"If we want to improve America's schools, we will have to apply in the classroom what we know about humans as intelligent, learning, thinking creatures."

John T. Bruer,
Schools for Thought

How Students Learn

Mind and Brain

The physiological findings of brain research, although fascinating, are of use to educators only in their relationship to learning. Bodies of research by neuroscientists and developmental and cognitive psychologists stress the importance of experience in building the structure of the mind by modifying the structures of the brain. Practice builds learning, and there is a relationship between the amount of experience in a complex environment and the amount of structural change in the brain.

Learning Changes the Physical Structure of the Brain

Animals raised in complex environments have a greater number of capillaries per nerve cell and a greater supply of blood to the brain than caged animals, regardless of whether the caged animals live alone or with companions.[1] Experience increases the overall quality of brain functions.

Structural Changes Alter the Functional Organization of the Brain

Learning organizes and reorganizes the brain. Consider the following:

- When young animals are taught a maze, structural changes occur in the visual areas of the cerebral cortex.[2] When they learn the maze with one eye covered by an opaque contact lens, only the brain regions connected to the open eye are altered.[3]
- New patterns of organization in the brain, imposed by learning, are confirmed by electrophysiological recordings of nerve cell activity.[4] These developmental changes in the brain, first observed in rats, have been consistent in mice, cats, birds, and monkeys, and they almost certainly occur in humans.
- The number of learning-imposed connections is less important than the patterns that emerge over time in the organization of those connections.[5]

Different Parts of the Brain Are Ready to Learn at Different Times

Experience helps organize the brain and development is often timed to take advantage of different experiences. Consider the following:

- Very young children can discriminate the smallest units of speech much more acutely than adults, but they lose this ability when certain boundaries are not supported by experience with spoken language. For example, native Japanese speakers typically do not discriminate the "r" from the "l" sounds that are evident to English speakers. The ability to do so is lost in early childhood because it is not present in the speech they hear.[6]

- Reading in Italian activates different regions of the brain than reading in English. For example, English letter combinations often have different sounds in different contexts (e.g., chief, chef, chemistry). Italian letter combinations are much more consistent and demand a less interpretive process.[7]

It is clear that the brain is changed by the experiences it encounters. Intellectual development depends on and benefits from experience. However, as John Bruer cautions, research on the chemical and electrical functioning of the brain may provide little to assist educators.[8] Neuroscience has discovered a great deal about neurons and synapses, but not nearly enough to guide educational practice. Nonetheless, a bridge to practice is being built, one rivet at a time, by cognitive psychologists. Yet, it is not clear in any great detail which educational practices should be changed, eliminated, or added to the teacher's repertoire.

Adapted from J. D. Bransford, A. L. Brown, R. R. Cocking, *How People Learn: Brain, Mind, Experience, and School,* National Academy Press, Washington, DC, 1999.

Endnotes

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7. E. Paulesce, E. McCrary, et al, "A Cultural Effect on Brain Function," *Nature Neuroscience, 3*(1), January 2000.
8. J. Bruer, "Education and the Brain: A Bridge Too Far," *Educational Researcher, 26*(8), November 1997.

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This work was produced in whole or in part with funds from the U.S. Department of Education under Eisenhower grant number R168R50003. The content does not necessarily reflect the position or policy of the Department of Education, nor does mention or visual representation of trade names, commercial products, or organizations imply endorsement by the federal government.