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METHODS OF RACIAL ANALYSIS[1]

SIGNIFICANCE OF THE TERM "RACE"

THE term "race" as applied to man is commonly employed with no accurate and well-defined meaning. One often sees references to the "white race," the "Jewish race," the "Latin race," the "Irish race." Such indiscriminate use of the word "race" implies a confusion of criteria. To speak of the "white" race is to assume that race is a matter of skin pigmentation; to refer to the "Jewish race" is to differentiate race on a basis of religion; a "Latin race" implies a linguistic criterion, and finally any reference to an "Irish race" must mean a race characterized either by geographical position or, failing that, by temperament. Such confusions of usage are usually confined to the non-anthropological writing public. All anthropologists agree that the criteria of race are physical characters. The tests of racial distinction are the morphological and metrical variations of such bodily characters as hair, skin, nose, eyes, stature—differences in shape and proportions of the head, the trunk and the limbs.

Although there exists among anthropologists this general agreement as to the physical basis of race, there is no such unanimity of opinion with respect to the further implications of a classification of mankind on the score of bodily attributes.

One school of anthropologists is disposed to deny that there are any cultural or psychological correlates of race. For these the somatological variations whereby race is determined are of little significance, except as convenient characters for classificatory purposes. They regard them principally and ultimately as effects of environment, though perhaps immediately heritable. Pigmentation may be dismissed by such as a result of climate, stature as a consequence of nutrition, head-form as a manifestation of individual variation or a by-product of separately inherited size-factors. Logically, such anthropologists refuse to recognize that language, material culture, mental capacity or social organization stand in any biological, mathematical or rational relationship to races as determined by these plastic and transitory physical characters. For them race is a congeries of environmentally determined bodily features, significant principally because it effects differences in outward appearance which arouse the prejudice of the ignorant.

[1] Address of the vice-president and chairman for Section H, American Association for the Advancement of Science, Kansas City, Missouri, December, 1925.

A second group of anthropologists, or more properly biometricians, devotes itself principally to the statistical analysis of anthropometric measurements and to the determination of the relationship of such measurements to each other and to various environmental conditions. Under the brilliant leadership of Professor Karl Pearson, these biometricians have developed precise statistical tools, whereby errors incident to the sampling process may be taken into account, variabilities may be reckoned and the relation of variables to each other may be measured by coefficients. These biometrical anthropologists recognize the physical basis of race, but they have not, for the most part, attempted to isolate racial types in the populations which they study. While admitting, doubtless, the racially mixed character of such people as the English they tend to deal with them as if they were racially homogeneous. The late Charles Goring, for example, in his magnificent study of the English criminal divided his large series of convicts into groups classified according to type of offence, and investigated almost every conceivable relationship between their physical characteristics, their mental qualities, their environmental surroundings and the nature of their delinquency. He neglected utterly, however, to distinguish between the various racial types which may have been represented in his sample and attributed such physical differences as he discovered to the influence of social class. In this he exemplified the tendency of the biometric school to study populations as a whole or by selected classes without attempting to distinguish between the various racial types included in them.

A third group of writers on racial subjects, usually not professional anthropologists, associates cultural and psychological characteristics with physical types on wholly insufficient evidence. These race propagandists commonly attribute to the physical subdivision of mankind to which they imagine that they themselves belong all or most of the superior qualities of mankind, physical, mental and moral. They talk of the psychological characteristics of this or that race as if they were objective tangible properties, scientifically demonstrated. Starting from an *a priori* assumption that physical types have psychological correlates, they attempt to refer every manifestation of the psychological qualities assumed to be the exclusive property of this or that race to the physical type in question. Great men of whatever period are claimed to be members of the favored race on the basis of their achievements and sometimes with a total disregard of physical criteria. In no case has any serious effort been made by such ethnomaniacs to isolate a pure racial type and to study either its mental qualities or its material culture. The fact that most if not all peoples are racially mixed is consistently ignored. While some of the conclusions of such writers may be correct, none of them have been scientifically established.

DEFINITIONS OF "RACE"

In the existing confusion as to the connotation of race, it is clear that the term requires exact definition, if any progress is to be made in studies which relate to race analysis or racial problems. I offer the following definition, not with the hope or expectation that it will be generally accepted, but merely in order to elucidate my own position.

