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Racial Identification from the Midfacial Skeleton with Special Reference to American Indians and Whites

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ABSTRACT: Successful approaches to race determination of unidentified human remains have been developed by anatomists and physical anthropologists, but few quantitative methods are available for distinguishing American Indian crania from those of whites. The leading method in use today is particularly ineffective in its placement of American Indian skulls from the western regions of the United States. Recent development and testing of a new metric method suggests a much more effective technique. The method involves six breadth and projection measurements of the midfacial skeleton, the calculation of three indices, and a simple direct reading of results. The method has the additional advantage of use in the autopsy room with minimal dissection of soft tissue required. Based upon a less extensive test of East Asian and Arctic Mongoloid crania, the method appears to be even more effective in separating them from the sharp featured whites. Larger samples of American blacks and Polynesians are presently under study and these also appear to separate quite readily from whites using the same or similar sectioning values.

KEYWORDS: physical anthropology, human identification, musculoskeletal system, race determination, craniofacial metrics

Many successful approaches to race determination from the human skeleton have been developed over the years of the history of physical anthropology, and the majority of these are reviewed in the standard reference works of Krogman [*1*] and Stewart [*2*]. A more recent review including several new methods is also now available [*3*]. Very few skeletal criteria have been established historically, however, for distinguishing American Indians from whites. Yet the need to distinguish unidentified remains from these two morphologically similar geographical races is great, throughout the Americas, both in a forensic science and in an archaeological context.

If the specimen possesses anterior dentition, the problems of race determination are lessened because of the high incidence of shovel shaped incisors among the American Indians (and related Mongoloids). However, race differences for this trait are far from absolute [*4*], and also postmortem absence of incisors is a problem encountered often in human skeletal

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identification. The Giles and Elliot [5] craniometric discriminant function method exists for differentiating the three main geographical races of North America (American Indian, white, black), and it has the advantage of objectivity which is lacking in most traditional anthroposcopic techniques (yet so useful in the courtroom setting). Unfortunately, however, the Giles and Elliot method has been found lacking when applied to American Indian samples in the Northwestern Plains [6], Central Plains [7], Southwest [8], and elsewhere [9]. For these reasons the present research was undertaken, and a new metric method of race determination from the midfacial skeleton developed.

Preliminary results of earlier phases of this research have been previously reported [10–15], as well as a forensic science test case in which the method was successfully utilized [16]. The history of the development of the method has likewise been reviewed [16].

The objective of the study has been to develop a reliable osteometric method for racial identification from the midfacial skeleton, with particular reference to this difficult problem of separating the remains of American Indians from those of whites. In the course of investigation, however, samples of American blacks, East Asian and Arctic Mongoloids, and Polynesians have also been added. Analyses of these additional samples are not yet completed.

Many interorbital and midfacial measurements of nasal projection, and indices derived from them were developed and used successfully during the first third of this century by Bennington [17], Ryley and Bell [18], Morant [19], von Bonin [20], and Woo and Morant [21]. An instrument known as the *simometer*, which is a modified coordinate caliper, was used in many of these earlier studies. It is illustrated by Howells [22] (see Howells' Appendix B). The caliper has in fact been in use since 1882 [24], and is capable of taking the refined measurements necessary in the evaluation of midfacial projection.

Most of the common midfacial measurements appear to have been discontinued by the late 1930s as a result of a criticism by Pearson [23] who emphasized the lack of standardization among the various calipers. Subsequently, a trend developed away from the use of the simometer and away from all interorbital measurements and indices except nasal height, breadth, and nasal index. This seems to have been part of a wider effort to simplify and standardize. Unfortunately, in doing so, physical anthropologists have since been largely overlooking one of the best areas of the skeleton for the identification of racial affinities. We have thus taken the more recent suggestions of Howells [22,25] and returned to the use of the simometer and the valuable measurements and calculations generated by its use. Furthermore, we have developed one additional set of measurements, and an index of our own, the *alpha index*, which has proven to be the best single metric discriminator of all (see below).

