Letters to the Editor

Discussion of "Independent Instances of 'Souvenir' Asian Skulls from the Tampa Bay Area"

Dear Sir:

In the May 1990 issue of this journal, Dr. Curtis W. Wienker and his colleagues discuss "souvenir" Asian skulls from Florida [*1*]. Aside from a general description of seven skulls and the circumstances of their discovery, the article consists of a critique of the use of discriminant function techniques to determine sex and race in crania. The critique is based on an application of discriminant functions originating from American black, white, Hispanic, and American Indian crania published by Giles and Elliot [*2,3*] and Jantz and Moore-Jansen [*4*] to these seven skulls of putative "East Asian or East Asian-derived ancestry" from India. Wienker and his co-workers conclude that their results "reemphasize" the point that "forensic anthropologists need to be extremely cautious in applying discriminant function analyses to their professional cases."

No one would deny the importance of evaluation and refinement of discriminant function and other metric techniques for the determination of sex and race in crania. I [*5*] and others have participated in this, and the research of Jantz and Moore-Jansen [*4*], Gill et al. [*6*], and others updates and, particularly in dealing with American Indians, improves on the work of Giles and Elliot [*2,3*] in the early 1960s. Scientifically questionable "evaluations," however, such as that of Wienker et al. [*1*], are counterproductive, whether or not one wishes to utilize discriminant functions in forensic anthropology. Their visually assessed sex for the seven crania, ascertained with no postcranial or documentary supporting evidence, differs in four crania from that determined by discriminant functions based on two separate studies [*3,4*], which give identical results for all seven crania. Such results should induce caution in those championing visual assessment, not the other way around, particularly since expert visual assessors, such as T. D. Stewart [*7*] and W. M. Krogman [*8*], who have tested themselves on known-sex skulls, emerge with no greater accuracy than that provided by the discriminant function technique.

Whether the seven skulls originated in East Asia or South Asia (India), they appear almost certainly not to be derived from the groups involved in the discriminant function studies of either Giles and Elliot [*2*] or Jantz and Moore- Jansen [*4*] for determining race. It may be useful to be reminded that discriminant functions are based in specific populations, but to suggest that the accuracy of such techniques applied to those specific populations is somehow testable by applying them to specimens such as these seven skulls, demonstrably not from their statistical universe, is more contradictory than helpful.

A decision by Wienker and his colleagues not to use quantitative techniques in examining their small and unusual sample of skulls is certainly defensible; using that sample as a stick with which to beat the discriminant function technique is not.

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References

[*1*] Wienker, C. W., Wood, J. E., and Diggs, C. A., "Independent Instances of 'Souvenir' Asian Skulls from the Tampa Bay Area," *Journal of Forensic Sciences,* Vol. 35, No. 3, May 1990, pp. 637–643.

[2] Giles, E. and Elliot O., "Race Identification from Cranial Measurements," *Journal of Forensic Sciences,* Vol. 7, No. 2, April 1962, pp. 147–157.
[3] Giles, E. and Elliot, O., "Sex Determination by Discriminant Function Analysis of Crania," *American Journal of Physical Anthropology,* Vol. 21, No. 1, March 1963, pp. 53–68.
[4] Jantz, R. L. and Moore-Jansen, P. H., "A Data Base for Forensic Anthropology: Structure, Content and Analysis," Report of Investigations No. 47, Department of Anthropology, University of Tennessee, Knoxville, TN, 1988.
[5] 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. 448–460.
[6] Gill, G. W., Hughes, S. S., Bennett, S. M., and Gilbert, B. M., "Racial Identification from the Midfacial Skeleton with Special Reference to American Indians and Whites," *Journal of Forensic Sciences,* Vol. 33, No. 1, Jan. 1988, pp. 92–99.
[7] Stewart, T. D., "Medico-legal Aspects of the Skeleton: I. Age, Sex, Race, and Stature," *American Journal of Physical Anthropology,* Vol. 6, No. 3, Sept. 1948, pp. 315–321.
[8] Krogman, W. M., "The Human Skeleton in Legal Medicine: Medical Aspects," *Symposium on Medicolegal Problems,* Series 2, S. A. Levinson, Ed., Lippincott, Philadelphia, PA, 1949.

