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Thickness of Facial Tissues in American Blacks

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ABSTRACT: The production of a three-dimensional plastic face on a human skull has been practiced sporadically since the latter part of the last century. In recent years, the technique has been revived and applied to forensic science cases. Contemporary facial reproductions are based on a small sample collected before the turn of the century. In this paper, we present data on a heretofore unstudied segment of *Homo sapiens,* the American black. Facial tissue thicknesses for this group vary greatly from those previously reported in European whites and in Japanese. Use of these data should make possible more accurate facial reproductions on the skulls of American blacks.

KEY WORDS: physical anthropology, human identification, tissues (biology), facial reproduction

Identification of a skeleton or a decomposed body is generally made in terms of such characteristics as age, sex, race, stature, and skeletal features peculiar to that individual (see, for example, Refs *1* to *3*). In cases where leads to an identification are difficult to produce, a face may be modeled directly on the skull. This technique has been used to good advantage by Dr. Clyde Snow and Ms. Betty Gatliff of the Federal Aviation Administration to provide investigators with the reproduction of a face that may be photographed and distributed through the various media. Although there is some lingering doubt as to the efficacy of plastic facial reproduction, faces have been reproduced on skulls for many years with a high degree of success. Such work began scientifically with Welcker [*4,5*], who reproduced the faces of Schiller and Kant, and continued with His [*6*], who reproduced the face of J. S. Bach.

Although faces of less exalted folk have also been reproduced [*7*], the process fell into disrepute. It surfaced from time to time as a sort of "scientific parlor trick"; anthropologists were aware of it, but apparently distrusted it. Indeed, not until 1970 [*8*] was any real test of facial reproduction attempted. Although many successful identifications have been reported [*9-13*],[3] reliance on data collected before the turn of the century [*14*] has led to some justified reservations as to the general applicability of the process.

It is possible to model a face on a skull by building up thicknesses corresponding to the various facial muscles, adding an amount to equal the presumed mass of fat, and covering the whole with a layer the thickness of skin. This is the method apparently adopted by

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Gerasimov [*15*] and his followers. One may also build up a face solely on the basis of artistic criteria, but most contemporary workers in this country have adopted the average tissue thickness method used by Welcker [*4*] and by His [*6*]. Clearly explained by Krogman [*1*] and by Gatliff and Snow [*16*], the method involves placing markers on the surface of the skull; these markers correspond to the measurements of tissue thickness at specified locations using the pooled data of His [*6*] and Kollmann and Büchly [*14*], as shown in Fig. 1. The intervening spaces are then filled with clay and the features added according to the criteria set forth by Gatliff and Snow [*16*].

It can be seen that the reproduction of a face is a time-consuming task that requires some artistic skill to accomplish properly. In order to reduce the amount of time invested, one can work out a pencil sketch over the traced outline of the skull as described by Angel [*17*] or use the more elaborate pencil technique suggested by Krogman [*1*]. These drawings are best done by an anatomically trained artist, with coaching from the anthropologist, or by an anthropological artist. Both of these methods lack the full features of a three-dimensional reproduction, which can be viewed from any angle and may be photographed from different angles and with different lighting to accentuate various features or aspects.

Despite the potential of facial reproduction, and its continuing successes, there remains a reservoir of reluctance to accept the method as fully validated. As previously noted, no testing had been conducted prior to 1970 [*8*]. Facial tissue thicknesses used for modern work have been those of Kollmann and Büchly [*14*], taken on a small sample, with inadequate controls over freshness of cadavers. As shown by Table 1, not all major racial groups of man are represented, and the numbers of each sample are so small as to be of questionable statistical validity.

There is a clear effect of sexual variation on the data. It may further be assumed that age affects tissue thickness. Thus far, the populations have been too small to admit of a serious attempt to statistically test the effects of age, whether the thicknesses of one racial group are significantly different from those of another, and whether it makes any difference to the observer's perception of a finished face which group of tissue thicknesses were used. None of the studies to date has collected a sufficient mass of bilateral data to ascertain whether systematic differences occur between left and right sides of the face (Table 2).

