Franz Boas and Native American Biological Variability

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Abstract The contributions to physical anthropology with which Franz Boas is usually credited are in the areas of growth, plasticity of head and body form, and biometric genetics. Such a listing of Boas's contributions overlooks the tremendous amount of research he did with biological variability of Native American populations. The rediscovery of his anthropometric data documents the tremendous investment in time, money, and effort Boas devoted to the topic and provides the opportunity to rediscover his insights into a subject that is of continuing interest. The design of his massive anthropometric survey of native North Americans reveals a concern for population analyses and a rejection of the typological framework of the time. If Boas's ideas had been adopted at the turn of the century, the development of physical anthropology in America might have been much different.

The contributions to physical anthropology with which Franz Boas is credited are mainly in the areas of growth, influence of the environment on body form, and biometric genetics (Howells 1992). The part of Boas's career dealing with biological variation among native North Americans is less well known and understood and is frequently omitted from his list of contributions to physical anthropology. This aspect of Boas's career has remained obscure because the data resulting from his activity had been relatively unknown and unavailable until recently. From 1888 to 1903 Boas was responsible for assembling anthropometric data on 15,000 Native Americans and 2000 Siberians. Boas's data collection efforts were supported by several large projects that permitted uninterrupted data collection over this 15-year period. Boas's data collection was supported by the Committee for the British Association for the Advancement of Science, the Bureau of American Ethnology, the World's Columbian Exposition, the Jesup North Pacific Expedition, and the Huntington California Expedition. The magnitude of this undertaking is difficult to imagine from the vantage point of the present, much less the difficult conditions under which fieldwork had to be conducted in the late nineteenth century.

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The obscurity of Boas's activities was ensured by his apparent reluctance to describe the projects in detail and by his inability to conduct meaningful analyses with the pencil-and-paper data-processing capabilities of the time. The only general paper, which appeared in German in a relatively obscure journal, dealt with height and cranial index variability (Boas 1895). The 1895 paper is a remarkable paper. It is as close as Boas ever came to using the vast quantity of data obtained for the World's Columbian Exposition. It presents summary statistics, means, standard deviations, and frequency distributions of height and cephalic index for about 60 tribes. The tally sheets on which Boas tabulated frequencies survive in the collection of his papers and illustrate the immense number of calculations required.

Other papers resulting from the World's Columbian Exposition data include Boas's (1899) description of Shoshonean tribes and Sullivan's (1920) analysis of Siouan tribes. Sullivan's paper also represents a staggering number of calculations.

Boas's work for the Committee of the British Association for the Advancement of Science resulted in several reports that included the original data. These data were used by Hall and McNair (1972; see references cited therein) in an investigation of British Columbian populations. This is apparently the first use of Boas's data since Sullivan's (1920) research.

The Jesup North Pacific Expedition (JNPE) is arguably the most important project with which Boas was involved. It extended the anthropometric data well into Siberia and resulted in a database reaching halfway around the world, from Nova Scotia at 60°W longitude to Yakutsk at 130°E longitude. Boas's reluctance to produce the summary volumes desired by Jesup have been previously noted (Freed and Freed 1983), and the Jesup anthropometric data were never reported. Jochelson-Brodsky's (1906) paper dealing with anthropometric variation among female Siberians is apparently the only publication to result from the Siberian data until Ousley (1993, 1995) and Comuzzie et al. (1995) used them.

In the decade since Boas's data were rediscovered (Jantz et al. 1992), my colleagues and I have managed to identify several principles that were important to Boas as he designed this research. The various projects had different goals, which Boas describes in various places. The data collected for the World's Columbian Exposition were used to construct exhibits at the fair. These consisted of maps and charts showing the distribution of height and cranial index. These exhibits were sold to the University of Chicago at the fair's end (D. Cole, personal communication, 1987). In a partial manuscript, unpublished and undated as far as I can ascertain, Boas lays out several points to be addressed by the exhibits:

1. What are the principal characteristics of Native Americans?

2. Can a number of types be distinguished among them?
3. Does the distribution of types give a clue to the ancient migration in North America?
4. Does intermixture result in any negative effects?
5. How does the mixed population differ from the unmixed?

