, '56; Sassouni, '57), of the living; others have been based on measurements of skin thicknesses over certain bony landmarks. It is this latter method that concerns us here.

An early attempt at reconstruction of the original contours of a face was made by His (1895) who used the means of skin depth measurements of 24 male and four female cadavers in the restoration of the face of Johann Sebastian Bach. Kollman and Büchly (1898) added measurements of 21 male and four female cadavers to His's total, thus producing mean measurements for 45 males and eight females. The subjects ranged between 17 and 72 years of age and all were described as moderately well nourished. Although tissue

thicknesses were determined before embalming and within 24 hours after death, it should be recognized that dehydration and other post-mortem changes might influence their values. A description of the measurements and their means may be found in Krogman ('62). Harselm-Riemschneider ('21, '22) gave skin depth data for 14 Papuans and Melanesians; Suzuki ('48) for 48 male and seven female Japanese, and Ziedler ('19-'21) for three African Negro sub-adults. Using these data, attempts at reconstruction have involved the application of clay or plastic in appropriate thicknesses over the landmarks, contouring the facial outline and, as a final step, building up the soft features of the nose, mouth, eyes, and ears. Obviously, the size and shape of the latter features have little correlation with skeletal structure and in fashioning them, the restorer must rely on various artistic canons, personal experience, skill, and intuition.

The many uncontrollable sources of error involved in producing facial reconstructions have naturally led to some differences of opinion on their value as aids in identification. Krogman ('46) restored the face of a male American Negro cadaver and stated "the restoration was readily

recognizable," and "the technique . . . is useful . . . in the identification . . . of an individual represented by a skull alone." Montagu ('47), commenting on this restoration, said, "I am convinced that recognizable reconstructions would be impossible in the vast majority of Whites. Certainly one could not expect that a close likeness to a person's appearance during life could be established from the skull alone" Suk ('35) pointed out many of the pitfalls of the technique and questioned its value in forensic contexts. Stewart ('54) stated that "because of the time and artistic talents required in restoring the features, the results do not often justify the effort." Brues ('58), with characteristic forthrightness, said that such attempts are "probably best left to the ample literature of detective fiction."

Missing from all the discussions is an objective assessment of the value of the technique as an identification tool. Krogman ('62), for example, admitted that "the skull-head plastic reconstruction method has never been thoroughly tested." No case could be found in the literature in which such a restoration was compared to the *in vivo* photograph of the subject. Tests of the accuracy of two facial restorations are the subject of this paper.

MATERIALS AND METHOD

A total of four restorations have been made in this laboratory. In three, the subjects sent here for identification by the Oklahoma State Medical Examiner. Positive identification was made in each case by means independent of the restoration. In the fourth case, the skeleton was that of a known individual whose body had been donated to the local medical college. In all cases premortem photographs of the subjects were available.

One of the authors of this paper (B.P.G.), a professional medical illustrator and amateur sculptress, made the four restorations following the technique outlined by Krogman ('62). She was given the age, race, and sex of the skulls and the tables of skin depth. She did not see the photographs of the subject until her restorations were complete.

Case 1 (fig. 1a,b). This was the skeleton of a purportedly full-blood Cheyenne

Indian male, aged 26. The evidence indicated that he had died of natural causes and tumbled into a farm pond. His decomposed body was found in the pond five months after his death.

Case 2 (fig. 1c,d). This was the skeleton of a 56-year-old white female. The bones were found in a wooded area where she had been strangled several months before.

Case 3. This skull belonged to a 67-year-old white female, a retired college professor, who had donated her body to the University of Oklahoma Medical School.

Case 4. This skeleton was that of a 36-year-old white male. His body was found on a creek bank where it had been concealed by his murderers two months previously.

In Case 1, the tissue thicknesses derived from white male cadavers were used despite the known Mongoloid ancestry of the decedent. Aside from subjective comparisons with his premortem photographs, the only attempt to validate the accuracy of the restoration was by showing it to several of his friends, all of whom were aware that the authors had participated in the identification of his skeleton. All agreed that the restoration was a reasonable likeness.

In Case 2, the only photograph of the victim was a studio portrait taken approximately 25 years earlier. The resemblance was not impressive. Acquaintances of the victim who were asked to view the restoration also expressed reservations about its accuracy.

The first test of the technique was conducted on Case 3. Three views of the restoration were mounted beneath a series of seven photographs one of which was of the subject. The other six were colleagues whose photographs appeared on the same page of a university yearbook from which the subject's photograph was selected. These photographs were taken approximately 25 years prior to the subject's death.