In view of these serious problems with facial reproduction, we have been collecting data on tissue thicknesses of human faces and have defined a number of goals:

(1) to ascertain, by collecting comprehensive bilateral measurements, whether patterns of facial asymmetry exist;

(2) to test the differences in tissue thicknesses between males and females;

(3) to discover how aging changes facial tissue thicknesses;

(4) to add to the literature data on heretofore underrepresented blacks and, subsequently, other groups as well;

(5) to establish thereby the nature of the differences in facial tissue depths in various gene pools of contemporary *Homo sapiens* and how those differences are expressed in the physiognomy; and

(6) to fill in the terra incognita in the cheek region, between the malars and the inferior border of the mandible. Only Suzuki [*19*] (see Fig. 2) has attempted to define this region which is so troublesome to novice reproducers of the face.

Method and Materials

Of necessity, we, like prior investigators, have resorted to the use of a cadaver population. Like most others collecting such data, we have eschewed the double-edged knife of

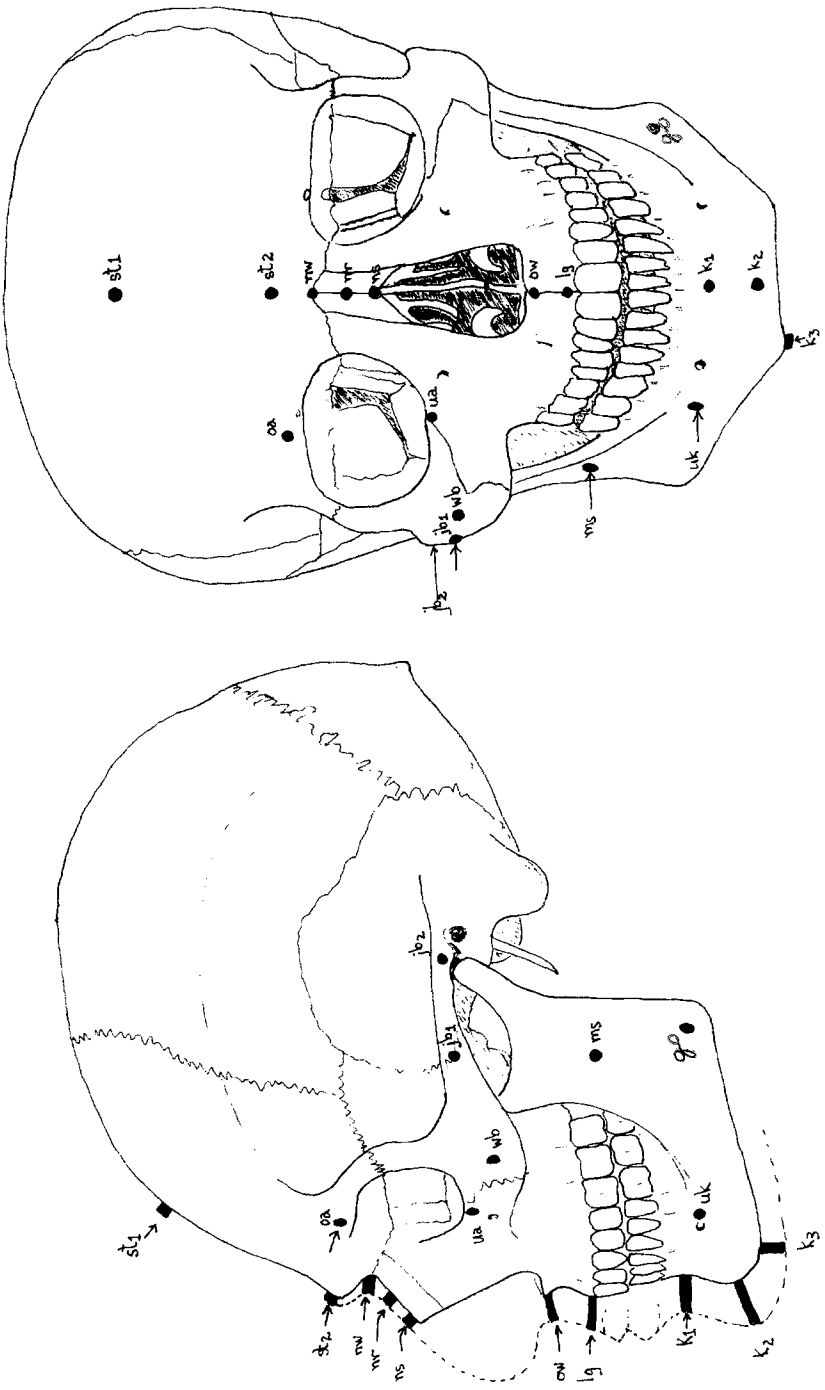

FIG. 1—*Facial tissue measurements according to the method of Kollmann and Büchly* [14].