The Committee of the British Association for the Advancement of Science and the JNPE were projects designed to investigate the little known tribes of the American Northwest, and the Jesup project had the further goal of investigating linguistic, cultural, and biological relationships between North America and Siberia (Boas 1897).

The size of the database assembled by Boas raises a question, the answer to which may provide considerable insight into Boas's general philosophy. Why, given the data-processing capabilities of the time (i.e., pencil and paper), did Boas invest his resources in collecting data he really had no hope of analyzing adequately? This question can be addressed in several ways. One has to do with Boas's rejection of the typological approaches of the time. Although he uses the term *type*, it is clear that for Boas variability was paramount. Boas (1895, p. 367) writes:

> Der Gesichtspunkt, welcher mich bei der Sammlung des Materials leitete, war wesentlich auf die Thatsache begründet, dass die durch Messungen zum Ausdruck gelangenden Unterschiede zwischen Menschen-Varietäten so gering sind, dass nur bei grossem Beobachtungsmaterial sichere Schlüsse gezogen werden können. [The point of view which has guided my collection of this material was based essentially on the fact that differences between human varieties expressed through measurements are so small that reliable conclusions can only be drawn with large numbers of observations.]

In contrast to Hrdlicka, who despised statistics (Howells 1992), Boas understood them and their necessity in understanding small differences in variable populations. Despite the computational burden, Boas recognized that the statistical approach was essential.

Another factor that must have motivated Boas was the rapid pace of change and assimilation that Amerindian populations were undergoing by the late nineteenth century. Boas realized that the data he collected would soon not be possible to obtain. Today it is even more obvious how farsighted Boas was in his efforts to preserve information. Whether it was Boas's intention to collect data to be used by future generations is not clear. If so, he took few steps to ensure their availability. If not, then he overestimated his ability to deal with the large quantities of data resulting from these projects.

The design of large-scale anthropometric projects such as these required a number of methodological considerations, such as measurement selection, sample selection and documentation, interobserver variation,

and training of observers. It is essential to understand Boas's philosophy on these matters and the choices he made if his data are to be properly understood.

Measurement Selection

Boas's standard data sheet contains 12 measurements: (1) height standing, (2) height of shoulder, (3) height of point of second finger (this actually refers to digit 3), (4) finger reach (span), (5) height sitting, (6) width of shoulders, (7) length of head, (8) breadth of head, (9) height of face, (10) breadth of face, (11) height of nose, and (12) breadth of nose. An example of this standard data sheet is given by Jantz et al. (1992). This data sheet was used in the World's Columbian Exposition project, the most ambitious of Boas's anthropometric surveys, but its basic design was established earlier (Boas 1892).

The measurements are evenly divided between head and face dimensions and body dimensions. The measurements are described by Boas (1892) and by Sullivan (1920). Boas intended shoulder height and finger height to be used to calculate arm length (Boas 1892; Sullivan 1920). The body measurements are biased toward longitudinal dimensions; shoulder width is the only transverse dimension included. Consequently, there is considerable redundancy among the measurements.

The head and face dimensions would today be considered standard dimensions. We have been unsuccessful in locating a reference to a measurement authority on which Boas relied in setting up his measurements. Because Boas's early training in physical anthropology took place under Rudolph Virchow, the measurement definitions are presumably those of the developing German school. Boas was present in Berlin in 1885 when nine visiting Bella Coolas were measured by Virchow (Cole 1985), an event that must have impressed upon him the importance of anthropometry.

An earlier version of Boas's data sheet also included a variant of face height, hairline to chin, and some observers occasionally included ear height and hand length on their data sheets. The data sheet for the Siberian part of the JNPE was considerably expanded, and the one used in the Huntington, California, project also included more measurements than Boas's standard sheet. Although the variables collected by the different projects vary somewhat, the basic 12 dimensions included in Boas's World's Columbian Exposition format are always a common set.