A race is a great division of mankind, the members of which, though individually varying, are characterized as a group by a certain combination of morphological and metrical features, principally non-adaptive, which have been derived from their common descent.

A primary race is one which has been modified only by the operation of evolutionary factors, including the selection of its own intrinsic variations and of the modifications, adaptive or non-adaptive, possibly caused by environmental stimuli.

A secondary or composite race is one in which a characteristic and stabilized combination of morphological and metrical features has been effected by a long-continued intermixture of two or more primary races within an area of relative isolation.

Assuming, for the moment, the validity of the foregoing definitions, it is apparent that the present population of the world consists for the most part of secondary races and that primary races are represented only by inbred peoples within areas where little race contact is known to have taken place. Of such inbred peoples only a small fraction represent primary racial types either because they are absolutely unmixed or because pure racial types have been segregated out in relatively few individuals. For man has been a migratory animal from proto-human times down to the present and the contact of races has always resulted in race mixture.

I do not propose to enter into any elaborate discussion as to the specific unity or diversity of existing types of man. Certainly if fertility in interbreeding is regarded as the test of species all present varieties of man must be assigned to one group.

CRITERIA OF RACE

The criteria by which race classifications are established are admittedly physical. Furthermore, they are necessarily multiple. No single bodily character exhibits a sufficient range of variation to enable us to assign to each of the great human groups which

require racial classification a distinct and exclusive development of that feature. There are not enough variations of any one feature to go around, unless we confine ourselves to two or three primary and well-nigh hypothetical races. A man's head must be broad in proportion to its length, narrow in proportion to its length or of medium breadth; his hair must be straight, wavy or curly. But there are more distinct types of men than distinct categories of hair-form or cephalic index, and one extreme variant of a bodily feature is not always associated with the same modification of another feature in individuals or in groups. Separate bodily characters in their various grades of development are not necessarily correlated with each other. It follows that racial classifications must be made upon the basis of a sum total of significant morphological and metrical features according to the measured and observed combinations of distinct variations of such features in large human groups.

If race implies the common possession of certain variations as a result of the same ancestry, significant racial criteria should be based principally upon non-adaptive bodily characters. No bodily characters are absolutely unmodifiable, but certain organs are more or less stabilized in their functions, and the less important these functions are, the greater is the probability of hereditary variations manifesting themselves unimpeded and unmodified in such organs. Heredity runs riot in indifferent variations and atrophied organs. The very insignificance of certain features, such as the form of the hair or the thickness of the lips, insures their hereditary transmission in the absence of selected adaptive modifications that have survival value. The human foot, on the contrary, is rigorously adapted and modified for support and locomotion in all varieties of man, and the practically identical requirements of a functional nature tend to obscure and obliterate any racial variations which may have existed or to subordinate them to such variations as may be consequent upon the habits of going barefoot or shod.

I regard the following bodily characters as mainly non-adaptive variations: the form, color and quantity of the hair, and its distribution in tracts; the color of the eyes and the form of the eyelid skin-folds; the form of the nasal cartilages; the form of the lips and of the external ear, the prominence of the chin; the breadth of the head relative to its length; the length of the face; the sutural patterns, the presence or absence of a postglenoid tubercle and a pharyngeal fossa or tubercle, prognathism, the form of the incisor teeth; the form of the vertebral border of the scapula, the presence or absence of a supracondyloid process or foramen of the humerus, the length of the forearm relative to the arm; the degree of bowing of the radius and ulna; the length of the leg relative to the thigh. This list is not, of course, exhaustive. Many of the features enumerated above, and perhaps all of them, may be functionally modified, if the need for such modification arises. For example, the breadth of certain Eskimo skulls appears to have been constricted by the hypertrophy of the temporal muscles. Usually, these characters, however, show no apparent relationship to function, and seem to maintain themselves by the inertia of heredity, occurring sometimes as individual or family variations, and sometimes more widely distributed in racial stocks.

Another group of bodily characters include those the distinctive variations of which may have originated in functional modifications, but which have become so stabilized as to persist in certain stocks even in contravention of their original function. These may also be utilized as racial criteria, subject to a precaution, *viz.*, that they may be remodified in an opposite direction. Among these are pigmentation of the skin, breadth of the face, height and breadth of the nose, size and prominence of the malars, shape and proportions of the hard palate, height of the head, volume of the brain, proportions of the thorax, relative length of the lower extremities, relative length and angle of inclination of the heel-bone and size and development of the calf muscles.