TABLE 1—*Subjects of facial tissue thickness studies.*

Author	Reference	Date	Male	Female	Total	White	Mongoloid	Black	Remarks
Welcker	*4*	1883	13	...	13	13	...	...	...
His	*6*	1895	24	4	28	28	...	...	9 additional males not included: died from "wasting illness"
Kollmann and Büchly	*14*	1898	21	4	25	25	...	...	these data combine with His's; used as basis for modern work
Birkner	*20*	1903–1907	6	...	6	...	6	...	Beheaded Chinese
Fischer	*21*	1905	2	...	2	...	2	...	Papuans
von Eggeling	*22*	1909	3	...	3	...	...	3	Hereros
Stadtmüller	*23*	1923–1925	15	3	18	2	14	2	2 New Hollanders, 1 Javanese, 13 Melanesians, 2 Cameroons
Suzuki	*19*	1948	48	7	55	...	55	...	Japanese
Present study	...	1976–1978	68	23	91	32	...	59	...
Totals	...	...	200	41	241	100	77	64	...

TABLE 2—*Facial measurements collected by different investigators.*

Author	Reference	Date	Midline	Lateral	Bilateral	Total	Cephalometry	Other
Welcker	*4*	1883	9	...	...	9	...	...
His	*6*	1895	9	6	...	15	...	3
Kollmann and Büchly	*14*	1898	10	8	...	18	ND[a]	ND
Birkner	*20*	1903–1907	10	8	...	18	ND	ND
Fischer	*21*	1905	10	8	...	18	ND	ND
von Eggeling	*22*	1909	10	8	...	18	ND	ND
Stadtmüller	*23*	1923–1925	12	8[b]	14[b]	20	2	4
Suzuki	*19*	1948	10	13	...	23	6	12
Present study	...	1976–1978	10	...	22	32	19	27

[a] ND = not determined.
[b] Two subjects only.