Materials and Methods

Machinist-technicians at the University of Wyoming have built simometers from standard coordinate calipers, according to a slight modification of the Howells plan. In an initial pilot study [13] the simometer was used to collect a set of 14 promising interorbital, nasal, and other midfacial measurements, and 7 indices were calculated from them and plotted. Univariate analysis of the samples with regard to the 14 measurement variables proved less rewarding than the separations provided by 3 of the 7 indices.

Subsequent discriminant function analysis with expanded samples showed that the best discriminators were still the three indices: maxillofrontal, zygoorbital, and alpha. The indices likewise have the advantage of being simpler and much quicker to apply. This has supported a prediction made by Eugene Giles in 1979, after reviewing a preliminary report of this study, that the three indices in combination would turn out to be simpler and more efficient in making separations than the use of discriminant function approaches.

The six measurements, taken with the simometer, are defined as follows:

1. *Maxillofrontal breadth*—Breadth between maxillofrontale left and right; often termed "interorbital breadth."

Maxillofrontale is defined by Bass [*26*] as the intersection of the frontomaxillary suture and the "anterior lacrimal crest, or the crest extended (medial edge of the eye orbit)" (p. 60). The measurement is illustrated in Fig. 1*a* and is the distance between right and left Points 1.

Naso-maxillofrontal subtense—The projection (subtense) from the maxillofrontal points to the deepest point on the nasal bridge. This is *not* a precise point, but is the point at which a minimal reading is obtained on the vertical scale of the simometer. In other words, it is "instrument determined." The vertical line from Point 1, to the nasal bridge, in Fig. 1*b*, illustrates this subtense measurement.

2. *Mid-orbital breadth*—The breadth between zygoorbitale left and right.

Zygoorbitale is defined by Howells [*22*] as "the intersection of the orbital margin and the zygomaxillary suture" (p. 170). Occasionally the suture meanders along the orbital border; then its most medial location is chosen as zygoorbitale (see Points 2, Fig. 1*a*).

Naso-zygoorbital subtense—The projection (subtense) from the zygoorbital points to the deepest point along the nasal bridge. This "deepest point" is also "instrument determined" by the minimal vertical reading on the simometer to the nasal bridge, wherever that minimal diameter is found. The vertical line from Point 2 to the nasal bridge, in Fig. 1*b*, illustrates this subtense measurement.

3. *Alpha cord*—The breadth between alpha points right and left.

Point alpha is the deepest point, left and right on the maxilla along a line from zygoorbitale to the point where the naso-maxillary suture meets the nasal aperture (note Points 3 Fig. 1*a*). To determine alpha, a straight line is pencilled connecting the above two points, and the skull tilted until the profile of a straight edge and the pencilled line are clearly visible. The deepest point is then marked along the pencilled line (see Fig. 2). The deepest point usually coincides with a depression or "break" where the maxilla begins to rise anteriorly toward the nasal aperture. When a definite break or depression is not visible along the pencil line, but instead the concavity forms a long gradual shallow depression in profile, a deepest point is difficult to determine. Then the mid-point along the pencilled line is chosen.

Naso-alpha subtense—The projection (subtense) from the alpha points to the deepest point on the nasal bridge. The deepest point here is instrument determined as in the above two cases. Note the line from Point 3 to the nasal bridge in Fig. 1*b*, which illustrates this subtense measurement.

