Commentary

Head to head with Boas: Did he err on the plasticity of head form?

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Ever since Anders Retzius' invention of the cephalic index late in the nineteenth century, legions of anthropologists armed with spreading calipers have bravely endured the apprehension of their subjects and have accumulated thousands of measurements of head lengths and breadths and divided the latter by the former to achieve that purportedly objective characterization, the cranial index, mellifluously categorized as "dolichocephalic, mesocephalic, or brachycephalic." From this index, one could (if properly trained) hazard a guess about whether someone was from the Northwestern, the Mediterranean, or the Alpine region of Europe. There was even hope that all groups throughout the world could be characterized and classified similarly. The uses to which this index were put ranged from the beneficent to the grotesque, from simple curiosity to preventing people from being accepted as immigrants, and to the characterization of "ideal" racial types as ingredients in racial classifications. On the humorous side, Hooten (1) noted that only hat makers paid no attention to the differences in head shape. I confess that over my years of teaching human skeletal biology, I have enjoyed almost each and every head measurement that I've taken. I ordinarily managed to demonstrate that the index meant nothing in terms of defining whence came a person. I doubt that any of us practicing these arts have failed to mention the findings of Franz Boas' 1910–1913 publications (2) that the offspring of immigrants born in the United States showed a "significant" difference from their immigrant parents in this index. (I say significant because that was what we were taught.) This finding was perhaps one of the most instrumental in overturning notions of genetic fixity in bodily form and was the essential demonstration that the environment had an important role in the expression of such traits. If the cephalic index could change in a generation, so could anything else, and thus was added a continuing optimism that societies throughout the world could improve their people's lot simply by changing environments for the better. Boasian anthropology was firmly in place, including the biological side and that of head form, in particular.

Over the years, Boasian anthropology has taken some hard hits. The debacle of Margaret Mead's *Coming of Age in Samoa* is but one casualty. The recent fiasco over Patrick Tierney's *Darkness in El Dorado*, involving the vilification of Napoleon Chagnon and the late James Neel (the latter fully vindicated by the National Academy of Sciences this past year), hopefully will lead scientists, social and otherwise, to reflect more carefully on the various mantras and myths that have been collected, particularly by anthropologists of the Boasian persuasion. Science should, hopefully, march on.

Enter now a new study of the cephalic index based on Boas' original data, but employing a set of statistical procedures more sophisticated than were available in his day, including calculations of heritability, principal components, regression, etc. There would be few among us willing to bet the farm on one outcome or another, but the result of Sparks and Jantz's reanalysis in this issue of PNAS (3) is simply that Boas was wrong. The genetic component was, in fact, stronger, and the heritability of the index was high, although not as high as that reported by Osborne and De George (4), which was based on heritability calculated from monozygotic and dizygotic twin data, and thus, was expectably stronger. The importance for this writer is not that the changes in head shape were not as statistically significant between immigrants and offspring, or that head shape as characterized by the cephalic index has a greater genetic component. Rather, this finding leads me, and I hope others, to wonder what else one might discover that shows that anthropological holy writ isn't so holy after all. This comment is not to be taken as a call for the wholesale collection of or resuscitation of studies dealing with the cephalic index, but we still remain ignorant about whether it has any adaptive meaning and whether, in fact, normalizing selection might be at work on the trait, where both extremes, hyperdolichocephaly and hyperbrachycephaly, are at a slight selective disadvantage. In other words, despite Boas' study and the claims of his students, the topic of head form ought to be alive and well.

Although I believe that this contribution by Sparks and Jantz clearly suggests that Boas had this matter of human variability wrong, it is important that a fuller description be available of how these findings came about. Given how much faith and trust has been put into Boas' analyses, it is very important that studies on his data be as thorough and clearly presented as possible. In his paper with Helena Boas, Franz Boas (2) clearly states that his studies never claimed that there were no genetic components to head shape, rearticulated again in his study of the measurements from Holland (5). The myth that the cephalic index was totally plastic and shaped by the environment was not something that Boas himself believed, but to what degree he corrected his students and colleagues otherwise is uncertain. Klineberg's (6) little book on "race" makes a similar point, and it is particularly useful as it provides actual cephalic indices. For example, Sicilian males born in Sicily had an average index of 77.7, whereas those born in America had an index of 81.5. That surely suggests a really significant change, but where are the statistics to show whether it truly is? Hooten's *Up from the Ape* (1) has an excellent discussion of the cephalic index, recognizing both genetic and environmental aspects, as well as Harry Shapiro's (7) discussion of his anthropometric researches in Hawaii on Japanese and Chinese immigrants and their descendents.

Boas and his associate, Dr. Fishberg, measured some 13,000+ individuals. This study is a rich resource, and this brief paper leaves us wanting badly more detail. For example, the present study is based on 8,500 of those individuals: what happened to the other 4,500? How were the 8,500 chosen? Did Boas base any of his findings about the cephalic index on the complete

See companion article on page 14636.

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www.pnas.org/cgi/doi/10.1073/pnas.242622399

set? What tests did Boas use? How different are the results of Sparks and Jantz's study with regard to the actual values that Boas found for the index in the different groups (shown in figure 1 of ref. 3)? Were their calculations of standard deviations and errors the same as Boas'? Boas' many tables of changes of indices between foreign- and American-born show differences of roughly 1–2 points. Do we know what the measurement error might have been?

Boas knew that there was a correlation between stature and head length (not head breadth), so if the "Hebrew" sample, largely eastern European, showed an increase in the direction of dolichocephaly for the American-born offspring, might that not be associated with increased stature? Would controlling for stature affect the ANOVA results? The regression analysis reports R^2, and in the case of Scots, the correlation coefficient would be 0.345, and that for Polish women would be 0.484; both are quite strong and at least offer a clear-cut suggestion that exposure might be important in some groups but not in others. Ref. 8 has an extended discussion and a much fuller statistical analysis than could possibly be presented in PNAS, and the interested reader is urged to consult this very fine piece of work.

These questions are not meant to detract from Sparks and Jantz's studies, but rather to suggest that the topic might not be dead yet. There is more to know about genetic and environmental influences that might vary in different populations, not to mention the whole old issue of brachycephalization as an evolutionary trend starting in the Mesolithic age. More importantly, perhaps, it is possible that without answers to these questions, Boas might not have gotten it so wrong after all, or so others might be inclined to argue. Legions of us are dying to know the answers.

1. Hooten, E. A. (1946) *Up from the Ape* (Macmillan, New York).
2. Boas, F. & Boas, H. M. (1913) *Am. Anthropol.* **15,** 163–188.
3. Sparks, C. S. & Jantz, R. L. (2002) *Proc. Natl. Acad. Sci. USA* **99,** 14636–14639.
4. Osborne, R. H. & De George, F. V. (1959) *Genetic Basis of Morphological Variation* (Harvard Univ. Press, Cambridge, MA).
5. Boas, F. (1933) *Hum. Biol.* **5,** 587–599.
6. Klineberg, O. (1935) *Race Differences* (Harper-Collins, New York).
7. Shapiro, H. L. (1937) *Scientific Monthly* **45,** 109–118.
8. Sparks, C. S. (2001) in *Department of Anthropology* (University of Tennessee, Knoxville).