The decision to use a small rather than larger number of dimensions was dictated by the desire to maximize the number of subjects. Measurements were selected to avoid removal of clothing, since that would reduce participation and require more time per subject (Boas 1895). Minimizing interobserver variation was also a consideration (Boas, partial

unpublished, undated manuscript). One suspects that Boas also had the computational burden in mind in deciding on a small number of measurements.

Boas also included a large number of anthroposcopic variables on the data sheets. These variables are either descriptions of the form or color of hair, eyes, nose, face, or ears or numbers that the observer would compare to a set of standards. Boas considered the degree of interobserver variation so great that results of different observers were not comparable. Moreover, we have not been successful in locating the keys that would allow decoding of the numerical scores.

Training of Observers and Interobserver Variation

Most of the information concerning the training of observers and interobserver variation comes from the partial unpublished and undated manuscript included among Boas's data. Boas clearly recognized that interobserver variation was a problem and took steps to minimize it. These steps included providing each observer with a standard set of instruments, providing each observer with a set of printed instructions, training the observers before sending them out, and sending more than one observer to the same tribes.

The instruments with each observer was provided consisted of (1) a measuring rod 2 m long with a level to ensure vertical placement, (2) a pair of jointed steel calipers of Virchow's design, (3) a pair of small vernier calipers for face measurements, and (4) a millimeter scale 40 cm long (Boas, partial unpublished, undated manuscript). No examples or even pictures of these instruments have been found in Boas's material. Likewise, we have not come across any copies of the instructions with which observers were provided.

Boas indicated that he personally trained observers from the East Coast; observers from the West Coast practiced with their instructors. Boas also described his attempt to control interobserver variation by having two observers measure each tribe, independent of one another. Boas was emphatic on this point:

> In order to check the observers so far as possible, the whole country was subdivided in such a manner that two observers took measurements of one tribe, independent of each other. In most cases the results thus obtained proved the accuracy of both observers, while in others discrepancies were found. There were few cases only in which any doubt existed as to whose measurements were more correct, because I had so arranged as to be able to compare the measurements of each observer with those of two others. In a number of these cases I was able to send a new observer into the field in order to verify the observations. (Boas, partial unpublished, undated manuscript)

Boas also conducted an interobserver analysis using data from several children measured one year apart by two different observers (Boas 1899). This was not an ideal test, because growth and observer variation may be confounded. The test showed that face height and nose height were subject to greater interobserver variation because of the difficulty in locating the nasion.

Our experience with Boas's data indicates that he exaggerated the degree of quality control he was able to exert over the data. In several instances a tribe was measured by only one observer. The Cree, for example were measured by Isaac Cowie, and some of his variables are almost certainly in error. There is also evidence that Boas recruited observers on an ad hoc basis. For example, T. Proctor Hall of Clark University, an observer presumably trained by Boas, wrote the following to Boas: "I also carefully instructed Rev. Mr. Wilson in the art and tested his accuracy. I find him *careful* and *accurate*" (original emphasis) (*The Professional Correspondence of Franz Boas*, 1972, letter dated July 9, 1891). Despite examples such as these, Boas was able to produce a data set considerably more comparable than would ever be possible by assembling information from observers whose activities were not coordinated.

Sample Selection and Documentation

As is evident from the discussion so far, Boas was intent on sampling large geographic areas. He managed to send observers to nearly all the areas in North America where Native Americans were to be found. His strategy for gaining access to the Indian communities was summarized as follows (Boas, partial unpublished, undated manuscript):

> Besides the general printed instructions each observer was given detailed instructions defining the territory which he was to visit. The Commissioners of Indian Affairs of the United States and of Canada gave their support to the investigations by furnishing our observers with introductions to Indian Agents. The efforts of the latter were of material help in carrying out the measurements.