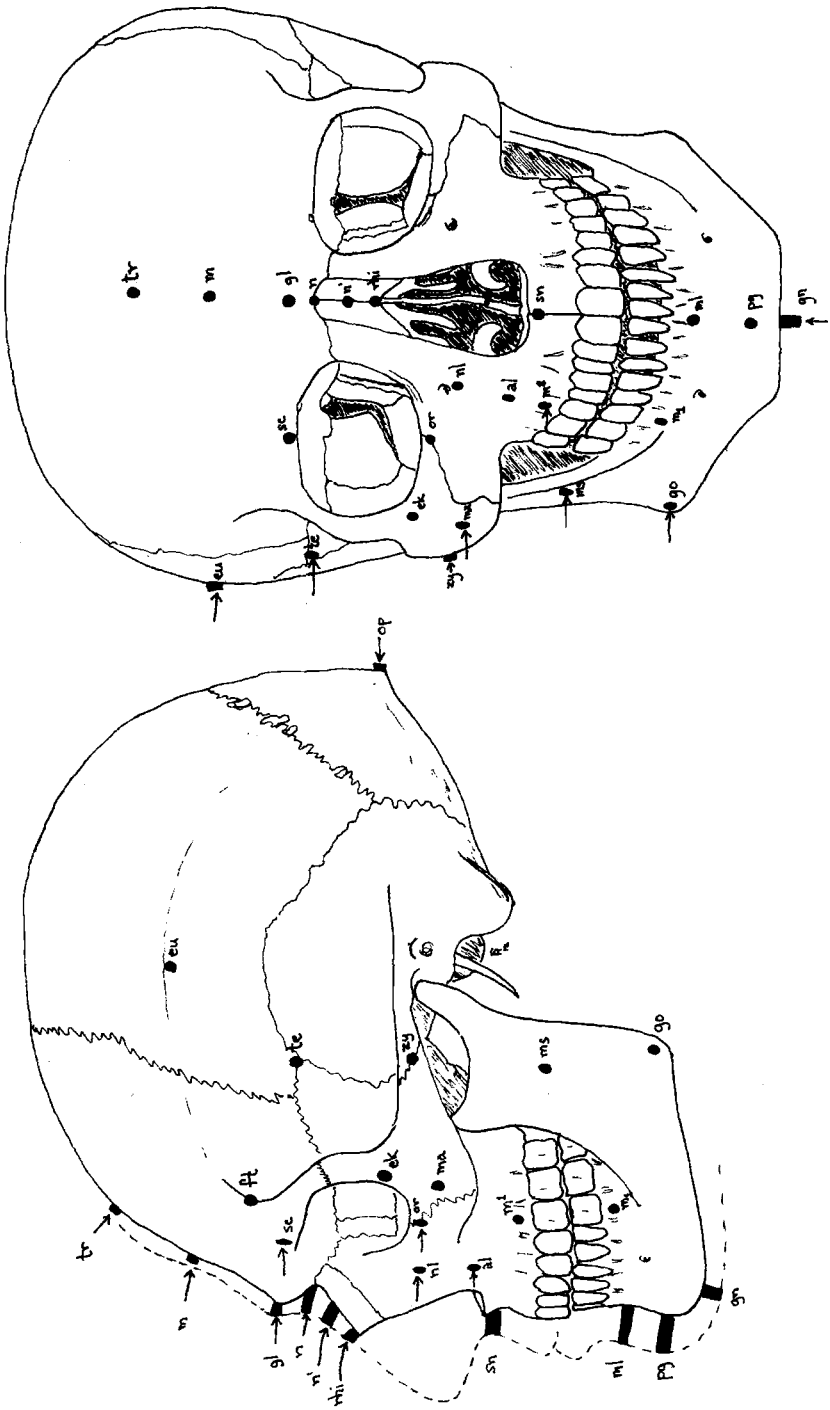

FIG. 2—*Facial tissue measurements according to the method of Suzuki* [19].

Welcker [*4,5*]. We have chosen a needle with a small rubber stopper, rather than using a soot-covered needle as did Kollmann and Büchly [*14*] and some later investigators. His [*6*] allowed the stopper to be displaced upward by the skin. We have chosen to push the stopper down lightly into contact with the skin by tweezers, after ascertaining that the skin was not puckered around the needle. We have found that the tendency for the needle to displace the skin downwards can be corrected by leveling the skin back up with the fingers of the free hand. The thickness is then read off a metric scale under magnification to the nearest 0.25 mm. Figure 3 illustrates each of the locations at which measurements of tissue depth were taken on our sample.

We have also been careful to select only unembalmed individuals, either deceased no more than 12 h or kept in a refrigeration unit no longer than overnight, to avoid distortion in the tissues caused by postmortem changes. Thus, we have found it necessary to pass over potentially useful individuals with the aim of rendering our data more trustworthy. We have also been quick to disqualify individual measurements where perimortem or postmortem distortion was demonstrable or suspect. All of our subjects appeared to be adequately nourished, some of them perhaps immoderately so. However, no attempt was made to eliminate either the thin or the more amply endowed. Some cephalometric data were collected in the usual way from the standard landmarks; some anthroposcopic data were also collected in addition to information about age, sex, cause of death, and so on. These additional data will be the subject of future analysis.

Although our initial concentration was on American blacks, we have also collected some data on other groups as indicated in Table 1. Table 1 shows only those data that we have analyzed so far: 59 blacks out of a sample of more than 250 individuals. Although 32 whites are analyzed in Table 1, they will not be included here because we think the sample is too small to lend reliable information on racial variability. Our location in New Mexico has provided us with an opportunity to sample from a heterogeneous population of whites and Indians, and various combinations of Indian and European mixtures.

The key to a successful analysis of such a mass of data is a computer. To date, we have been concerned only with extracting data on means and ranges to compare to the data of Kollmann and Büchly [*14*] and to place potentially useful information in the hands of those who wish to apply it to facial reproductions. As our sample size increases, we will be able to begin to test for significance in these results and to assess interracial and age variability as well as lateral differences.