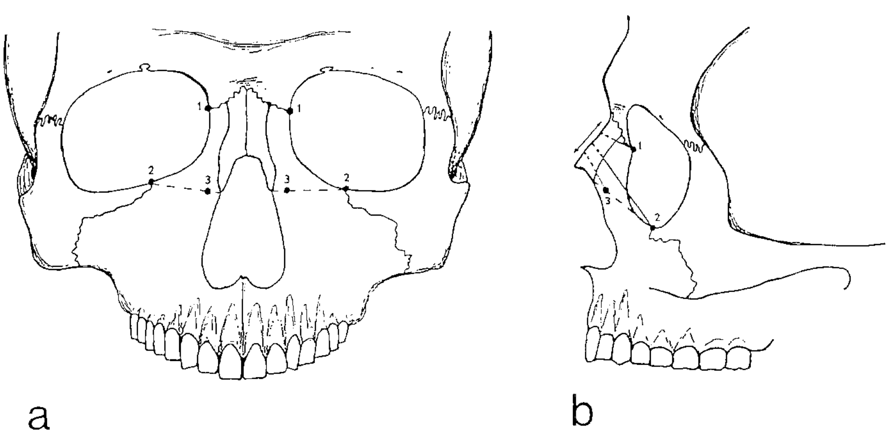

FIG. 1—*Frontal* (a) *and left lateral views* (b) *showing the three sets of points from which the six simometer measurements are taken.*

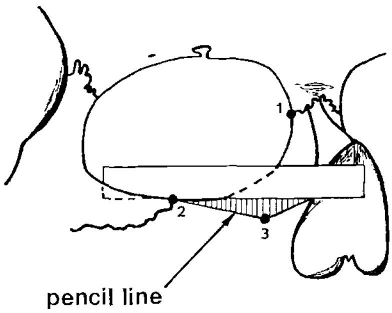

FIG. 2—*Profile view below the right orbit showing the establishment of the right alpha point* (3).

The three indices are calculated by dividing the three breadth measurements into the three corresponding subtense measurements (×100). Below is an example from our male Northwestern Plains Indian sample.

Measurements		Indices	Amer-Indian		White
1. Naso-maxillofrontal subtense	8				
	÷ =	44.44	___	40	X
Maxillofrontal breadth	18	(maxillofrontal)			
2. Naso-zygoorbital subtense	18				
	÷ =	30.00	X	38	___
Zygoorbital breadth	60	(zygoorbital)			
3. Naso-alpha subtense	15				
	÷ =	44.12	X	60	___
Alpha cord	34	(alpha)			
		Race:	American Indian		

The dividing points between whites and Indians for the three indices are 40, 38, and 60, as shown above. Those specimens that produce values on both sides of the sectioning points, like the example, are racially classified by the placement of two-out-of-three index values.

At an earlier preliminary stage of this study [*16*] when sample sizes were small, cutoff values were listed as 40-40-60. Our new 40-38-60 values, developed from larger samples, have produced slightly higher percentages of correct placement. These three sectioning values have been selected by choosing the mid-points between the two population means for each of the three index values.

The sectioning points are based upon a sample of 125 whites and 173 American Indians. The majority of whites (n = 103) are drawn from the Terry Collection, Smithsonian Institution, and the remainder are frontier whites or forensic science specimens from Wyoming, or represent forensic science cases from Tennessee and northern Colorado (n = 22).

The American Indian sample has been drawn from geographically well dispersed tribal groups. A shortcoming of the Giles-Elliot discriminant function method of race determination appears to be that all metrics (for American Indians) were drawn from a single population from the mid-West (Indian Knoll). Therefore an effort has been made here to avoid that kind of limitation. The sample of American Indians is made up of the following: Arikara (n = 20), Pawnee (n = 31), Dakota (n = 33), N.W. Plains (various tribes of Wyoming, Montana, N. Colorado) (n = 21), Omaha (n = 17), Minnesota (various tribes [n = 27]), Mimbres (n = 27), and miscellaneous (n = 2).