Such a sampling strategy led to many samples, such as those described by Moore and Campbell (1995), which consisted of the more acculturated male employees of the agencies. The sampling strategies were actually quite varied and included, in addition to the agencies, Indian schools and direct sampling of communities, as in the Cherokee of North Carolina (Starr 1892). Boas's samples of Native Americans cannot be regarded as random samples from the communities, but that is the case with most anthropological samples.

An especially important feature of Boas's research design is the information about each subject he included on the data sheets. Each sheet

contains the following fields that provide information about the subject: place and date of observation, name and age of subject, place of birth, tribe of mother and father, and mode of life. Separate data sheets were constructed for the two sexes. Data sheets for females included, in addition to the information just listed, the number of children alive and the number of children dead. Both data sheets also contained the identification numbers of other individuals in the sample to whom the subject was related as parent or sibling.

Boas used the fertility information to combat notions of inferiority thought to be associated with mixed ancestry (Boas 1894). Boas never used some of the information, such as the genealogies, which Konigsberg and Ousley (1995) used for the first time. The "place of birth" and "tribe of mother and father" entries on the data sheets hold much potential for intertribal gene flow and population structure, particularly in the Northwest, where Boas personally collected detailed data.

Conclusion

Boas's opposition to the then-current theories and methods is a matter of record and may in part account for what Washburn (1984) referred to as a tradition in physical anthropology of minimizing Boas's contributions. Unlike the situation in ethnology and linguistics, Boas's ideas in physical anthropology were not carried forth by large numbers of students. He apparently had only two students at Columbia, Marcus Goldstein and Isabel Gordon Carter. Carter apparently ceased professional activity after her dissertation (Carter 1928). But it is also true that the amount of time, effort, and money Boas invested in physical anthropology is generally unappreciated. Our database documents that Boas personally measured 2088 Native Americans between 1890 and 1897. If we estimate that it required an average of 20 minutes to measure a subject, then measuring alone consumed about 4 months of 40-hour work weeks over this 7-year period. Add to this the time invested in statistical analysis, which Boas performed himself, and in writing the numerous papers that appeared during this time, and it becomes apparent that Boas was probably devoting a larger share of his resources to physical anthropology than to ethnology or linguistics.

Particular individuals contribute to the development of a discipline only insofar as their ideas are embraced. Boas's approaches were rejected in favor of the typology of Hrdlicka and Hooton, both larger historical figures in physical anthropology than Boas. Yet Boas anticipated many of the themes that are currently important but that came to physical anthropology much later and by means of different routes. Before Hrdlicka began classifying Amerindians into types, Boas was concerned with geo-

graphic patterning. His maps showing the distribution of stature and cranial index probably are the first spatial analyses and anticipate the current focus on this problem.

Typological approaches emphasize within-group homogeneity, but Boas was explicitly concerned with variation. He observed that "whenever a tribe is located between two tribes of different types its variability is increased" (Boas, n.d.). Boas perceived the role of gene flow in variability, an anticipation of later concern with this topic culminating in formal models for its analysis (Relethford and Blangero 1990).

Boas's interest in biocultural interaction anticipates much of the current interest in that topic. Boas expressed his perception of the complexity of anthropometric relationships as follows: "The anthropometric method is a most important means of elucidating the early history of mankind and the effect of the social and geographic environment upon man" (Boas 1912, p. 562). To those who take the view that language marks biological history, or in the case of Amerindians, separate migrations, Boas's admonition should provide a reminder of the complexity of this issue:

> Tribes speaking different languages and having different customs may have the same type and on the other hand, tribes, the same in language and the same in customs may be composed of different types. . . . It is clear therefore that classification based on type, language and customs, cannot possibly be expected to coincide. (Boas, n.d., pp. 2–3)

The rediscovery of Boas's data comes at a propitious time. We now have the data storage and processing capability that Boas lacked and a renewed interest in quantitative genetics. The papers in this special issue of *Human Biology* illustrate some of what can be accomplished with Boas's data, but there is much more that might be done. That many of the studies reported here develop themes that Boas anticipated points more clearly than ever to his large but neglected significance as a founder of modern human biology.

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