Results

We are continuing to collect data, so Table 3 shows only that portion already analyzed. Many of the ranges are quite large because no attempt was made to select only individuals of medium build. Our intention was, rather, to sample from the broadest possible range. In most tissue thickness dimensions, the female faces are as large as or slightly less than the measurements for the corresponding location on the male faces. The greatest exceptions appear to be in the region beneath the eyes and on the sides of the face. Inasmuch as female skulls are smaller and more lightly constructed than those of males, the greater tissue thickness would exaggerate the fullness at those points. Table 4 compares Kollmann and Büchly's data [*14*] on European whites to Suzuki's Japanese [*19*] and our black sample. Inasmuch as Suzuki's sample included people in various states of nutrition, we have used only the adequately nourished ones for comparison. It will be seen that, in almost every case, the Japanese face of 1948 is smaller than the European face of the late 19th century.

Our American black sample, however, is larger, and often greatly larger, than either of the compared studies, except for the frontal eminence (Kollmann and Büchly's Point oa

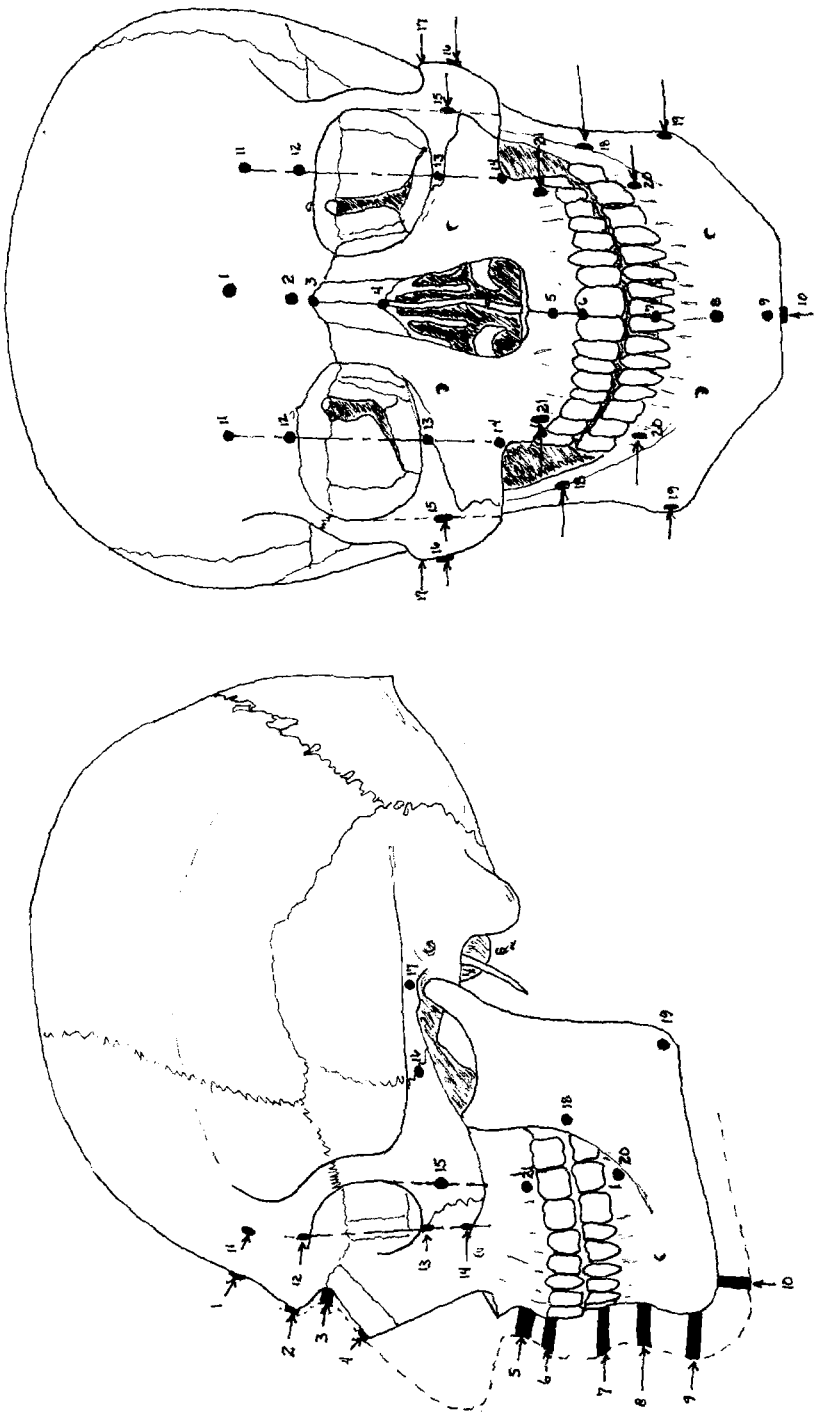

FIG. 3—*Locations of facial tissue measurements made on the present sample.*

TABLE 3—*Means and ranges of black facial tissue thicknesses measured on 44 males and 15 females.*

