NEUROLOGY

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Richard N. Aslin and Bradley L. Schlaggar

Neurology 2006;66;304-305
DOI: 10.1212/01.wnl.0000201189.32928.fb

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Editorial

Is myelination the precipitating neural event for language development in infants and toddlers?

Richard N. Aslin, PhD; and Bradley L. Schlaggar, MD, PhD

Language is uniquely human and emerges rapidly during early childhood. Many speculations have been raised about brain mechanisms that might mediate these two properties, most notably the specialization of regions of the left frontal and temporal cortices. The metric of left hemisphere specialization comes in various forms, including greater volume, superior processing efficiency for linguistic materials, and—the focus of the article by Pujol et al.[1]—enhanced fidelity of intracortical and corticocortical communication due to progressive myelination. Although their article is not the first to propose, based on gross anatomy, that myelination is suspiciously coincident with the timing of early language/cognitive development,[2] Pujol et al. provide a novel, detailed quantitative assessment of the time course of myelination in the lateral perisylvian region of each hemisphere between birth and 39 months postnatally in a cross-sectional study. Anterior and posterior regions of the lateral perisylvian cortex were assessed bilaterally, along with a presumptive nonlanguage, sensorimotor control region. White matter volume from each of these three regions (normed to overall volume) was estimated bilaterally.

The findings show a clear difference between the rates of myelination for language regions compared to the control region. The 50th percentile of myelination was achieved by 6 months of age for the control region, but not until 18 months of age for both the anterior and the posterior language regions. The 90th percentile ages were 8 months for the nonlanguage control and 35 months for the language regions. Hemispheric differences did not generally favor the left hemisphere in language regions but rather showed the greatest asymmetries in frontal cortex, with modest but significant asymmetries in sensorimotor cortex and no asymmetries in the temporal cortex. Other structural imaging studies have found asymmetries in posterior perisylvian regions including the posterior aspect of the sylvian fissure and the planum temporale.[3,4] The Pujol et al. findings suggest that a general anterior to posterior gradient regulates hemispheric asymmetries in white matter volume.

The foregoing results provide useful new data on the postnatal progression of myelination in the developing brain. And the creation of a time-lapse video of this progression makes for a useful instructional tool. But it is the speculations about how this changing anatomy influences language development that often lead investigators into a common trap, where conclusions are drawn about the development of function based on data regarding the development of structure.[5] In addition to volumetric analyses obtained with MRI, Pujol et al. gathered parental report data on the commonly observed "spurt" in vocabulary growth that emerges around 18 to 24 months of age. Their figure 5 plots growth curves for vocabulary and for myelination in the frontal and temporal regions of both hemispheres, and they note that myelination asymptotes at about the same age as the onset of the vocabulary spurt. They conclude: "Figures 4 and 5 suggest that the characteristic spurt in toddlers' vocabulary occurs only after a certain degree of myelination is attained."

As seductive as this conclusion may appear, it suffers from five problems, all of which Pujol et al. clearly recognize. First, myelination is not the only factor that is necessary for language development. Second, even if it were the only necessary factor, myelination was not measured in other brain regions that could have been more important than Wernicke and Broca areas. Third, the measure of vocabulary growth is only one (admittedly crude) metric for lan-

See also page 339

From the Department of Brain and Cognitive Sciences (R.N.A.), Rochester Center for Brain Imaging, University of Rochester, NY, and Departments of Neurology, Radiology, Anatomy & Neurobiology, and Pediatrics (B.L.S.), Washington University School of Medicine and St. Louis Children's Hospital, St. Louis, MO.

Disclosure: The authors report no conflicts of interest.

Address correspondence and reprint requests to Dr. R.N. Aslin, Department of Brain and Cognitive Sciences, Rochester Center for Brain Imaging, University of Rochester, Meliora Hall, River Campus, Rochester, NY 14627; e-mail: aslin@cvs.rochester.edu

guage development. Having a substantial vocabulary is not viewed by linguists or neuropsychologists as the defining characteristic of human language, and so one would have preferred a measure of grammatical complexity or at least other parameters derived from the MacArthur–Bates Communicative Development Inventory (used by Pujol et al.), such as mean length of utterance.[6] Fourth, whereas regression analysis reveals that extent of myelination reliably accounts for 42% of the variance in the vocabulary measurement, in a separate regression analysis, age reliably accounts for nearly 70% of the variance in the vocabulary measurement. Further, in yet another regression analysis, age accounts for roughly 85% of the myelination measure. A solution to the age confound is to use multivariate regression to partial out age so that the unique contribution of myelination to vocabulary size can be measured. Further, a longitudinal element to the design would have been welcome. Bates et al. have shown a good deal of individual variability in the trajectory of vocabulary growth using the MacArthur–Bates instrument.[7] Demonstration of a strong relationship within subjects of myelination and vocabulary volume would be more convincing. Finally, even though there was a significant correlation between myelination and vocabulary (showing an exponential growth function), that does not imply causality. Thus, whereas myelination could contribute to language development, other anatomic or functional variables (e.g., synaptic efficiency) could be correlated with myelination and serve as the true causal agent of vocabulary growth.

Despite these caveats, Pujol et al. have provided an important advance in the quantitative assessment of myelination in language-related regions of the infant and toddler brain. The sophistication of their segmentation techniques from MRI data and the substantial sample size will, it is hoped, spur other investigators to conduct similar, perhaps longitudinal, studies in the future.

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