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Corrections to a paper on race and sex differences in brain size and intelligence

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Summary—This paper presents two corrections to an earlier paper by Rushton (*Personality and Individual Differences, 11,* 785–794, 1990). The first is to the equation used to calculate cranial capacities from externally measured head sizes. Eleven millimeters should be subtracted from head length and width for fat and skin around the skull. When the subtractions are made the cranial capacities for the different races are about 200 cm^3 smaller than previously reported, although the significant rank ordering of Mongoloids > Caucasoids > Negroids is preserved. The second correction is to the statement that there are no sex differences in brain size when body size variables are controlled. Two recent studies using large data sets show that after covariance adjustment for body size, women's brains average 100 g lighter and 110 cm^3 smaller than men's. These findings are best understood from the perspective of human evolution.

In a recent exchange with Cain and Vanderwolf (1990), I calculated a table of cranial capacities for 26 male populations from external head measurements provided by Herskovits (1930). I used an equation from Lee and Pearson (1901, p. 235, Table VII, No. 5) based on German males, as also used by Passingham (1979):

$$CC\ (cm^3) = 6.752\ (L) + 11.421\ (B) - 1434.06 \quad (1)$$

where L and B are length and breadth of the head in millimeters.

The results showed statistically significant racial differences. Mongoloid samples averaged 1651 cm^3 ($n = 5$, SD = 20), Caucasoid samples averaged 1621 cm^3 ($n = 9$, SD = 49), and Negroid samples averaged 1495 cm^3 ($n = 12$, SD = 44). It was noted that these estimates of cranial capacities were higher than those typically reported.

Equation (1) as used by Passingham (1979) and Rushton (1990) is not correct. Eleven millimeters should have been subtracted from the external head measurements for fat and skin around the skull. This was made clear by Lee and Pearson (1901, p. 252) in their later discussion. Because Lee and Pearson did not introduce the correction until later in their paper the correction was overlooked. Thus Lee and Pearson's equation for estimating cranial capacity (in males) based on length and breadth of head should be modified to:

$$CC\ (cm^3) = 6.752\ (L - 11\ mm) + 11.421\ (B - 11\ mm) - 1434.06 \quad (2)$$

To examine the difference in result between equations (1) and (2) I tested them both against a set of 24 male military samples (4 Mongoloid, and 20 Caucasoid) compiled by the United States National Aeronautics and Space Administration (1978), as analyzed by Rushton (1991). This study had used a "panracial" equation (for males) from Lee and Pearson (1901, p. 252, No. 14) that took into account head height as well as head length and breadth and subtracted 11 mm for fat and skin around the skull.

$$CC\ (cm^3) = 0.000337\ (L - 11mm)\ (B - 11\ mm)\ (H - 11\ mm) + 406.01 \quad (3)$$

Equation (3) gave the Caucasoids a mean cranial capacity of 1467 cm^3, a figure that fits with other data, including autopsy data. Using this as the criterion, equation (1) gives a figure of 1642 cm^3, an overestimation of 175 cm^3, and equation (2) gives a figure of 1442 cm^3, an underestimation of 25 cm^3. For the Monogoloids, equation (1) overestimated by 183 cm^3 and equation (2) underestimated by 16 cm^3. Thus, if only length and breadth of the head are available, equation (2) is more appropriate.

Because Rushton's (1990) re-analysis of Herskovits's (1930) data has now entered the literature and may be included in metaanalytic and other reviews, it is important to have all the corrected data available. Table 1 presents a re-analysis of Herskovits's (1930) data using equation (2).

The Mongoloid samples averaged 1451 cm^3 ($n = 5$, SD = 22), the Caucasoid samples averaged 1421 cm^3 ($n = 9$, SD = 49), and the Negroid samples averaged 1295 cm^3 ($n = 12$, SD = 44). Treating each sample mean as an independent entry, a 1-way ANOVA reveals that overall the races differ significantly in brain size [$F(2,23) = 33.65$, $P < 0.001$] with a highly significant trend in the predicted direction, Mongoloids > Caucasoids > Negroids [$F(1,23) = 60.53$, $P < 0.001$].

Since the Rushton exchange with Cain and Vanderwolf, additional data sets using external head measurements have confirmed the racial pattern and general magnitude of results. In Rushton's (1991) study, discussed above, the calculated cranial capacity, after adjusting for the effects of height, weight, and total body surface area was, for Mongoloids, 1460 cm^3 and for Caucasoids 1446 cm^3. In a stratified random sample of over 6000 U.S. Army personnel measured in 1988, Rushton (1992) found, after adjusting for the effects of stature, weight, rank and sex, that Asian–Americans averaged 1403 cm^3, Caucasian–Americans averaged 1361 cm^3, and Afro–Americans averaged 1346 cm^3.