	Black		European [14]			Japanese [19]		
Location	Male	Female	Point	Male	Female	Point	Male	Female
Midline								
1. Supraglabella	4.75	4.50	st_1	3.50	3.50	m	3.00	2.00
2. Glabella	6.25	6.25	st_2	4.75	4.25	gl	3.80	3.20
3. Nasion	6.00	5.75	nw	5.00	4.50	n	4.10	3.40
4. End of nasal	3.75	3.75	ns	2.00	2.00	rhi	2.20	1.60
5. Mid-philtrum	12.25	11.25	ow	11.50	10.00	...	...	...
6. Upper lip margin	14.00	13.00	lg	9.50	8.25	...	...	...
7. Lower lip margin	15.00	15.50	...	...	...	...	...	...
8. Chin-lip fold	12.00	12.00	k_1	10.00	10.00	ml	10.50	8.50
9. Mental eminence	12.25	12.25	k_2	10.25	10.00	pg	6.20	5.30
10. Beneath chin	8.00	7.75	k_3	6.00	6.25	gn	4.80	2.80
Lateral								
11. Frontal eminence, left	8.25	8.00	...	...	...	...	...	...
Frontal eminence, right	8.75	8.00	...	...	...	...	...	...
12. Supraorbital, left	4.75	4.50	oa	5.75[a]	5.25[a]	...	...	...
Supraorbital, right	4.75	4.50	...	...	...	sc	4.50	3.60
13. Suborbital, left	7.50	8.50[b]	ua	4.25	4.50	...	...	...
Suborbital, right	7.75	8.25	...	...	...	or	3.70	3.00
14. Inferior malar, left	16.25	17.25	...	...	...	...	...	...
Inferior malar, right	17.00	17.75	...	...	...	...	...	...
15. Lateral orbits, left	13.00	14.25[b]	wb	6.75	7.75	...	...	...
Lateral orbits, right	13.25	12.75	...	...	...	ma	5.40	4.70
16. Zygomatic arch, left	8.75[b]	9.25[b]	jb_1	4.25	5.25	...	...	...
Zygomatic arch, right	8.50	9.00	...	...	...	zy	4.40	2.90
17. Supraglenoid, left	11.75	12.00	jb_2	6.75	7.00	...	...	...
Supraglenoid, right	11.75	12.25	...	...	...	...	...	...
18. Occlusal line, left	19.50[b]	18.25	...	...	...	...	...	...
Occlusal line, right	19.00	19.25	...	...	...	...	...	...
19. Gonion, left	14.25	14.25	go	10.50	9.50	...	...	...
Gonion, right	14.75	14.25	...	...	...	go	6.80	4.00
20. Sub-M_2, left	15.75	16.75	...	...	...	...	...	...
Sub-M_2, right	16.50	17.25	...	...	...	m_1	10.20	9.70
21. Supra-M^2, left	22.25[b]	20.75	...	...	...	...	...	...
Supra-M^2, right	22.00	21.25	...	...	...	m^1	14.50	12.30
Sample size	44	15		45	8		9[c]	7
Average age	38.0	32.8		over 40			over 40	

[a]Kollmann and Büchly's measurements [*14*] are larger.
[b]Left measurement greater than the right.
[c]*Only well-nourished individuals included.*