Features that seem easily modifiable in the individual and in the group through the action of environmental factors, and especially by quality of nutrition, diet, gait and exercise, can not be trusted as criteria of race, except in the absence of evidence for the operation of such environmental causes. These include stature, weight, length of the upper extremity, proportions of the hand, most variations of the bones of arm, degree of lumbar curvature and pelvic inclination, most of the variations in the long bones of the lower extremity, including femoral torsion, bowing, pilaster, platymeria, variations of the articular surfaces of the tibia and of the shape of the tibial shaft.

The Application of Racial Criteria

In the actual practice of racial analysis a number of questions arise as to the relative importance of various criteria and the method of procedure in the application of the different tests. What differences in methods of analysis are involved in the study of living peoples as contrasted with the investigation of skeletal remains? Should stress be laid upon morphological or metrical observations or a combination of both? Is the diagnosis to be made upon the basis of individual combinations or group means? How may we isolate pure racial types?

Let us consider first the application of racial test to living peoples in comparison with the study of

skeletons. Certain obvious advantages obtain in the investigation of the living. The material is more abundant, there is no doubt as to sex identification and comparatively little doubt as to age; data with respect to individual and family history and ethnic affinities are ascertainable, as well as the environmental backgrounds of the people under investigation. Many significant features lacking in skeletal material such as the form of the soft parts of the eyes, nose and mouth, the form and distribution of hair and the pigmentation of the body may be examined.

On the other hand, there are certain disadvantages involved in the study of the living. The personal reactions of the subjects must be considered and opportunities for assembling and subdividing the grouped material are lacking. Each individual can as a rule be observed and measured only once. Measurements on the soft parts are far less accurate than measurements on the skeleton, and most significant skeletal features can not be observed or measured on the living. Certain striking and obvious characters of living subjects are likely to mislead the investigator in his racial analysis. The form and color of the hair is often radically altered by artificial means. Phenomena of dominance tend to obscure relationships in composite races, particularly in pigmentation and the form of the hair and soft parts. A wash of yellow-brown pigment and the dominance of straight, coarse, black hair has, in my opinion, for instance, created a mistaken impression of the physical homogeneity of the American Indian.

The advantages and disadvantages of analyzing racial elements in skeletal material are naturally the opposite of those that obtain in the case of living material. Our present imperfect knowledge of the correlation of variations of the soft parts with those of the bony skeleton renders uncertain many racial determinations upon bones, but studies on the living are subject to the same disadvantage. But in the investigation of early and extinct types of man and of past populations our dependence is naturally upon skeletal material. I am of the opinion that racial characteristics are better defined in the skeleton than in the soft parts. This seems to be the case particularly in the skull. Many individuals of mixed blood, who are fundamentally white, show characters of skin, pigmentation and soft parts which would lead a superficial observer to classify them as predominantly negroid. But the skull and framework of the body may show a basically non-negroid morphology. On the other hand, it is equally true that some persons who appear to be white show definite negroid or mongoloid skeletal features. An ideal method of racial investigation would be to follow the study of the soft parts with the examination of the skeleton in each case, but so far as I know this method is pursued only by Professor Wingate Todd at Western Reserve University, and racial studies are naturally confined to such types as happen to pass through the dissecting room. Correlations of features of the soft parts with skeletal structure may sometimes be obtained in the living by the use of the X-ray, but this method is usually impracticable.

The comparative importance of morphological and metrical observations for purposes of racial diagnosis has not been clearly established. Every student of the subject knows that many of the significant characters of the skeleton and the soft parts are non-measurable. They are, however, capable of classification according to presence or absence, grade of development and form, if the observer is experienced and is able to maintain a consistent standard for his morphological appraisals. These qualitative observations have usually been neglected by students of race because of the difficulty of recording them and of dealing with them statistically. Now, however, thanks to the work of the biometricians, methods have been developed whereby such qualitative observations may be treated mathematically. The method of mean square contingency enables one to express by a coefficient the interrelationships of different non-measurable features within a series, and it is also possible to ascertain the correlation between measured and observed characters. There is now no excuse for neglecting morphological observations.