Authors' Response

Sir:

Professor Giles' letter contains some very thoughtful points and important reminders for forensic anthropologists. However, our submission of the skulls to discriminant function analysis was never intended to be an "evaluation" (his term) of that technique. Indeed, one of us (CWW) has used the technique (including the well-known and highly valuable formulae which he and Elliot [*1,2*] developed) frequently and with documented success in forensic anthropology cases.

Nor did we intend the results of our discriminant function analysis exercise to support or "champion" visual assessment techniques of assessing human osteological remains. Indeed, Prof. Giles' comment regarding caution with respect to visual assessment, given the results of our exercise, is very well taken. As Krogman and İşcan [*3*] note, all osteological evidence pertinent to race and sex (and other parameters) should be assessed and interpreted before conclusions are formulated.

In our report, we acknowledged the virtual certainty that the seven skulls were not derived from those populations on which the discriminant function formalae are based. However, without *knowing* the specific population affinity and gender of each skull in a test sample, an evaluation of the accuracy of a discriminant function formula is not possible. Our discriminant function exercise was never intended as an "evaluation" of "accuracy," as Prof. Giles has apparently concluded, nor did we indicate it to be, in our report. If somehow our remarks were misleading in that regard, we apologize to him and others who may share his feelings.

Rather, as we indicated, we wished "to determine the *consistency* [emphasis added] with which the formulae classified the skulls," in light of the population from which they appeared to have been derived. In fact, the relevant formulae were consistent with respect to sex. However, the same was not true of the formulae for race. There, some inconsistencies are evident; only the Giles/Elliot [*2*] and 3-way Jantz/Moore-Jansen [*4*] formulae are entirely consistent. It should also be noted that consistency cannot be considered accuracy.

We have carefully reviewed our report in light of Prof. Giles' letter. We believe that it is straightforward and scientific, and that our conclusions are objective and prudent. "Using the sample as a stick with which to beat the discriminant function technique" is something we never intended to do, nor do we perceive that we have done so. We regret that Prof. Giles has reached such a conclusion; we find no evidence for it either in our report or in the comments resulting from the original manuscript's peer-review process.

As scientists we undertook an investigation of discriminant function consistency with a sample that was admittedly inappropriate. We believe that the not-unsurprising inconsistent results support our call for caution, especially in cases involving isolate bones, skulls in this instance. Perhaps we should have underscored that, in particular. In our experience, isolated skulls are not rare in our professional case loads involving human skeletal material, and their frequency may be increasing.

In closing, we would like to correct our very stupid geographical erratum; the Tampa Bay region is in west-central, not east-central, Florida.

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References

[1] Giles, E. and Elliot, O., "Race Identification from Cranial Measurements," *Journal of Forensic Sciences,* Vol. 7, No. 2, April 1962, pp. 147–157.
[2] Giles, E. and Elliot, O., "Sex Determination by Discriminant Function Analysis of Crania," *American Journal of Physical Anthropology,* Vol. 21, No. 1, March 1963, pp. 53–68.
[3] Krogman, W. M. and Işcan, M. Y., *The Human Skeleton in Forensic Medicine,* 2nd ed., Charles C Thomas, Springfield, IL, 1986.
[4] Jantz, R. L. and Moore-Jansen, P. H., "A Data Base for Forensic Anthropology: Structure, Content and Analysis," Report of Investigations No. 47, Department of Anthropology, University of Tennessee, Knoxville, TN, 1988.

Predicting the Second Breath Alcohol Measurement from the First: An Application of Regression Analysis

Sir:

The National Safety Council's Committee on Alcohol and Other Drugs has made the formal recommendation that jurisdictions collect and analyze two separate breath alcohol samples for forensic purposes and that they require repeatability within ±0.02 g/210 L [*1*]. This recommendation has strong scientific support since replicate analyses are often necessary to evaluate precision and measurement variability. The procedure of performing duplicate breath alcohol concentration (BrAC) measurements is also much preferred over duplicate standard (simulator) measurements, since the total random uncertainty, composed of both analytical and biological factors, can be evaluated [*2,3*]. With duplicate simulator measurements and only one breath sample, one is limited to evaluating analytical variability only. As a result, many jurisdictions perform duplicate breath alcohol measurements and require appropriate limits on variability.