TABLE 4—*Comparisons of facial tissue thicknesses.*

Location	Black		European [*14*]			Japanese [*19*]		
	Male	Female	Point	Male	Female	Point	Male	Female
Midline								
1. Supraglabella	4.75	4.50	st_1	3.50	3.50	m	3.00	2.00
2. Glabella	6.25	6.25	st_2	4.75	4.25	gl	3.80	3.20
3. Nasion	6.00	5.75	nw	5.00	4.50	n	4.10	3.40
4. End of nasal	3.75	3.75	ns	2.00	2.00	rhi	2.20	1.60
5. Mid-philtrum	12.25	11.25	ow	11.50	10.00	...	...	...
6. Upper lip margin	14.00	13.00	lg	9.50	8.25	...	...	...
7. Lower lip margin	15.00	15.50	...	...	...	...	...	...
8. Chin-lip fold	12.00	12.00	k_1	10.00	10.00	ml	10.50	8.50
9. Mental eminence	12.25	12.25	k_2	10.25	10.00	pg	6.20	5.30
10. Beneath chin	8.00	7.75	k_3	6.00	6.25	gn	4.80	2.80
Lateral								
11. Frontal eminence, left	8.25	8.00	...	...	...	...	...	...
Frontal eminence, right	8.75	8.00	...	...	...	...	...	...
12. Supraorbital, left	4.75	4.50	oa	5.75[a]	5.25[a]	...	...	...
Supraorbital, right	4.75	4.50	...	...	...	sc	4.50	3.60
13. Suborbital, left	7.50	8.50[b]	ua	4.25	4.50	...	...	...
Suborbital, right	7.75	8.25	...	...	...	or	3.70	3.00
14. Inferior malar, left	16.25	17.25	...	...	...	...	...	...
Inferior malar, right	17.00	17.75	...	...	...	...	...	...
15. Lateral orbits, left	13.00	14.25[b]	wb	6.75	7.75	...	...	...
Lateral orbits, right	13.25	12.75	...	...	...	ma	5.40	4.70
16. Zygomatic arch, left	8.75[b]	9.25[b]	jb_1	4.25	5.25	...	...	...
Zygomatic arch, right	8.50	9.00	...	...	...	zy	4.40	2.90
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Supraglenoid, right	11.75	12.25	...	...	...	...	...	...
18. Occlusal line, left	19.50[b]	18.25	...	...	...	...	...	...
Occlusal line, right	19.00	19.25	...	...	...	...	...	...
19. Gonion, left	14.25	14.25	go	10.50	9.50	...	...	...
Gonion, right	14.75	14.25	...	...	...	go	6.80	4.00
20. Sub-M_2, left	15.75	16.75	...	...	...	...	...	...
Sub-M_2, right	16.50	17.25	...	...	...	m_1	10.20	9.70
21. Supra-M^2, left	22.25[b]	20.75	...	...	...	...	...	...
Supra-M^2, right	22.00	21.25	...	...	...	m^1	14.50	12.30
Sample size	44	15		45	8		9[c]	7
Average age	38.0	32.8		over 40			over 40	

[a]Kollmann and Büchly's measurements [*14*] are larger.
[b]Left measurement greater than the right.
[c]Only well-nourished individuals included.

[*14*]). Kollmann and Büchly's Point oa (Fig. 1) seems to be in precisely the same location as our Points 12 on (Fig. 3) the supraorbital torus. Though 1.0 mm is not a large difference, it is curious that thickness at this location should be larger in European populations. Our 32 analyzed white individuals (for whom data are not shown) fall between the blacks and Kollmann and Büchly's Europeans.

The remaining measurements are all larger, and aside from systematic error in measurement, four explanations may be offered:

1. Our rejection of all but fresh cadavers has probably produced higher values. Many earlier investigators had been unable to gain access to cadavers before many hours, or even days, had passed. Our access to a complete medicolegal investigation system, including rapid transportation to a central receiving station, assured a sufficient number of cadavers of recent demise.
2. Our sample includes a large number of individuals, otherwise in a good state of health, prematurely dead of violence or accident.
3. During at least the last century, there has been a well-documented and much remarked-upon increase in stature and weight in the developed countries. Inasmuch as some 80 years have elapsed between the collection of the two sets of figures, it is not unreasonable to conclude that we are seeing evidence of that trend in the face, as has been shown (see, for example, Ref *18*) for weight, stature, and earlier maturation.
4. It is possible that all of the differences between the measurements of Kollmann and Büchly [*14*] and those elicited in the present study are due to racial differences; that is, that blacks have larger faces with thicker tissue layers than whites. Given the trends noted immediately above, however, it seems unlikely that all the differences can be attributable to race. Modern whites would thus be expected to show greater tissue thicknesses than those collected before the turn of the century. Indeed, our preliminary figures reveal that they do.