Results

Plot points of individual American Indians and whites with regard to each of the three indices are shown in Fig. 3. As will be noted in the figure, whites reveal higher values on all three indices, indicating narrower faces, higher nasal bridges, and an overall greater midline

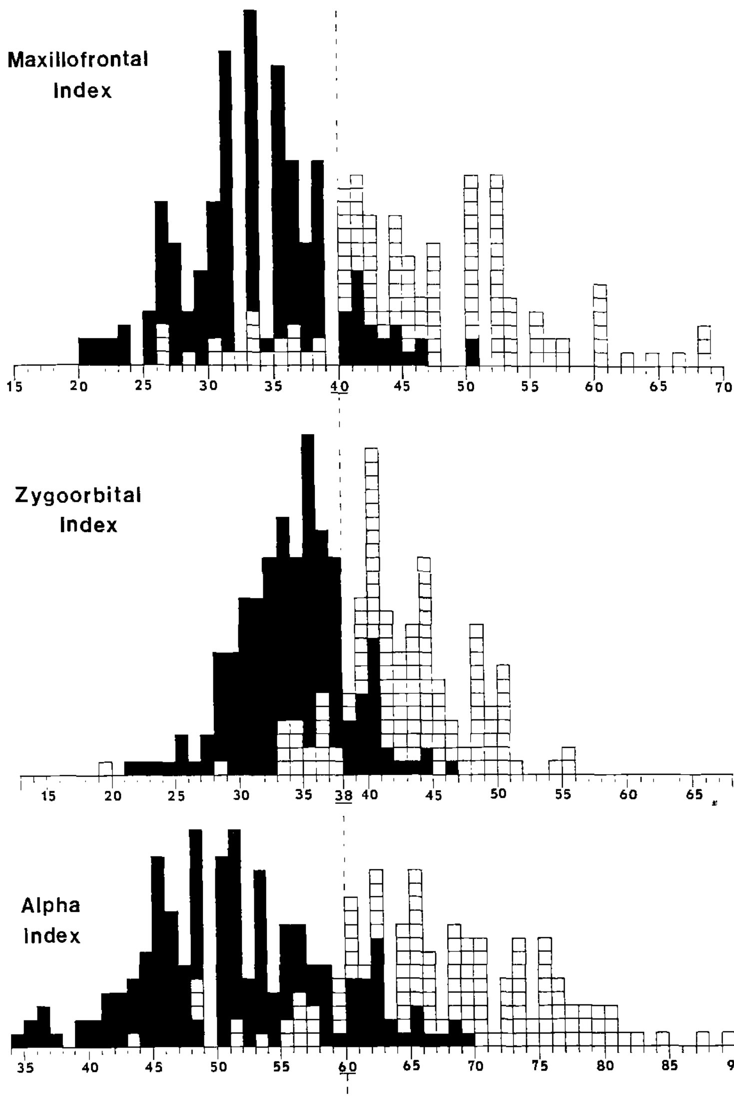

FIG. 3—*Plot values for American Indians* ■ *and whites* □ *for each of the three interorbital indices.*

prominence of the face. Most American Indians, on the other hand, with their wide, projecting cheek bones, and lower nasal bridge (or at least lower overall projection) fall to the left side of the 40-38-60 sectioning points.

The means for each of the three indices are compared in Table 1. As may be seen the following spreads occur between the Indian and white averages: 13 points between maxillofrontal index means; 9 points between zygoorbital means; and 17 points between the alpha index means. The greater precision in the zygoorbital index sectioning point. as it has been changed from 40 to 38, increases the percentage of correct placement among the 125 whites from 84.8 to 88.8%. Table 2 illustrates the percentage correct placement for all individuals by sex, by race, and among the American Indians, by tribe.

Discussion

As may be seen from Table 2 the interorbital indices are quite successful in separating American Indian crania from those of whites, and this is especially true if sex of the specimen is known to be female. In such cases the probability of correct placement rises to over 90%.

