TABLE 1. Residuals for Homo sapiens *of various neural nuclei, based on Stephan et al. (1981) (volumes in mm³)*

Structure	Correlation	Predicted	Observed	Difference	% Difference
Striatum	0.994	48,394	28,689	−19,705	−68.7
Septum	0.983	2,095	2,610	515	19.7
Thalamus	0.995	25,288	18,222	−7,066	−38.78
Hippocampus	0.954	10,863	10,287	−576	−5.6
Cerebellum	0.992	131,226	137,421	6,195	4.51
Neocortex	0.998	1,126,181	1,006,530	−119,651	−11.89
Medulla	0.988	16,745	9,622	−7,123	−74.03
Mesencephalon	0.994	9,214	8,087	−1,127	−13.94
Meninges	0.946	14,688	13,205	−1,483	−11.23
Ventricles	0.956	8,934	18,732	9,798	52.31

relative increase of neural structures is calculated. Using the data of Semendeferi et al. (2001) on area 10 without the human data points, one can calculate the regression equation for available primate area 10. This equation allows one to calculate the expected human value based on the size of the brain. Subtracting the actual volume of area 10 from the expected volume provides a measure of the residual value, which can be compared with other known residuals from the large data base provided by Stephan et al. (1981) for other neural structures. In this case, the neural structures, e.g., the neocortex and cerebellum, had the log (base 10) values regressed against the log (base 10) of brain volume. Total brain volumes were not corrected, and included the volume of the particular structure, which in the case of the neocortex, varies from about 60–76% of total brain volume. The other structures are relatively small, and correcting them does not appreciably alter the residuals.

RESULTS

Table 2 of Semendeferi et al. (2001, p. 234) shows that in absolute terms, the human volume of area 10 is approximately seven times as large as the chimpanzee's volume of area 10, and their Figure 7 (Semendeferi et al., 2001, p. 235) shows graphically the large absolute increment of human over other great ape volumes, being ca. 1.2% of brain volume in *Homo*, but only ca. 0.6–0.7% in the chimpanzee. However, their Figure 8, a log-log plot of volume of area 10 upon total brain volume, shows that the human point is almost exactly on the regression line they calculated. If one asks what the *residual* value is for the human value, using only the ape values and predicting what the expected human value of area 10 should be, the amount is 903.03 mm³. The equation for predicting the human volume is

$$Y = -5.808 + 1.639\,(X)$$

Where X is log base 10 volume,

using only the five ape values for area 10 and their respective brain volumes, the predicted volume for *Homo* of area 10 would be 13,314.96 mm³, and the actual volume would be 14,218 mm³. Thus

$$(14{,}218 - 13315)/14218 = .0635, \text{ or } 6.35\%$$

This amount is certainly not dramatic, and we await more sampling before knowing whether 6% is indeed a significant relative increase. Put in the perspective of residuals known for other structures of the human brain, Table 1, based on the data set of Stephan et al. (1981), gives some examples of human residuals, expressed in percent difference between observed and predicted values. The human cerebellum comes closest, being 6.20% larger if all 44 species of primate are used, but −9.5% if only anthropoids are used. The human neocortex is −11.33% less than expected, and yet it is universally accepted that the human value of the neocortex lies directly on the total primate regression line of volume of the neocortex against total brain volume. There is no claim in the literature that these residuals are truly significant in a statistical way. More dramatic residuals are −121% for the primary visual cortex (area 17) and −144% for the lateral geniculate nucleus (for more examples, see Holloway, 1997), and these suggest that the residuals are significant. The 95% confidence intervals curve sharply away from the regression lines at the ends of the distributions when using log-log plots, making it difficult to assess significant departures.

DISCUSSION

The work being done by Semendeferi et al. (1997, 2001) is important and represents long-overdue and valuable additions to our understanding of comparative primate neurology and human brain evolution. As the residuals in Table 1 suggest, it is very likely that while brain size has important relationships with the conservation of various neural structures (e.g., see Finlay et al., 2001), there have been important shifts of other neural nuclei and fiber systems in the human brain during its evolutionary course, representing reorganization of the brain. It is quite likely that the human cerebral cortex has also undergone mosaic evolutionary changes, but it remains to be demonstrated exactly which regions have changed the most in terms of volumes, and cytoarchitectonic organization of layers and cell types. For the time being, however, I see these data as more strongly suggesting that it will be connectivity patterns rather than volumes of neural tissues that make the human brain distinct from those of our