Measurements have always been favored in the investigation of racial groups, because of their precision and because of the ease with which they may be handled mathematically. But crude dimensions are not often racially significant in the individual, and their value for this purpose is somewhat questionable even when the means of groups and the variabilities are calculated. For this reason it has long been customary for anthropologists to calculate indices which express the relation of one dimension to another as a percentage. These indices are conventionally and somewhat arbitrarily divided each into three or more categories, according as the ratio of one dimension to another is small, medium or large. How far these index divisions correspond with racial variations is a moot question. Certainly it is dangerous to invest these artificial gradations of ratios with the official status of race determiners, without due investigation of their individual and intra-racial ranges of variation. Further, indices seem not to be inherited *in toto,* but the measurements of which indices express ratios may be inherited from the same or different parents, and more than one factor may be involved in a single measurement, not to speak of the individual variations which may crop out. In spite of these

difficulties indices are a convenient and valuable means of expressing group and individual characteristics and should by no means be banished from the assemblage of racial criteria.

Rather more important than the problem of the comparative validity of morphological observations, measurements and indices is the way in which these are utilized. Should the racial analysis be based upon the combinations of metrical and morphological features in each individual included in the group or, on the other hand, upon group means of the various racial characters? Over-emphasis upon combinations of measurements, indices or morphological features in the individual is almost certain to result in the distinguishing of manifold physical types, many of which have no racial significance but are simply manifestations of individual or sex variations. On the other hand, combinations of group means may not represent any individual physical type whatsoever, but merely averages of independently variable characters. It seems to me that the solution of this difficulty lies in a proper realization of the significance of race. Races are great groups and any analysis of racial elements must be primarily an analysis of groups, not of separate individuals. One must conceive of race not as the combination of features which gives to each person his individual appearance, but rather as a vague physical background, usually more or less obscured or overlaid by individual variations in single subjects, and realized best in a composite picture. Nevertheless, if a group is racially comparatively homogeneous, a certain number of individuals will approximate very closely to the appearance of the composite. And the individual who departs farthest from the racial composite is likely to be the one who has the largest admixture of another strain. So it is probable that taking a sufficiently large sample of a relatively unmixed group one will find that the modal type tends to show a combination of approximations to the group means of the various characters. I am therefore of the opinion that the best method of testing the physical homogeneity of a group is to calculate the means and variabilities of separate characters and then to ascertain whether or not the individual types of most frequent occurrence manifest these average values of the separate characters in combinations.

A Method of analyzing Race

A considerable experience in the study of skeletal material and especially of skulls has resulted in the working out of the following method of racial analysis which utilizes both morphological and metrical observations. On each skeleton the usual measurements are taken and the conventional indices are calculated. Morphological observations, carefully graded, relating to every significant non-measurable character, are recorded on appropriate blanks. After measurements and observations are concluded each skull is assigned to a racial type or to some distinctively designated type, according to the anatomical judgment of the observer. Thus a skull may be called "Negroid," "Nordic," "Alpine-Mediterranean," etc., or it may be called some name indicative of a local type, such as "Guanche," "Basket-Maker," etc.

The next step is the statistical reduction of the measurements and indices for the group as a whole, the two sexes, of course, being separated. This involves the calculation of means, standard deviations, coefficients of variation and their probable errors. Percentage distributions of the index subdivisions are also reckoned. The graded morphological observations are likewise analyzed for the whole group, the percentages of each grade of every character being tabulated for each sex separately. We now have determined the general anthropometric and morphological features of the group as a whole, although the qualitative and quantitative data are as yet unrelated.

There follows the comparison of our group as a whole with other entire groups for which comparative data are available, which are possibly related and of which the racial composition may be more or less accurately known. The comparison is effected by taking the differences of the means of the two groups in the case of every measurement and every index. If the difference between the means of the two groups with respect to a given measurement or index is less than three times the probable error of such a difference, the two groups can not be said to differ significantly with respect to the mean of that measurement or index. Coincidences in the means of two or three measurements or indices are not necessarily indicative of relationship, but if a large number of measurements and indices in the two groups show insignificant differences the odds in favor of the two populations being of similar racial composition are greatly increased. When a substantial majority of means of measurements and indices in two series coincide or differ from each other only slightly, we are justified in concluding that similar racial elements have entered into the composition of the two groups, and if we know what the racial elements are in one of the groups we may infer that these are present in the other also. By comparing a number of groups with the one under investigation, one soon finds out the closest affinity of the latter.