Regression analysis has an application in evaluating duplicate breath alcohol measurements. Regression analysis is basically a statistical process by which the dependence of one variable (the dependent variable y) upon another variable (the independent variable x) is determined [*4*]. Association and causation are other aspects that regression analysis can provide insight into [*5*]. Regression is a powerful tool for modeling and

predictive purposes and has many applications with biological data [*6,7*]. Like most biological data, breath alcohol measurements have a great deal of variability. However, by evaluating a sizable body of data one can establish limits on the variability and a confidence interval around a regression line and use these limits for predictive purposes.

Regressing the second breath alcohol measurement (BrAC2) upon the first (BrAC1) allows construction of a confidence interval about the best-fit linear regression line. The resulting linear equation can then be used to predict a second breath alcohol measurement from the first, along with the associated uncertainty or confidence limits. Plotting variable pairs such as BrAC1 and BrAC2 generates a bivariate normal distribution in which there is error in both variables. There has been some discussion concerning the appropriateness of applying regression analysis in this situation, yet it still provides useful insight into the relationship between the variables [*8*].

Figure 1 shows the results of regressing BrAC2 upon BrAC1 for field-collected evidentiary BrAC measurements in the state of Washington during April 1990. The data were collected utilizing the BAC Verifier Datamaster (National Patent Analytical Systems, Inc., Eastern Electronics, East Hartford, Connecticut) infrared breath alcohol instrument. The data were obtained from approximately 150 instruments. One data pair having a difference of 0.13 g/210 L was removed from the data prior to analysis. This pair exceeded 4 standard errors of the estimate (SEE) from the regression line and was

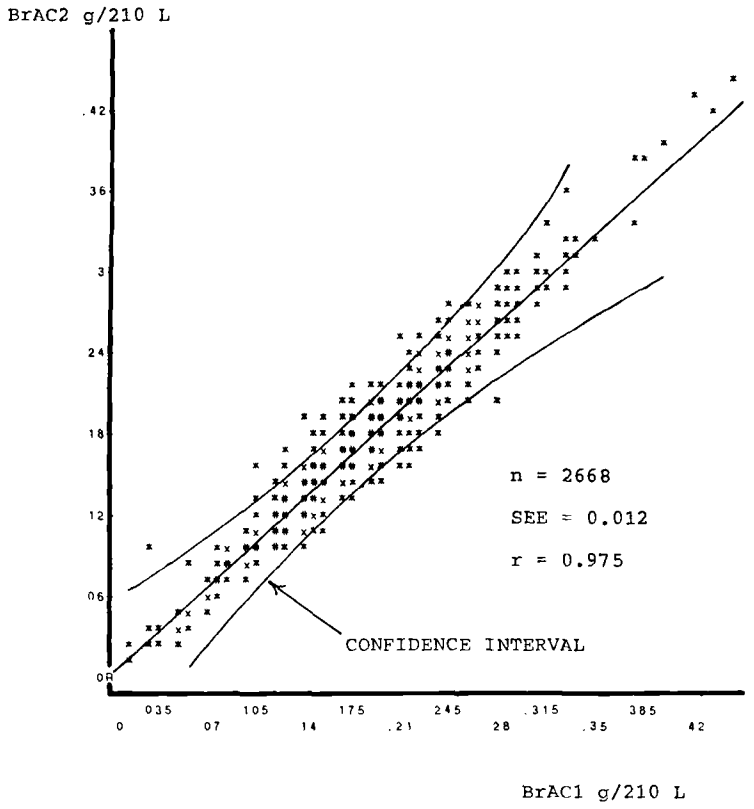

FIG. 1—*Regression of the second breath alcohol measurement (BrAC2) upon the first (BrAC1).*

considered to be an outlier [9]. The important regression parameters computed with a statistical program (SPSS/PC+, SPSS Inc., Chicago) are the following:

Regression equation	BrAC2 = 0.966 BrAC1 + 0.004
Standard error of the estimate (SEE)	SEE = 0.012
Coefficient of linear correlation (r)	r = 0.975
Coefficient of determination (r^2)	r^2 = 0.951

Figure 1 also shows the 95% confidence interval around the regression line. The confidence interval is hyperbolic in nature since the greater confidence exists at the mean value of both variables. The confidence interval about a computed BrAC2 value is given by:

$$\text{BrAC2} \pm t \cdot \text{SEE} \sqrt{1 + \frac{1}{n} + \frac{(\text{BRAC1} - \overline{\text{BRAC1}})^2}{(n-1)S_x^2}} \quad (1)$$

where BrAC2 is computed from the linear function and S_x is the standard deviation of the BrAC1 data. The statistic t comes from the t tables for the selected confidence level. With n so large (n = 2668), the value under the radical in Eq 1 becomes essentially 1, leaving SEE as the only relevant value. The following illustrates an application of estimating BrAC2 from BrAC1:

BrAC1 = 0.15 g/210 L
BrAC2 = (0.966)(0.15) + 0.004
BrAC2 = 0.149

The 95% confidence interval around the estimate of BrAC2 is

$$\text{BrAC2} \pm (1.96)(0.012)$$

or

$$0.149 \pm 0.024$$

As a result, based upon the first breath alcohol measurement, we are 95% confident that the second breath alcohol measurement will be within 0.125 and 0.173 g/210 L.

Figure 2 shows a histogram of differences for the same data. This is informative but tells nothing about differences at various concentrations. Regression analysis, therefore, is to be preferred since it evaluates the confidence interval based upon the relevant concentration and uses SEE, which is based upon the entire range of the data.

This information can be useful in situations in which a person provides only one breath sample and one wants to estimate what the second sample would have been based on the first result. In doing so, one must be sure to explain all assumptions and parameters employed. It would be best to use the model from data generated during the same time frame and from the same type of instrumentation as that used for the individual's single sample.

This may also have application in jurisdictions that perform only one measurement. Such jurisdictions could obtain data from others who employ the same instrument and use it to make some limited prediction of what the second result would have been. This is the less preferred procedure, and one must use caution in making strong predictions based on data obtained using other instrumentation and other measurement contexts.

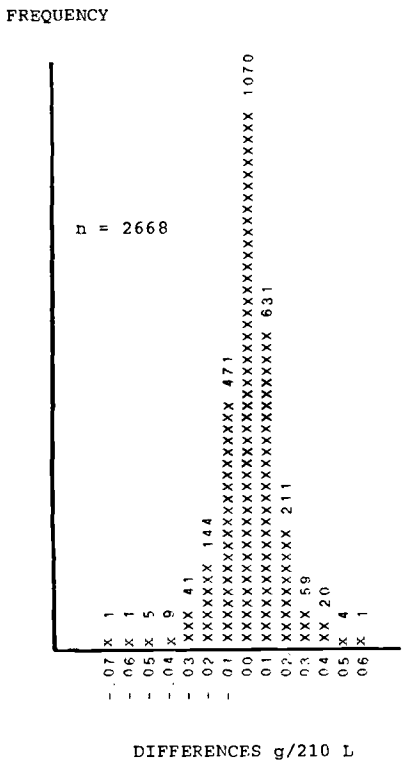

FIG. 2—*Differences between duplicate breath alcohol analyses (BrAC1 − BrAC2).*

The reason for caution is that one is not able to demonstrate that a single test system is in a state of statistical control [*10*]. Statistical control can only be demonstrated by continual analysis of duplicate breath results and then applying appropriate regression analyses.

