best focus attained so far with x-rays (less than 50 nanometers) is five times finer than what lenses can achieve for visible light (4).

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Response: I agree with Kirz and regret that my Perspective made no reference to the current work on diffractive lenses for x-rays and neutrons. Although great strides have been made in this field, we are still a long way from achieving resolution on the atomic scale with such lenses, so they cannot contribute as yet to the imaging of individual atoms. Nevertheless, Kirz's point is a valid one, and the lack of atomic resolution with such lenses in no way detracts from their importance, either current or potential.

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Brain Activation and Sentence Comprehension

In their report "Brain activation modulated by sentence comprehension" (4 Oct., p. 114), M. A. Just *et al.* conclude that "[t]he answer to the question of how the brain responds to increased comprehension demand is that it recruits more neural tissue. . . ." On this basis they argue that the relation between cognitive functions and brain sites is not fixed, and thus that there "cannot be a static cartography of brain anatomy." We see two problems with this argument.

Just *et al.* measured neural activation in four brain areas with functional magnetic resonance imaging (fMRI) during comprehension of three sentence types presumed to vary in processing complexity. The number of voxels showing activation significantly above baseline increased with sentence complexity. According to Just *et al.*, this finding implies that more neural tissue is recruited as processing demand increases.

We disagree. For purely statistical reasons, the identical result (an increase with sentence complexity in the number of voxels reaching a significance threshold) is expected under an alternative hypothesis—that the same tissue becomes increasingly active with increasing sentence complexity.

Consider a situation in which neural activity is uniformly elevated above baseline throughout a brain region. Because of noise, some voxels in that region are likely to fall short of the criterion for classifying a voxel as activated above baseline. If the region's activation is only slightly higher than baseline, the number of such voxels will be large; however, as the region's activation increases, more voxels will reach criterion (other things being equal). Thus, even if the tissue implicated in comprehension were exactly the same across sentence types, a uniform increase with sentence complexity in the activation of that tissue would lead to the reported result. Therefore, the result

does not demonstrate that more neural tissue was recruited as processing complexity increased.

A second problem lies in the assumption made by Just *et al.* that the three sentence types differ solely in the quantitative demands placed on a common set of language comprehension operations. The evidence they cite on this point does not rule out the possibility that the sentence types also differ in the specific cognitive operations (syntactic or otherwise) required for comprehension. Therefore, even if the data did imply differences across sentence conditions in the amount of neural tissue recruited, these differences could reflect differences in processing operations, rather than differences in processing demand.

We do not suggest that the conclusions made by Just *et al.* are necessarily incorrect, but that the evidence they provide is no more consistent with their stated conclusions than with rejected alternative hypotheses.

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Response: By using fMRI to assess brain function during the comprehension of three sentence types of different complexity, we tested and found support for the hypothesis that more demanding language computations engendered more activation in Wernicke's area, Broca's area, and their right hemisphere homologues. "More activation" was operationalized in two ways: (i) a greater volume of tissue becomes activated and (ii) the same tissue becomes activated to a higher level. Rapp and McCloskey suggest that we interpreted the increases only in terms of volume, and imply that we rejected the activation-level interpretation. To the contrary, in support of (ii), we reported a reliable increase in signal intensity in a set of voxels in Broca's area and in its right hemisphere homologue.

The spatial resolution of most contemporary neuroimaging methods is not well suited for distinguishing between these two aspects of quantitative increase, and, more importantly, they need not be mutually exclusive. In sensory systems, increases in stimulus intensity are encoded by both an increase in firing frequency in some neurons and an increase in the number of activated neurons (*1*). Thus, determining the functional relation in various cognitive domains between the amount of computational demand and the amount of brain activity is a fruitful precursor to finer grain studies of the nature of the increases.

As Rapp and McCloskey state, both kinds of increase lead to a measurement of an increase in activation volume with sentence complexity. Thus, ignoring the effect of demand in mapping a functional brain area produces a static and potentially misleading cartography of an inherently dynamic system.

With respect to Rapp and McCloskey's second point, we did not propose that differences in amount of quantitative demand imposed by the three sentence types were the only distinction in how they were processed, but that the quantitative differences in demand would be predictive of the amount of brain activation, which they were.

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Corrections and Clarifications

In the response by Timothy Rowe (31 Jan., p. 684) to the technical comment by K. K. Smith *et al.* under the heading "Comparative rates of development in *Monodelphis* and *Didelphis*" (31 Jan., p. 684), the first sentence was incorrect as the result of an editing error. The sentence should have read, "Do *Didelphis* and *Monodelphis* really have differing rates of development?"

In the letter of 25 October by Gustave K. Kohn (p. 481), the URL in reference 1 should have been http://www@nde.lanl.gov/cf/tritweb.htm

Letters to the Editor

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