airborne lead concentrations have a winter maximum due to a lower inversion layer (*11*).

Unlike the linear downward trend and the annual cycle, the 84-day term reflects no obvious physical cause with that frequency. Rather, its existence in both the raw and smoothed data may be an artifact of attempting to use sine waves to describe the observations, which rise more abruptly in the spring and fall more gradually in the autumn than could be described by a single sine wave.

A small number of the samples (N = 323 or 2.9 percent) had lead concentrations of 1.9 $\mu g\ dl^{-1}$ or less, near the blank-dominated detection limit of our analytical system. Surveys in remote, nonurban, nonindustrial locations have yielded population means at these concentrations in adults and children (*12*). However, umbilical cord blood samples, which may be expected to exhibit lower lead concentrations, have not been measured in these investigations.

The National Health and Nutrition Survey (NHANES II) indicated that 3.9 percent of American children between 1 and 5 years of age had blood lead concentrations greater than 30 $\mu g\ dl^{-1}$, the defined threshold for undue lead exposure (*10*). The downward trend in umbilical cord blood lead concentrations over time has drastically reduced the number of infants exceeding this highest risk range. Only five of our subjects (0.05 percent) had blood lead concentrations in excess of 30 $\mu g\ dl^{-1}$. The safe limit for infants has not been established, but considerable evidence indicates that fetuses are more sensitive than children. Forward studies of neuropsychological outcome from birth onward are required to determine what level of exposure to lead is acceptable.

MICHAEL B. RABINOWITZ*
HERBERT L. NEEDLEMAN†
Department of Psychiatry, Harvard Medical School, and *Children's Hospital Medical Center, Boston, Massachusetts 02115*

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* Send reprint requests to M.B.R. at Children's Hospital Medical Center, Boston, Mass. 02115.
† Present address: Departments of Psychiatry and Pediatrics, University of Pittsburgh School of Medicine, Pittsburgh, Pa. 15261.

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Sexual Dimorphism in the Human Corpus Callosum

Abstract. *Preliminary observations suggest a sex difference in the shape and surface area of the human corpus callosum. The sexual dimorphism is striking in the splenium, the caudal or posterior portion of the corpus callosum. The female splenium is both more bulbous and larger than the male counterpart. Since peristriate, parietal, and superior temporal fibers course through the splenium, this finding could be related to possible gender differences in the degree of lateralization for visuospatial functions.*

Although sex-related allometric variations in brain weight have been reported (*1*), to our knowledge no reliable sex differences in human brain morphology have been evidenced to date (*2*). In examining corpora callosa, we observed a sex difference in the shape of the splenium—the caudal or posterior portion of the corpus callosum. This serendipitous finding, later quantitatively substantiated, is of pragmatic interest to the forensic scientist. In addition, it has wide-ranging implications for students of human evolution and comparative neuroanatomy, as well as for neuropsychologists in search of an anatomical basis for possible gender differences in the degree of cerebral lateralization. To our knowledge, the existence of sexual dimorphism in the major cerebral commissure has not been reported and thus has promise for future research on anatomical sex differences in the human brain.

Whole normal brains [N = 14: male (M) = 9, female (F) = 5] were obtained upon autopsy (*3*). All of the brains were suspended by their basilar artery in a 10 percent Formalin-saline solution (*4*) for a minimum of 3 weeks and cut midsagittally, precisely through the cerebral aqueduct. Kodachrome slides were taken of the medial aspect of the brains along with a millimeter ruler. The slides were back-projected onto a glass table, and the outline of the corpus callosum was drawn at a magnification of 1.7 to 2.2. Drawings of the corpora callosa were used for (i) gross morphological examination; (ii) computation of the anterior-to-posterior distance (callosal length) and maximum splenial width (*5*); and (iii) computer-assisted planimetric measurements of the total callosal cross-sectional surface area as well as of the partial areas of the posterior fifth, fourth, and third of the corpus callosum. The partial surface areas, which were determined on the basis of the anterior-to-posterior distance, were used as an objective quantification of splenial area since there is no natural division between the body and splenium of the corpus callosum. All of the measurements were obtained without any information on the sex, age, brain weight, and so forth, of the individual (*6*).

Gross morphological examination (Fig. 1) revealed a sexual dimorphism in the shape of the splenium. The female splenium is bulbous and widens markedly with respect to the body of the callosum. In contrast, the male counterpart is approximately cylindrical and is relatively continuous in width with the body of the corpus callosum. All drawings were correctly classified according to sex by three impartial observers on the basis of a verbal description of the sex differences.

A quantitative analysis of the maximum splenial width yielded a nearly bimodal distribution for males and females and confirmed the visual observations ($t = -5.03$; $P < .001$) (Table 1). No sex differences were found in the absolute length of the corpus callosum. However, planimetric measurements did evince a sexual dimorphism: The average area of the posterior fifth (determined to be most representative of splenial surface area) of the corpus callosum was larger in females than in males ($t = -1.85$; $P = .08$), and although the average total

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callosal area was not absolutely larger in either sex, it was greater in females relative to brain weight (Table 1). In addition, the total surface area of the callosum correlated significantly with splenial width in females (r_s = .74; P = .03) but not in males (r_s = .35, P = .10). A discriminant analysis (*7*) using total callosal area, maximum splenial width, and surface areas of the posterior fifth and third as variables classified the callosa as male or female with 100 percent accuracy. Partial correlations of maximum splenial width with sex by brain weight, body weight, height, and age accounted for very little of the variance ($P > .1$). Therefore, the relationship between maximum splenial width and sex cannot be explained on the basis of these variables.