A similar poster was made for the reconstruction of Case 4. The subject's photograph was taken during a booking by local police a few months prior to his murder. The remaining six photographs were selected from the same file by taking the

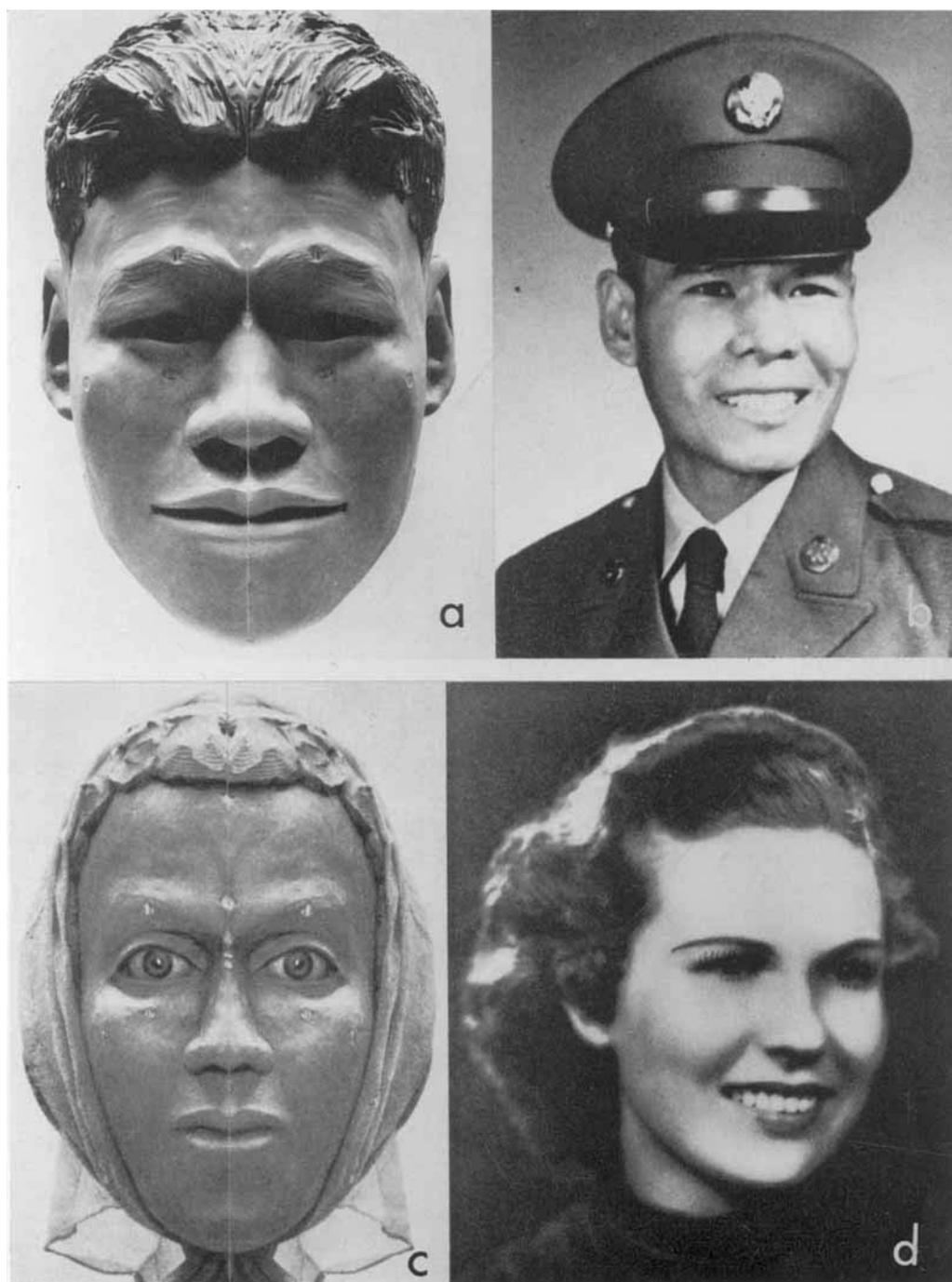


Fig. 1 Facial reconstructions and portraits of Case 1 (above) and Case 2 (below).