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References

[*1*] National Safety Council Committee on Alcohol and Other Drugs, Meeting Notes, Oct. 1986.
[*2*] Harris, E. K., Kanofsky, P., Shakarji, G., and Cotlove, E., "Biological and Analytic Components of Variation in Long-Term Studies of Serum Constituents in Normal Subjects: II. Estimating Biological Components of Variation," *Clinical Chemistry,* Vol. 16, No. 12, 1970, pp. 1022–1027.
[*3*] Fraser, C. G., and Fogarty, Y., "Interpreting Laboratory Results: Analytical and Biological Variation Must Be Taken Into Account," *British Medical Journal,* 24 June 1989.
[*4*] Bailey, N. T. J., *Mathematics, Statistics, and Systems for Health,* John Wiley and Sons, New York, 1977, pp. 27–39.
[*5*] Mosteller, F. and Tukey, J. W., *Data Analysis and Regression: A Second Course in Statistics,* Addison-Wesley Publishing, Reading, MA, 1977, pp. 260–262.
[*6*] Godfrey, K., "Simple Linear Regression in Medical Research," *New England Journal of Medicine,* Vol. 313, No. 26, 26 Dec. 1985, pp. 1629–1636.
[*7*] Giles, E. and Klepinger, L. L., "Confidence Intervals for Estimates Based on Linear Regression

in Forensic Anthropology," *Journal of Forensic Sciences*, Vol. 33, No. 5, Sept. 1988, pp. 1218–1222.
[8] Berkson, J., "Are There Two Regressions?" *American Statistical Association Journal*, June 1950, pp. 164–180.
[9] Cornbleet, P. J. and Gochman, N., "Incorrect Least-Squares Regression Coefficients in Method-Comparison Analysis," *Clinical Chemistry*, Vol. 25, No. 3, 1979, pp. 432–438.
[10] Taylor, J. K., *Quality Assurance of Chemical Measurements*, Lewis Publishers, Chelsea, MI, 1987, pp. 13–14, 129–146.

Discussion of "A Revised Glass Annealing Method to Distinguish Glass Types"

Dear Sir:

I enjoyed reading the paper on "A Revised Glass Annealing Method to Distinguish Glass Types," by John M. Marcouiller, published in the May 1990 issue of the *Journal of Forensic Sciences*. Continued research and method validation in the area of end use classification of small fragments of glass is vital to its continued utilization as a type of valuable trace evidence.

The author made reference to a study which I published in the October 1986 issue of this journal [*1*] also dealing, in part, with the tempered/nontempered classification of small colorless glass fragments. He noted the apparent contradiction between my tempered classification of 3 out of 8 laminated glass samples, using the annealing procedure described in my study, and his findings that all 43 laminated samples fell into the nontempered class when using the procedure described in his study. He further indicated that, after his personal communication with me, I reran the three samples and subsequently found that the laminated samples did indeed fall into the nontempered range, thus confirming his findings. I would like to take this opportunity to expound on that information.

In my study of 1986, 3 of the 8 laminated glass samples fell into the tempered region of the ΔN_D range. In this initial study, the specimens were annealed in uncapped porcelain crucibles without the aid of a programmable muffle furnace or a stainless steel annealing block. The limited number of samples, along with the crude method employed at that time, provided far from conclusive evidence of the potential overlap of laminated and tempered sheet glasses. It did, however, suggest caution in classifying laminated glass and suggested excluding it from the tempered classification range. Upon the 1988 request of Marcouiller, I subjected the laminated samples falling into the tempered range to replicate reanalysis using a more refined method employing an annealing block and controlled cool down of the furnace. As reported in Marcouiller's paper, the classification corroborated his data obtained for the substantially larger database of 43 laminated sheet samples. Thermal gradients in the furnace and the sample containers were apparently the cause of the spurious results.

Since the publication of my validation study, I have had the opportunity to subject 10 additional laminated sheet glass samples to an 8-h annealing method utilizing a programed cool down and a stainless steel annealing block. With the aid of this refined method, I also have found no impingement of laminated glass on the tempered glass ΔN_D range.

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Reference

[1] Ryland, S. G., "Sheet or Container?—Forensic Glass Comparisons with an Emphasis on Source Classification," *Journal of Forensic Sciences*, Vol. 31, No. 4, Oct. 1986, pp. 1314–1329.