SEX DIFFERENCES

Cain and Vanderwolf (1990) held that because there is a significant difference in brain size between women and men for which no apparent difference in IQ score existed it was not logical to interpret racial differences in brain size as mediating intelligence. Rushton (1990) responded that this was an unworthy argument because although an autopsy study by Ho, Roessmann, Straumfjord and Monroe (1980) based on 1261 adults aged 25 to 80 had shown a 136 g difference between

Table 1. Cranial capacities[a] in cm^3 calculated from head length and width (mm) provided by Herskovits (1930) for various male samples and classified by race or geographical region

		Length	Width	Capacity
Mongoloids and Asian				
540	Pure Sioux	194.90	155.10	1453
77	Half-blood Sioux	194.40	154.30	1441
50	Montagnais-Naskapi	194.00	157.10	1470
83	Marquesans	193.20	153.20	1420
86	Hawaiians	191.25	158.93	1472
	Mean	193.55	155.73	1451
Caucasoids and European				
727	Old Americans	197.28	153.76	1454
263	Scotch foreign-born	196.70	153.80	1451
959	Oxford students	196.05	152.84	1435
493	Aberdeen students	194.80	153.40	1433
46,975	Swedes	193.84	150.40	1393
1000	Cambridge students	193.51	153.96	1431
802	Cairo natives	190.52	144.45	1302
450	Foreign-born Bohemians	189.80	159.10	1465
60	American-born Bohemians	188.00	156.50	1423
	Mean	193.39	153.13	1421
Negroids and African				
961	American Negroes	196.52	151.38	1422
91	Masai	194.67	142.49	1308
34	Lotuko	192.90	141.30	1283
55	Kajiji	192.31	144.56	1316
27	Somali	191.81	143.19	1297
19	Ekoi	191.05	143.16	1291
40	Vai	188.85	142.45	1268
384	Akikuyu	188.72	143.25	1276
72	Kagoro	188.19	142.43	1263
128	Akamba	187.80	143.63	1275
48	Ashanti	187.33	145.01	1287
30	Acholi	187.30	141.80	1250
	Mean	190.62	143.72	1295

[a]Cranial capacities (cm^3) = $6.752 \times (L - 11\text{ mm}) + 11.421 \times (W - 11\text{ mm}) - 1434.06$ (from Lee & Pearson, 1901).

women and men, they had also shown that when body height, weight and surface area were controlled, the sex difference in brain size was removed. My counterargument, however, turns out to be incorrect.

Following a tentative result using magnetic resonance imaging by Willerman, Schultz, Rutledge and Bigler (1991), Ankney (1992) challenged the widely accepted view that there are no sex differences in brain size once body size is controlled. Ankney (1992) re-examined the brain-weight analyses published by Ho *et al.* (1980) and found that at any given surface area or height, brains of white men are heavier than those of white women as are brains of black men heavier than those of black women. For example, the brain weight of 5 ft 8 inch (173 cm) men averaged about 100 g heavier than those of women of the same height in both racial groups. Ankney showed that a serious statistical error had been made, one that permeates this literature. The mistake is to examine sex differences in brain weight using brain-weight–body-size ratios because these ratios decline as body size increases so that the mean ratios do not differ between men and women.

Ankney's (1992) re-analysis of Ho *et al.*'s (1980) autopsy data showing a 100 g difference between women and men has been confirmed with a quite different procedure by Rushton (1992). Using external head measurements from a stratified random sample of over 6000 U.S. Army personnel measured in 1988, cranial capacities were calculated from equation (3). After adjusting for the effects of stature, weight, rank and race, those of men averaged 1442 and those of women averaged 1332 cm^3. Because brain weight (g) = 0.87 cm^3, the sex difference of 110 cm^3 (96 g) is remarkably similar to the one of 100 g obtained by Ankney (1992). These sex differences were observed by Rushton (1992) to occur in each of the three racial groups and in officers as well as enlisted personnel.

DISCUSSION

Because there is about a 0.30 correlation between brain size and intelligence (Broman, Nichols, Shaughnessy & Kennedy, 1987; Jensen & Sinha, 1993; Johnson, 1991; Willerman *et al.*, 1991), the race and sex differences are of great scientific interest. The racial group differences in brain size are paralled by those found using measures of intelligence. Lynn (1991a) reviewed this literature from a global perspective from three points of view. Firstly, studies using intelligence tests indicated that Caucasoids of North America, Europe and Australasia generally obtain mean IQs of around 100. Mongoloids from both North America and North-east Asia typically obtain slightly higher means in the range of 100–106. Africans from south of the Sahara and Afro-Americans and Afro-Caribbeans obtain mean IQs of from 70–90. A second source of evidence that Lynn (1991a) reviewed came from studies of mental decision times which provide measures of the neurological efficiency of the brain. These studies show that Mongoloids have the fastest reaction times, followed by Caucasoids and then by Negroids. Thirdly, Lynn (1991a) assessed the races for their contributions to civilization. He concluded that the Caucasoids and the Mongoloids had made the most significant advances both in the foundation of the early civilizations and in more recent developments.

Lynn (1987, 1991b) and Rushton (1985, 1988) have proposed evolutionary hypotheses for why Mongoloid populations have evolved the greatest intelligence and the largest brains. From an African origin, those groups migrating into the colder climate of Eurasia, and evolving into the Caucasoids and Mongoloids, were selected for enhanced intelligence (Lynn) and

a *K*-parenting or reproductive strategy and life history (Rushton). The most extreme selection pressures occurred in North-east Asia, where Mongoloids evolved, partly because of the intense cold that prevailed there.

With the sex difference in brain size, Ankney (1992) has pointed to a paradox. Women have smaller heads than men but apparently have the same intelligence test scores. Ankney resolved the problem by proposing that the sex difference in brain size relates to those intellectual abilities at which men excel. Women excel in verbal ability, perceptual speed, and motor coordination within personal space; men do better on various spatial tests and on tests of mathematical reasoning (Kimura, 1992). Ankney suggested that the sex difference may be best understood within the context of evolutionary pressures for sexual dimorphism in the hunter-gathering society in which human brains evolved. Men roamed from the home base to hunt, a scenario that has been suggested as explaining the male advantage in spatial ability (Kolakowski & Malina, 1974). Ankney suggested that it may require more brain tissue to process spatial information.

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