We can only speculate on the functional significance of the sex differences. We know from topographic studies in rhesus monkeys (*8*) as well as in the human brain (*9*) that parietal, peristriate, and some superior temporal fibers course through the splenium of the corpus callosum. Animal studies in the cat (*10*), rhesus monkey (*11*), and chimpanzee (*12*), as well as data from human partial commissurotomies (*13*), have evidenced the role of the splenium in the interhemispheric transfer of visual information. If we are to believe that a larger splenium implies a larger number of fibers interconnecting cortical areas and that the number of interhemispheric fibers correlates inversely with lateralization of function, then our results are congruent with a recent neuropsychological hypothesis that the female brain is less well lateralized—that is, manifests less hemispheric specialization—than the male brain for visuospatial functions (*14*). Our results need to be replicated with a larger sample size, and we await quantitative ultrastructural information on the relative numbers and density of myelinated and unmyelinated fibers in the splenium as well as more refined neuropsychological tests before we can interpret further this correlation of our anatomical finding with neuropsychological observations.

Table 1. Quantitative aspects of sexual dimorphism in the human callosum. Statistical comparisons between male and female measurements were made with two-tailed *t*-tests.

Sex descriptors	Maximum splenial width (cm)*	Area (mm^2)		Brain weight (g)‡
		Posterior fifth†	Total	
Male				
Mean	1.14	186.1	704.3	1379.4
Standard deviation	0.174	24.9	131.5	90.7
Standard error	0.058	8.3	43.8	30.2
Range	0.9 to 1.41	155.9 to 243.1	578.6 to 962.1	1220 to 1520
Female				
Mean	1.64	218.3	708.3	1205.0
Standard deviation	0.182	41.1	116.6	170.7
Standard error	0.081	18.4	52.2	76.4
Range	1.4 to 1.8	148.9 to 258.6	533.4 to 845.0	1090 to 1500

*$t(12) = -5.03$, $P < .001$. †$t(12) = -1.85$, $P = .08$. ‡$t(12) = 2.54$, $P = .026$.

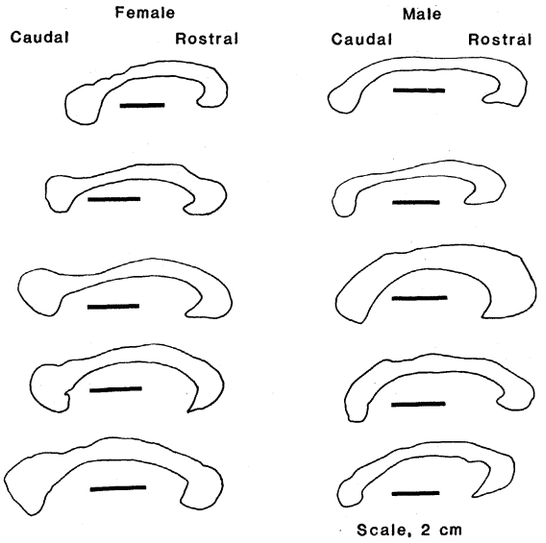

Fig. 1. Sexual dimorphism in the splenium. The female splenium is more bulbous and larger than the male counterpart. All female callosa (N = 5) used in this study are displayed; the males were randomly selected from the total sample (N = 9).

CHRISTINE DE LACOSTE-UTAMSING*
Department of Anthropology, Columbia University, New York 10027, and *Department of Neurology, University of Texas Health Science Center, Dallas 75235*
RALPH L. HOLLOWAY
Department of Anthropology, Columbia University

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3. Autopsies were performed at the Dallas Forensic Institute. One of us (C.L.U.) is analyzing another sample of adult normal callosa (N = 14; M = 6; F = 8) obtained by J. B. Kirkpatrick at the Baylor College of Medicine, as well as a sample of fetal callosa (N = 38; M = 20; F = 18) from the Yakovlev collection of the Armed Forces Institute of Pathology. Preliminary planimetric measurements confirm most of the observations reported in this report.
4. Saline was mixed with the Formalin to ensure that the brains floated and retained their original shape.
5. Maximum splenial width refers to the width obtained in the widest portion of the splenium. The line drawn representing this width had to be perpendicular to parallel lines drawn along the dorsal and ventral aspects of the splenium.
6. Although the partial surface areas were computed after we had noted the sex difference, all of the drawings and calculations of the total callosal surface area were completed before we suspected the existence of such a difference.
7. The "Discriminant" subprogram of SPSS [N. H. Nie, C. Hadlaihull, J. G. Jenkins, K. Steinbrenner, D. H. Bent (*Statistical Package for the Social Sciences* (McGraw-Hill, New York, 1975)] was used. The mathematical objective of the discriminant analysis is to weight and linearly combine a set of variables, selected by the researcher, to maximize the statistical distinctiveness of the two or more groups. In this analysis, the unstandardized canonical discriminant function coefficients (these give the weights of the discriminating variables) were total callosal area, −1.9474; maximum splenial width, 0.97378; area of the posterior fifth, 0.79470; and area of the posterior third, −0.02357.
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* Present address: Department of Cell Biology, University of Texas Health Science Center, Dallas 75235.

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