TABLE 1—*Interorbital index values.*

	MF		ZY		AL	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Whites (n = 125)	46.59	8.97	42.89	5.49	68.15	8.67
Sectioning points	40.00		38.00		60.00	
Amer-Indians (n = 173)	33.64	5.74	34.00	4.33	51.30	7.46

TABLE 2—*Correct placement of individuals.*

Samples	Misclassified	Percentage Correct Placement
White	14/125	88.8
M	12/103	88.3
F	2/22	90.9
American Indian	21/173	87.9
M	17/100	83.0
F	4/73	94.5
Arikara	5/20	75.0
Pawnee	3/31	90.3
Dakota	4/33	87.9
N.W. Plains	0/21	100.0
Omaha	4/17	76.5
Minnesota	3/22	86.4
Mimbres	2/27	92.6
Misc. (N.W. Coast and Peru)	0/2	100.0

It is also clear from the results in Table 2 that accuracy not only varies by sex, but by tribe among the American Indians. In the Northwestern Plains all specimens have been correctly classified by the method, while among the Arikara half of the males are misclassified. Even though there is some chance of white admixture among the Larson Site Arikara selected for this study,[5] the somewhat similar results among other North Central Plains tribes suggests to us that additional factors are involved. Fortunately, however, it appears that in the western United States, where the Giles-Elliot method seems to produce its poorest results, our interorbital method produces its best results. Many tribes from the eastern United States and other localities still remain to be tested, however.

Summary and Conclusions

Some advantages of the new metric method of racial identification described here are: (1) effectiveness in the courtroom since it is an objective, quantitative method with a known rate of success; (2) greater effectiveness than previous quantitative methods for separating whites from the morphologically similar American Indians, especially in the region of the Northwestern Plains where the Giles-Elliot method misclassifies 70% of American Indians [*6*]; (3) applicability to quite fragmentary crania and to those without dentition; (4) mathematical simplicity; and (5) utility on the autopsy table with minimal dissection [*16*].

Since this method has been developed on a large and broadly based sample of American Indians, as well as a fairly large and representative sample of American whites, we expect the method to have wide applicability, geographically, within North America. We expect, in fact, a probability of success with other forensic scientists in other regions comparable to that shown here among our own samples.

Additionally, from our preliminary results with a small sample of Asian Mongoloids (n = 28) and some larger samples of American blacks (n = 109) and Polynesians (n = 91), it would seem that the method, with the same or similar sectioning values, is even more effective in isolating these populations from the sharp featured whites. So, our present working hypothesis, which can in time be tested, is that the metric approach described here is an effective discriminator of the crania of whites from those of *all other populations*. This broad claim is of course not extended to racially admixed populations containing a significant Caucasoid component such as the Hispanics, or other groups which represent more of a "social race" than a well-defined biological entity.

[5]W. M. Bass, personal communication, 1987.

References

[*1*] Krogman, W. H., *The Human Skeleton in Forensic Medicine*. Charles C Thomas, Springfield, IL, 1962.

[*2*] Stewart, T. D., *Essentials in Forensic Anthropology*. Charles C Thomas, Springfield, IL, 1979.

[*3*] Gill, G. W., "Cranio-Facial Criteria in Forensic Race Identification," in *Forensic Osteology*, K. J. Reichs, Ed., Charles C Thomas, Springfield, IL, 1986.

[*4*] Carbonell, V. M., "Variations in the Frequency of Shovel-Shaped Incisors in Different Populations," in Symposia of the Society for the Study of Human Biology: Vol. V, *Dental Anthropology*. D. R. Brothwell, Ed., Pergamon Press, Oxford, 1963.

[*5*] Giles, E. and Elliot, O., "Race Identification from Cranial Measurements," *Journal of Forensic Sciences*, Vol. 7, 1962, pp. 247-257.

[*6*] Fisher, T. D., Gill, G. W., and Lanum, P. D., "Application of the Giles-Elliot Discriminant Function Formulae to a Cranial Sample of Northwestern Plains Indians," paper presented at the Symposium on Racial Identification, 36th Annual Meeting of the American Academy of Forensic Sciences, Anaheim, CA, 1984.

[*7*] Snow, C. C., Hartman, S., Giles, E., and Young, F. A., "Sex and Race Determination of Crania by Calipers and Computer: A Test of the Giles and Elliot Discriminant Functions in 52 Forensic Science Cases," *Journal of Forensic Sciences*, Vol. 24, No. 2, April 1979, pp. 448-459.