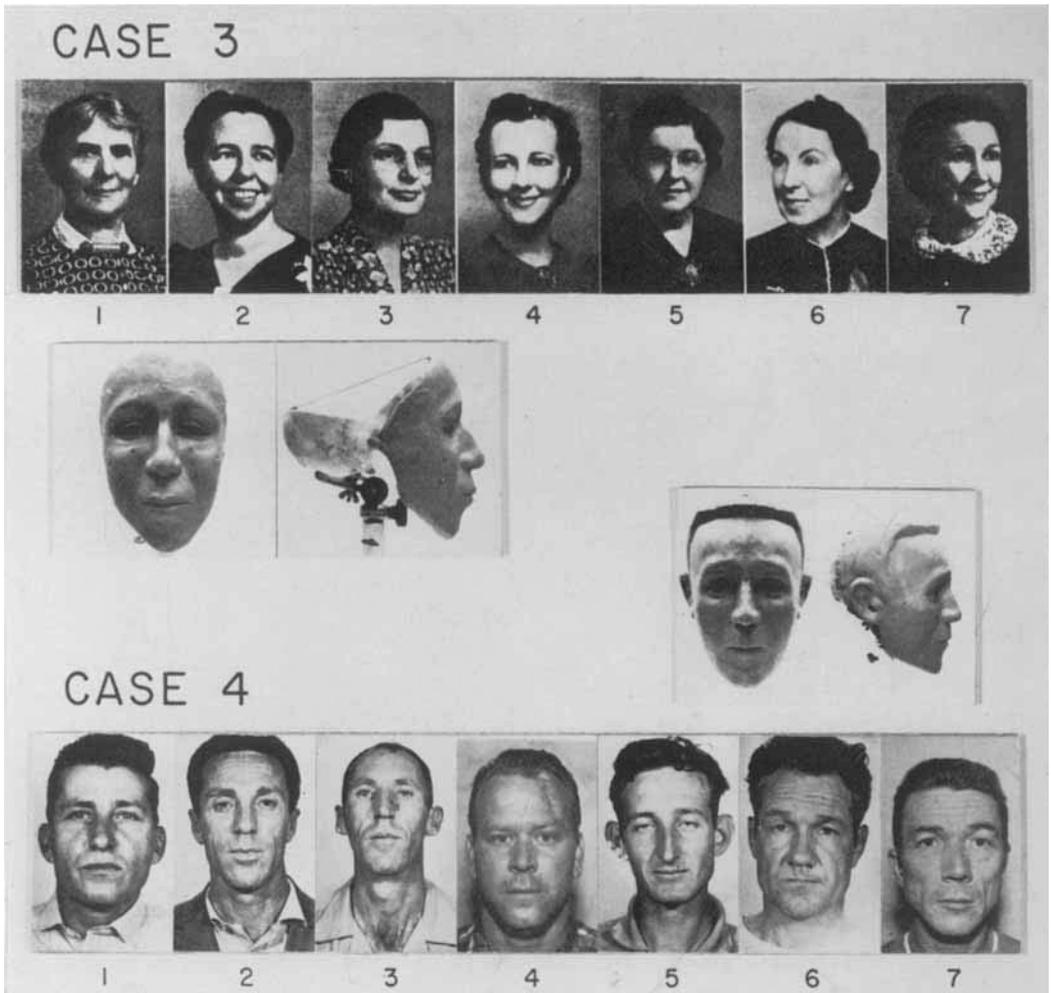


Fig. 2 Facial restorations and comparison photographs used in tests. In each case, photograph 2 of the comparison series is that of the reconstruction subject.

first six white males between 30 and 40 years of age that were booked after the subject. It should be noted that since a quantity of short-cropped, black hair was found with the remains, the sculptress provided the restoration with a "crew-cut." The shape and location of the hairline was purely conjectural.

The tests were conducted informally: The posters were set up in a central location along with a supply of blank forms. On the latter were printed instructions for selecting the photograph that the identifier thought most resembled the reconstruction.

Identifiers were also asked to give their sex, age, and, if police officers, their number of years of experience. A sealed box was placed beside the poster for deposition of the completed forms.

The locations selected for testing in Case 3 were: (1) the Civil Aeromedical Institute (CAMI) at the FAA Aeronautical Center, Oklahoma City, (2) the Midwest City Police Department, Midwest City, Oklahoma, and (3) the Village Police Department, The Village, Oklahoma. The poster on Case 4 was placed in (1) the foyer of the Headquarters Building, FAA

Aeronautical Center and (2) Tulsa Police Headquarters, Tulsa, Oklahoma. The latter site, some 120 miles from Oklahoma City, was selected to avoid bias since the reconstruction subject was well known to local police. At each location, the posters were placed near a reception desk and receptionists were instructed to answer questions concerning the purpose of the test but were not told which of the photographs was the correct one (photograph 2 in each case).

The two tests were conducted several months apart. The FAA respondents in the first test were mostly technicians and clerical personnel employed at CAMI; those in the second were mostly clerical and administrative personnel. In tabulating the results, policemen, who are generally more experienced in identification, were considered separately from civilians. Among the latter, males and females were considered separately. Chi square analyses, using Yates's correction when appropriate, were performed on the tabulated results. In the case of policemen, the means of their number of years of experience were calculated for those who correctly identified the subject and those who missed. These means were compared by a Student's *t* test. Age means of the civilians were similarly computed and compared.