The next process is the division of skeletal series into types, with the object of ascertaining the racial affinities of these types. Such classifications according to type may be attempted by several different methods. One is by individual combinations of index

subdivisions, as, for example, dolichocephalic- hyspicephalic- akrocephalic- leptoproscopic, etc. The principal difficulty involved in such a method of index combinations is that the number of individual types is practically limited only by the number of indices utilized in the combinations. For example, if one utilizes four indices, each of which has three subdivisions, the number of combinations possible is eighty-one. In a series of 245 Tenerife male crania thirty-four of eighty-one such possible combinations occurred in individual crania. If n be the number of indices utilized, each of which has three subdivisions, the number of combinations possible is 3^n. If any considerable number of indices is utilized the individual type combinations soon exceed the number of individual crania in the series. Exactly the same difficulty is encountered if one attempts individual combinations of graded morphological features. Utilizing twenty-two morphological features, each having five gradations, I found that no two individual skull curves in a series of 247 Tenerife male crania were alike. It is apparent that such methods do not delimit racial types. Rather they test the number of individual variations of the series, and in racially heterogeneous groups these seem to be limited only by the mathematical combinations of gradations and the number of criteria employed.

I have found what I believe to be a solution of this difficulty. In the routine measurement and morphological examination of individual crania, each one is assigned to a designated morphological type according to the anatomical judgment of the observer. I think that this method of distinguishing racial types on the basis of morphological judgment is the most natural and practical procedure. It would be very difficult for the most skilled anthropologist to decide that a man is a Polynesian from an array of his measurements and indices, whereas the same anthropologist would unfailingly classify the subject as Polynesian after a few moments of careful observation.

When the group has been divided into morphological types by this method the next step is to test the metric and morphological validity of these types. The means of measurements and indices of each type must be compared with the corresponding means of the entire group. The significance of differences in means between the subgroups and the whole series must be appraised in relation to their probable errors. If the morphological types distinguished show significant differences in means of a majority of measurements and indices from the averages of the entire group, it may be inferred that the subgroups represent metrical types. Ordinarily in such cases the standard deviations and the coefficients of variations of the subgroups will be less than those of the entire series. The relationship of these observed types to graded morphological features, individually observed, may be established by making contingency tables and calculating coefficients of mean square contingency. If the observed types are morphologically valid certain significant associations between gradations of morphological features and type classification will be manifest. By the same contingency method it is often possible to establish relationships between the morphological types and combinations of index subdivisions in individual crania. In short, the division upon the basis of morphological type seems to establish subgroups which are metrically, indicially and morphologically relatively homogeneous.

When the subgroups of both sexes have been established according to types and tested for metric and morphological validity, the distinguishing features of the types are very apparent. The series will now consist of several type subgroups, some of which appear to resemble known racial types and others of which may seem to be the result of local combinations. It is now necessary to take the type groups singly and compare them with the most authentic and least mixed series of crania available belonging to the races which the respective types are supposed to resemble. For example, if we have distinguished a "Nordic" type, this type should be compared with series of crania from the German Grave-rows. If on the basis of a comparison of means and probable errors it is found that our "type Nordics" show insignificant differences from the means of the authentic Nordics in the substantial majority of characters investigated, or if the "type Nordics" differ less from any of the authentic series of Nordics than these authentic series differ from each other, it may be concluded that the designation of the subgroup type under investigation as "Nordic" is correct. When the affinities of the supposed racial subtypes have been ascertained in this way, the final step in analysis is to examine the mixed types which are presumably due to the crossings of the pure types, and to try to find out what morphological and metrical features have been inherited from the several racial elements.

Whether or not such a method of analysis enables one to isolate pure racial type naturally depends upon the presence or absence of pure types in the population examined and the availability of pure racial groups for comparative purposes. After securing types which seem to predominate of one racial strain it is theoretically possible to select from them the individuals who bear the closest resemblance to the composite racial picture. Or one may attempt to distil the quintessence of the racial type by selecting individuals on the basis of combinations of the non-adaptive features in the gradations of development most typical for the race.