[*8*] Birkby, W., "An Evaluation of Race and Sex Identification from Cranial Measurements," *American Journal of Physical Anthropology*, Vol. 24, 1966, pp. 21-28.
[*9*] Ayres, H. G. and Jantz, R. L., "Giles and Elliot Race Discriminants Revisited: Modern Forensic Cases Speak," paper presented at the 38th Annual Meeting of the American Academy of Forensic Sciences, New Orleans, LA, 1986.
[*10*] Gill, G. W. and Hughes, S. S., "Race Determination from Interorbital Skeletal Features," paper presented at the 31st Annual Meeting of the American Academy of Forensic Sciences, Atlanta, GA, 1979.
[*11*] Bennett, S. M., "The Use of Discriminant Function Analysis in the Assessment of Race," Senior Honors Paper, Department of Anthropology, University of Wyoming, 1979.
[*12*] Gill, G. W., "Interorbital Skeletal Features in Race Identification: Additional Findings," paper presented at the 40th Annual Meeting of the Society for Applied Anthropology, Denver, CO, 1980.
[*13*] Hughes, S. S., "Differences in Nasal Projection Between American Indian and Caucasian Crania," *Wyoming Contributions to Anthropology*, Vol. 2, 1980, pp. 96-113.
[*14*] Gill, G. W., Hughes, S. S., Bennett, S. M., and Gilbert, B. M., "Race Determination from Projection of the Midfacial Skeleton," paper presented at the 34th Annual Meeting of the American Academy of Forensic Sciences, Orlando, FL, 1982.
[*15*] Gill, G. W., Gilbert, B. M., Hughes, S. S., and Bennett, S. M., "Racial Identity from Projection of the Mid-facial Skeleton," paper presented at the Symposium on Racial Identification, 36th Annual Meeting of the American Academy of Forensic Sciences, Anaheim, CA, 1984.
[*16*] Gill, G. W., "A Forensic Test Case for a New Method of Geographical Race Determination," in *Human Identification*, T. A. Rathbun and J. E. Buikstra, Eds., Charles C Thomas, Springfield, IL, 1984.
[*17*] Bennington, R. C., "A Study of the Negro Skull with Special Reference to the Congo and Gaboon Crania," *Biometrika*, Vol. 8, 1912, pp. 292-339.
[*18*] Ryley, K. V. and Bell, J., "A Study of the Nasal Bridge in the Anthropoid Apes and Its Relationship to the Nasal Bridge," *Biometrika*, Vol. 9, 1913, pp. 391-445.
[*19*] Morant, G. M., "A Study of the Australian and Tasmanian Skulls, Based on Previously Published Measurements," *Biometrika*, Vol. 19, 1927, pp. 419-440.
[*20*] Bonin, G. von, "A Contribution to the Craniology of the Easter Islanders," *Biometrika*, Vol. 23, 1931, pp. 249-269.
[*21*] Woo, T. L. and Morant, G. M., "A Biometric Study of the 'Flatness' of the Facial Skeleton in Man," *Biometrika*, Vol. 26, 1934, pp. 196-250.
[*22*] Howells, W. W., "Cranial Variation in Man," *Papers of the Peabody Museum of Archaeology and Ethnology*, Harvard University, Vol. 67, 1973.
[*23*] Merejkowsky, C. de, "Sur un Nouveau Caractere Anthropologique," *Bulletins de la societe d'Anthropologie de Paris*, 3 ieme serie, T.V., 1882, pp. 293-304.
[*24*] Pearson, K., "On Simometers and Their Handling," *Biometrika*, Vol. 20, 1934, pp. 265-268.
[*25*] Howells, W. W., "Criteria for Selection of Osteometric Dimensions," *American Journal of Physical Anthropology*, Vol. 30, 1960, pp. 451-458.
[*26*] Bass, W. M., *Human Osteology: A Laboratory and Field Manual of the Human Skeleton*, second ed., Missouri Archaeological Society, Columbia, MO, 1971.

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