Table 4 also shows that comparable figures from Suzuki [*19*] are smaller than ours, some of them considerably so. In only two locations are the tissue thicknesses on Japanese faces greater than those of Kollmann and Büchly's 1898 European white sample [*14*]. They are at the chin-lip fold (Kollmann and Büchly's Point k_1 [Fig. 1] and Suzuki's Point ml [Fig. 2]), where the Japanese faces were 0.5 mm thicker than European whites, and on the zygomatic arches (Kollmann and Büchly's Point jbl and Suzuki's Point zy), where the difference amounted to a mere 0.15 mm. In both cases, this is a trifling amount and would certainly not be noticed in a completed facial reproduction. Indeed, such figures are probably within measurement error. However, the Japanese faces appear to be so much smaller than those of European whites that to use thickness data interchangeably between races to reproduce faces will be likely to lead to a grievous error in the finished work.

As remarked earlier, the tissue thicknesses are much greater for blacks than for either whites or Japanese. In both sexes, the greatest differences between blacks and the other populations represented accumulate around the lips and the lower and lateral edges of the orbits. The mandibular measurements of blacks are also generally larger, particularly those of the females. The females also show greater thickness in the region inferior and lateral to the orbits. These observations agree with the sexual dimorphism noted by Suzuki [*19*] that can also be seen in the data of Kollmann and Büchly [*14*]. This suggests that an approximation of black proportions may be achieved by adding thickness to the lip region and to the suborbital and lateral orbital areas. One might also use these data on blacks to approximate faces of whites by a reduction of tissue thickness in those areas.

Discussion

The data presented here make possible the more accurate rendering of a plastic reproduction of a face on a black skull. Although our preliminary analysis of some data on whites suggests that Kollmann and Büchly's data [*14*] may produce a white face that tends toward the gaunt side, we think that to use the black data to restore white faces may affect accuracy. There is no question that the smaller Japanese face demands that data on Japanese tissue thickness be employed on those reproductions. As to other groups, the best choice may be to take the most conservative course, that is, to use Kollmann and Büchly's data for other nonwhite faces where the group concerned is not characterized by either very large or very small faces. Some information we have on the faces of Southwestern Indians suggests, for example, that even the great thicknesses of blacks may underestimate some Indian dimensions. For other Indian groups, data on whites may come quite close to the actual dimensions.

Though our collection of data on various groups has not ended, we could not possibly hope to collect data on a significant sample of all of the subgroups of contemporary *Homo sapiens*. Nor are we sure that the results would be worth the effort. Given the fact that this method of reproduction of faces operates from average figures (except where increased or reduced tissue masses are deemed appropriate on the basis of external data, such as relation of estimated stature to a measured waistline of pants found on the body), it is bound to underestimate the true facial dimension on some individuals and to overestimate on others. Coupling this with the fact that criteria for establishing dimensions and placement of nose, mouth, eyes, and ears are to an extent arbitrary, one can neither expect nor promise that the face will be an exact likeness of the subject every time. What will surely make or break a reproduction is the manner in which the details are handled. Indeed, the restorer may look on the average tissue thicknesses as guides and the skull as a pattern from which to emphasize the idiosyncracies inherent in the skull. This requires that a very careful analysis of the skull, from which the peculiarities and idiosyncracies are extracted, must precede any application of clay to the surface. Use of the appropriate data on tissue thickness will undoubtedly add credence to any facial reproduction, but the facial reproducer must also fortify himself or herself against a blind acceptance of any of these data in the light of informed analysis of the skull's idiosyncracies.

Summary and Conclusions

We have summarized some of our data and findings on American blacks, for whom accurate reproductions have not previously been possible. These data should prove useful to those who find themselves faced with the reproduction of a black. There are clearly many precautions required, both before and during the reproduction process, necessitating consultation with a forensic anthropologist before the reproduction is undertaken. However, because of both the growing interest in this process and the wider application it is now receiving, we suggest that it be employed whenever possible, both as a means of testing its reliability and as a technique for eliciting leads on which an identity may be established. We hope that the method gains general acceptance and may eventually be used as an early tool for producing investigative leads, rather than as a last-ditch effort years after the trail has evaporated.

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