health, science, technology
EXPLORE

Editor: Pauline Clay
(804) 649-6632
pclay@timesdispatch.com

Sci-Kids

It's not just an old shell – it's our state fossil • F4

www.timesdispatch.com

PLUGGED IN

Accessories can color their world

the little computer wiz- d in your house, Kidz- ouse Inc. offers a selec- rightly colored accesso- ied at making computing nd more fun for young children.

UG NLEY

Adding to its signature product, a mouse designed for those ages 2 to 10, the California-based company has branched out into keyboards and headphones.

KidzMouse keyboard ithstood a pounding dealt esting consultant, a ram- us 2-year-old boy who ex- , "Oh, cool!" upon seeing e first time.

martly designed key- as 67 keys rather than the d 104. Missing are the , pause/break, Num d other keys that chil- n't need, making it easier to find the ones they do. keyboard's best feature is software that prevents hildren from getting mul- ters because they held key too long. When chil- nt and peck out c-a-t, they t c-a-ttttttttt.

arly, the KidzMouse line al pointing devices is de- o match the way a child's rks — a squeeze rather up operates the buttons. v is a mouse with a scroll lightly larger than the the $30 scroll mouse is : preteens and teens.

Mouse products are avail- omputer, discount and ores. More information nline store is available at use.com

❖ ❖ ❖

ou take the bait? Think n't get caught in the g" net of online fraud?

STANLEY, *BACK PAGE* ▶

le

■ **Jane Brody:** More fruits and vegetables could help you shed some extra pounds. **Page F3.**

diac arrest: The FDA is g people buy defibrillators ut a prescription. **F4.**

opause test: Over-the- er menopause tests raise ions about usefulness. **F4.**

esDispatch.com

me: The Explore page e Internet now includes th health coverage, reports and a library nable by health topic or rd. Check it out at TimesDispatch.com; on Health & Science Lifestyle.

Does the brain function differently, depending on the language spoken? New techniques have given researchers a means of measuring brain activity.

PHOTO ILLUSTRATION BY DEAN HOFFMEYER/TIMES-DISPATCH

Chinese characters swirl around University of Richmond psychologist Ping Li, who speaks Mandarin Chinese, English, Russian, German and a little Dutch.

Language and the brain

BY A.J. HOSTETLER
TIMES-DISPATCH STAFF WRITER

This is your brain.

This is your brain on Chinese.

Scientists who study how we think and talk say your mother tongue, or even a second language, may affect your brain.

Armed with advances in imaging techniques that show in living color areas of a working human brain, cognitive scientists are upending long-held assumptions that the brain functions the same way whether the person's native language is Chinese, Spanish or Urdu.

Over the past few years, that research has provided new insight on the nature/nurture debate, helping to deflate the notion that language is universal and rooted in the brain's structure. The brain is far more dynamic, it seems.

"The brain is probably the most complex [organ] in the universe," said University of Richmond psychologist Ping Li.

Evidence from several areas of research increasingly points to a brain that changes with experience. This less static view is of a more plastic organ that can grow new cells, recover from terrible injury or disease, and is more complicated than our most advanced computers.

"It isn't like hardware machinery that's fixed" in time, said Li. "The neat thing about us humans is we can modify it over our lifespan."

The structure of the brain is fairly well-understood. Scientists know that much of the language and speech processing occurs in the brain's left hemisphere. But how and when particular parts of the brain activate is less understood, and scientists are still trying to identify where it all happens, a process called brain mapping, and discover any underlying sense to it.

❖ ❖ ❖

Long before scientists could watch a living brain at work, linguist Noam Chomsky in the 1950s began promoting the theory that there is a biological foundation at the root of language, that language is innate and that brain structure dictates a universal grammar.

In advancing Chomsky's theory, some researchers believe this means that theories of language processing apply in like ways to all languages.

Language does have certain universal tasks, such as to give warning or to allow people to talk about the past and the future, said developmental psychologist Brian MacWhinney of Carnegie Mellon University, who sometimes collaborates with Li. Some universals are at the core of language, such as the use of modifiers like adjectives.

Yet all languages are not alike, he said. For example, in English, word order signals "who did what to whom," while in Hungarian, inflection alerts the listener to meaning.

Chinese speakers, who focus on the relationship of words, must learn that word order is critical in English, said Li, who speaks Mandarin Chinese, English, Russian, German and a little Dutch.

The English articles "the" and "a" don't exist in Chinese, said Li, who struggled to learn subject-verb agreement in English and the inflections in German verbs.

Chomsky thought such variations were at the periphery of understanding language, focusing linguistics studies on the common qualities that make up every natural language. Slowly, however, a growing number of researchers began challenging that assumption. They proposed that language variations warrant new concepts for the principles and cognitive underpinnings of different languages.

Li says he's not promoting the wholesale dumping of Chomsky's universalist theory. But cultures differ — Samoan versus British, hunter-gatherer versus high-tech. Languages vary.

Why not variation in the brain?

The average native Chinese person knows about 4,000 characters, compared to just 26 letters in the Roman alphabet, MacWhinney pointed out.

"They've got to use parts of their

SEE **BRAIN**, *PAGE* **F2** ▶

Brain

— FROM PAGE F1

brain that we [native English speakers] don't even have to worry about," he said.