RESULTS

The differences in the results of the two tests were striking (table 1). Only about one-fourth of the 104 respondents correctly identified the restoration of Case 3. While the frequency of correct responses was significantly above chance expectations (Chi square = 4.296, (1 d.f.) *P* < 0.05), two of the control photographs (4, 6) were selected 25 times apiece, almost as often

as the restoration subject (table 2). The subgroup differences were not statistically significant but it is of interest to note that policemen and civilian females scored slightly better than civilian males, foreshadowing the stronger tendency in this direction found in Case 4 (table 3).

Approximately two-thirds of the 200 identifications collected on Case 4 were correct. Within each of the three subgroups, the frequency of correct responses was statistically significant at the 0.005 probability level (table 1). Together, the two "runners-up," photographs 7 and 3, accounted for 48 of the 65 incorrect identifications, although in neither case did the number of selections significantly exceed chance expectations. Policemen scored significantly better than civilian males (table 3). Civilian females also scored better than their male counterparts, although the differences were not statistically significant.

Among policemen, there was no significant difference in the number of years of experience between those who correctly identified the restorations and those who did not. Similarly, respondent age was not found to be a significant factor in influencing correctness of choice among civilians (results not shown).

DISCUSSION

While more rigid testing might lead to a more precise assessment of facial reconstruction as an identification tool, the casual experiments reported here sufficiently demonstrate that rather wide variation in results may be expected. Both these restorations were produced by the same sculptress, a professional medical illustrator with a good background of anatomical knowledge. In both restorations a common

TABLE 1

Number of correct identifications made by policemen, civilian males, and civilian females for the two facial reconstructions. (Probabilities are based on 2 x 2 Chi square analyses using N/7 for the number of chance-expected correct identifications.)

Restoration	Policemen		Civilian males		Civilian females		All subjects	
	N	Correct	N	Correct	N	Correct	N	Correct
Case 3	36	10	34	7	34	10	104	27 ¹
Case 4	91	73 ²	76	39 ²	33	23 ²	200	135 ²

¹ *p* < 0.05.
² *p* < 0.005.

technique, based on the best data currently available, was employed. Prior to each test, several persons who knew the decedents (former students in Case 3, local police officers in Case 4) viewed the restorations and all agreed that they closely resembled the subjects. Despite these factors, the tests ranged from a little better than chance results obtained in Case 3 to the much more impressive responses in Case 4.

Some of the factors which might account for the observed variation are:

1. *Age of subject.* The female restoration subject (no. 3) was 67 years old at the time of her death, the male (no. 4) only 36. The photograph used for comparison in the former case had been taken when the subject was in her early '40's. Remodeling and atrophic changes in the facial skeleton associated with age may have profound and hitherto unassessed effects on the accuracy of the reconstruction.

2. *Sampling errors in skin thickness tables.* As noted previously, the skin thicknesses used for reconstruction are based

on 45 males but only eight females. The female means, therefore, are probably statistically less firm than those based on the larger male sample.

3. *Photographic technique.* The *in vivo* photographs used in Case 3 were studio portraits. In such photographs pains are taken to eliminate or minimize uncomplimentary physical features which otherwise, often serve as cues to identification. Poses and facial expressions are also varied. In Case 4, the unretouched police photographs were taken in a standard manner with little variation in lighting, expression, and pose.

CONCLUSIONS

On the basis of the present findings, it is apparent that positive identification could certainly not be allowed to rest on a facial restoration alone. In certain cases, the technique might be used to eliminate certain suspected individuals. In others, a restoration may be useful in helping support an identification based on other skeletal evidence. It is possible that the accuracy of female reconstructions could be improved by enlarging the sample upon which presently used tissue thicknesses are based. In all cases, allowances should be made for the effects of age, sex, and where photographs are used, photographic technique. Women and policemen appear to be somewhat better at making such identification than civilian males.

In summary, Brue's ('58) consignment of the technique to the limbo of detective

TABLE 2
Distribution of selections in facial restoration

Photograph	Case 3	Case 4
no.		
1	3	5
2 ¹	27	135
3	4	16
4	25	6
5	2	1
6	25	5
7	16	32

¹ Photograph 2 was restoration subject in each case.

TABLE 3
Chi square analyses comparing frequency of correct identifications of policemen, civilian males, and civilian females

	Case 3			Case 4		
	Correct	Incorrect	Total	Correct	Incorrect	Total
Policemen	10	26	36	73	18	91
Civilian males	7	27	34	39	37	76
Total	17	53	70	112	55	167
	Chi square = 0.18 not significant			Chi square = 15.66 p < 0.001		
Civilian females	10	24	34	23	10	33
Civilian males	7	27	34	39	37	76
Total	17	51	68	62	47	109
	Chi square = 0.31 not significant			Chi square = 3.169 0.1 > p > 0.5		

fiction seems over-pessimistic. While the efforts of Hercules Pierot and James Bond will always be more spectacular, the pedestrian and Watson-like attempts of the anthropologist should not be totally disregarded.

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