The method described above has been developed in

the study of skeletal material, and, in particular, of crania.[2] I see no reason why it can not be applied equally well to the analysis of data gathered upon living subjects. It is a laborious method involving a large amount of calculation, but necessitating no extensive knowledge of higher mathematics. I have little faith in short-cut methods and no use whatever for personal impressions unsubstantiated by metrical and morphological data properly reduced. If physical anthropologists wish to achieve scientifically valid results they must not content themselves with the presentation of tables of raw measurements, supplemented by their personal reactions by way of interpretation.

If races differ quantitatively in intelligence and qualitatively in psychological characteristics, such differences can be established only by the segregation of pure racial types and the subsequent investigation of their psychological attributes.

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POPULAR ASTRONOMIC EDUCATION IN EUROPE[1]

IT was my privilege to visit astronomical observatories from the University of Upsala in northern Europe to the Vatican in the south, thus establishing contacts with the directors and other astronomers, and conferring with them about our project at the American Museum. All the astronomers that I visited showed a real interest in our proposed astronomical hall, and some contributed practical suggestions of value.

OBSERVATIONS

The director of the Vatican Observatory, Father J. G. Hagen, who by the way is a naturalized American citizen, strongly recommended the installation of a small telescope which could be used by visitors for viewing objects in the sky. This would not be for professional astronomical work, however, as our institution should not be an observatory, but rather a museum of astronomy. The objective lens of this telescope need not be larger than five or six inches in diameter. This advice of Director Hagen is strengthened by the popularity of the so-called *Uranias* of Europe. I am convinced that this is an excellent proposal and hope that place can be found for a small dome in which may be installed such a telescope.

Professor Elis Strömgren, director of the Astronomical Observatory at Copenhagen, had visited the Zeiss Projection Planetarium in Munich and was tremendously impressed with it, and several astronomers advised me to visit the *Urania* in Berlin, as well as the one in Vienna and the one in Zürich. These *Uranias* are popular observatories in which the people may, for a small fee, observe on any clear night celestial objects through a fair-sized telescope. These observations are aided and directed by a trained person who explains what is seen. When the sky is clear enough for observation, a red light is shown on the *Urania* building. Usually two lectures with observations are given, one rather early in the evening (eight to nine o'clock) and one rather late (ten-thirty to eleven-thirty o'clock). There was a large sign at the door of the Vienna *Urania,* stating that if the sky was clear on that night the following objects could be satisfactorily seen: Jupiter, Uranus, the star-clusters in Perseus and the great nebula in Andromeda. The *Uranias* are also open during certain hours of the day for the observation of sunspots with the astronomical telescope and for the viewing of mountains and other distant objects with a terrestrial telescope. How well established these *Uranias* are in Europe is indicated by this significant fact that both in Vienna and in Zürich the street passing the *Urania* is called *Uraniastrasse.*

The Astrophysical Observatory at Potsdam is one of the best constructed, one of the most complete and one of the most modern of those visited in Europe. Here, among other things, I examined their new Einstein Tower, which they believe to be an improvement on the one at our Mt. Wilson Observatory. With this equipment they will test the Einstein theory by measuring the displacement of the Fraunhofer lines, the spectrograph connected with this tower being very much more efficient than that connected with any refracting or reflecting telescope. The spectrum is spread out in a large room, which no one enters, and which is kept at a temperature constant to one one hundredth of a degree.

In Florence the Astronomical Observatory and Galileo's tower, which is restored, were visited. In the Museum of Physics I was greatly interested to see the two original telescopes of Galileo, with which he first saw the moons of Jupiter, the fiery ring of Saturn, the spots on the sun, the mountains on the moon, and Venus as a waxing and waning crescent.

[2] This method has been employed in the author's recent publication "The Ancient Inhabitants of the Canary Islands," Harvard African Studies, Vol. VII, Peabody Museum, Cambridge, Mass., 1925.

[1] In preparation of the plans for the Hall of Astronomy, for the use of students of all grades, which is now under consideration by the trustees of the American Museum of Natural History, Dr. G. Clyde Fisher was sent abroad during the summer of 1925. There is here printed an abstract of his report.