❖ ❖ ❖

Chinese doesn't just look different; its speakers use sound in ways foreign to English, said linguist Joan Sereno of the University of Kansas.

Studying these differences provides insight into the brain's processing, she said.

"These kinds of differences affect the way we comprehend, the way we speak," Li said. "Such differences are really important."

The connection between variation in language and the brain's structure or function could not be fully studied in healthy, normal patients until the 1980s. Much of our understanding was limited to the study of patients with brain injuries, such as the language or speech problems caused by stroke.

The brain has three main parts: the brain stem, the cerebellum and the forebrain, which contains the two cerebral hemispheres covered by the cerebral cortex. Each hemisphere has four main surface regions: the frontal, parietal, temporal and occipital lobes.

Brain function, however, is less understood. In the left hemisphere's frontal lobe, a region called Broca's area is important in producing speech. Nearby in the temporal lobe, a region called Wernicke's area is also involved in the comprehension of language, whether spoken or read. When a word is read, researchers believe, our brain responds by processing the information in Wernicke's area as if it had been spoken.

New methods of looking inside the body changed the field of psycholinguistics, particularly magnetic resonance imaging, which reveals the brain's structure, tissue, and blood flow.

As the MRI technology developed, scientists began using a new technique to look at the living, working brain without using an invasive procedure, just after the brain has done something, MacWhinney said.

Normal subjects can be studied over and over using functional MRI or fMRI.

The technique provides both an anatomical and a functional view of the brain. It examines in seconds the changes in blood volume, flow and oxygen levels brought on by activity in certain regions of the brain. It can distinguish structures activated by a thought process such as language less than a millimeter apart.

Using fMRI, scientists take a series of images of the brain in rapid succession and then analyze the differences. Images are taken when the subject is resting to provide a baseline. Then, the subject performs a task and another set of images is taken. Areas most visible in the comparison are thought to have been activated by the activity.

"It doesn't mean it's happening [only] there, but that area is doing something a little extra," MacWhinney said.

By the late 1990s, cognitive scientists started applying fMRI to study differences in language processing and brain activity.

Aware of the inherent differences between English and Chinese, Li decided to see if they were reflected in the brain by examining two basic ingredients in language: nouns and verbs. In Chinese, there are words that are ambiguous, lacking the noun-verb distinction in English.

Among English (and to some extent, German and Italian) speakers, verbs are processed in the left frontal lobe, nouns in the posterior temporal lobe. Li wanted to know whether fMRI would show the same pattern of brain activity in Chinese speakers, volunteer students from Beijing Normal University.

Instead, the study found that nouns and verbs in Chinese activate a wide range of areas in the frontal, temporal, parietal and occipital lobes in both the left and right hemispheres. There were no significant differences among areas activated by nouns, verbs or ambiguous words.

Their brains simply function differently from English speakers, according to Li's article, published in April in NeuroImage.

❖ ❖ ❖

Other recent studies provide fodder to challenge Chomsky. An article last month in Nature concluded that Chinese children with dyslexia suffer reading difficulties similar to Western children, problems that can be traced to different parts of the brain.

The researchers, led by Hong Kong cognitive scientist Li Hai Tan, said their work using fMRI suggests that "rather than having a universal origin, the biological abnormality of impaired reading is dependent on culture."

A new British study, published in Nature earlier this month, concluded that learning a second language affects not only function, but also brain structure. English and Italians who learned a second language increased the amount of gray matter — home to the information-transmitting neurons — in their cerebral cortices.

Li's own work also suggests that the brains of bilinguals differ, that the brains of Hong Kong citizens "act" Chinese when speaking Chinese and English when speaking English.

Such linguistic juggling is fairly common, Sereno said.

"The brain can easily handle" more than one language, she said. "The question is, are there two separate representations? You're dealing with the same brain . . . so there's got to be these overlapping activations for similar processing of language."

Sereno said her research shows that childhood is a critical time period for the brain to more easily handle a second language, and that learning another language and how to process it becomes more difficult as a brain ages.

How youngsters, such as Li's own daughter, learn to speak more than one language is providing clues to researchers such as MacWhinney and Sereno for how to better teach foreign languages to adults. The National Science Foundation is funding new research at Carnegie Mellon on developing computerized methods for teaching French and Chinese, MacWhinney said.

Researchers in other fields are beginning to see how to apply these findings to their own work. At Virginia Commonwealth University, brain-injury expert Dr. David Cifu plans to team with University of Richmond's Li to find new ways of helping patients "re-learn language."

Cifu, the director of the Rehabilitation and Research Center at Medical College of Virginia Hospitals, said once he learned of Li's research, "the overlap was obvious." He now wants to see if Li's research can be applied to help determine if specific medications or therapies help certain parts of the injured brain to recover.

Over the next year, he plans to work with Li to put together a pilot study to use VCU's fMRI machines to study patients with brain injuries (such as those from a stroke) who have severe language and communication problems.

Such research may also shed light on whether particular areas of the brain are more significant to individual languages than others, or whether certain languages are more vulnerable to specific injuries, MacWhinney said.

• Contact A.J. Hostetler at (804) 649-6355 or ahostetler@timesdispatch.com