Bright Ideas

"I read the bones, and the bones tell me

Mysteries of Mummies Unraveled

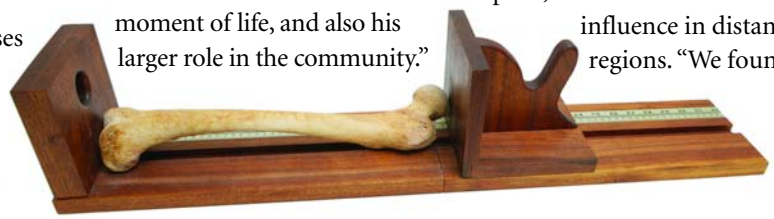
In 1994 when Tiffiny Tung was an undergraduate at the University of California–Santa Barbara, she began working in southern Peru conducting a brief archaeological survey in the region, and documented several ancient cemeteries in the Andes. "Unfortunately, a lot of the sites had been looted," remembers Tung, now an assistant professor of anthropology at Vanderbilt. "I was horrified to see this as an undergraduate. It became my goal to gather as much data as possible to recover information about these pre-Hispanic populations and to protect these sites."

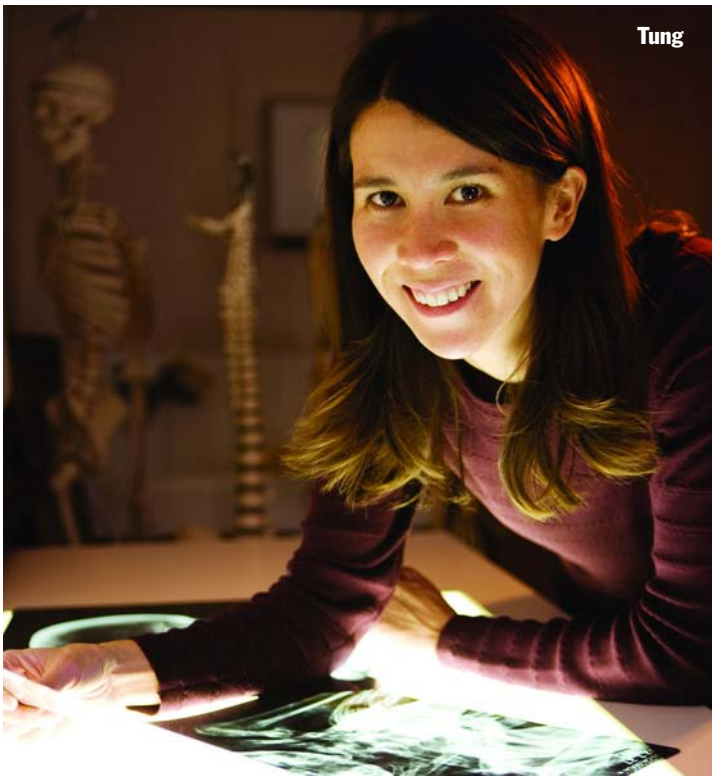
Bioarchaeologists like Tung employ a battery of scientific techniques—DNA analysis, computer tomography CAT scans, X-rays, radiocarbon dating, chemical analysis of ancient embalming fluids and strontium isotope testing—to build a detailed portrait of a person's life from his or her remains. "I read the bones, and the bones tell me a story of the individual and the community in which he or she lived," she says.

Tung's research focuses on the Wari, a warlike society that built a large empire in the Peruvian Andes from 550 to 1000 A.D. It was the largest polity in the Peruvian highlands before the Inca Empire.

One discovery at the site of Beringa in southern Peru was the mummy of a young man, wrapped in a beautiful and relatively intact feather poncho and headdress. The mummy was seated in a flexed position and wrapped in textiles, surrounded by ceramic vessels, textile bags containing peanuts and coca leaves, and a variety of weapons, including a mace and a sling for throwing stones. When Tung brought the mummy back to the lab, she noticed the textile was stained with what appeared to be blood. She continued analysis and found that the stain was near what appeared to be a stab wound. She sent a sample to scientists in Italy who can detect ancient blood proteins, and the tests came back positive for human blood.

"Judging from the wound and test results, it looked like he was stabbed in the thorax, which bled profusely onto his textile garments. He was then given an honorable burial by his community members," she says. "So from this mummy, we were able to learn about his last moment of life, and also his larger role in the community."





Tung

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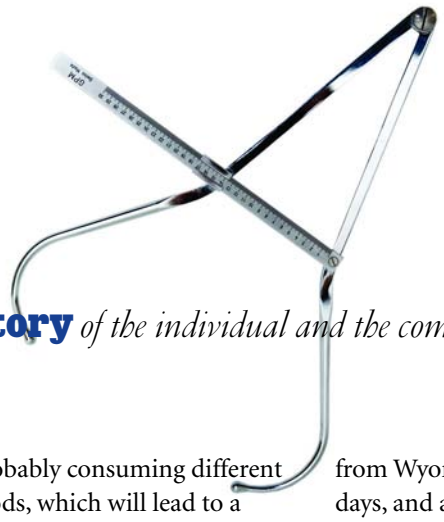
Tung's broader anthropological interests include investigating the health impact of imperial conquest on subject populations. After working extensively at a site in the core of the Wari empire in the central highland Andes, Tung became interested in settlements on the periphery of the capital and what these ancient communities could reveal about the culture and lives of those in the suburbs, so to speak, and about the Wari influence in distant regions. "We found sites with Wari ceramics and textiles 300 miles from the capital," she says. "I assembled a team and worked with the Peruvian government to get the necessary permits to start excavating cultural material and human skeletons."

Tung was particularly interested in how the Wari empire obtained and processed human "trophy heads"—heads that have been removed from their bodies, dramatically modified, and displayed in a ritualistic manner. "We wanted to know if the trophy heads represented local venerated ancestors or foreign enemies," Tung says. "If they were foreign, they were



a story *of the individual and the community.* —ANTHROPOLOGY PROFESSOR TIFFINY TUNG

probably consuming different foods, which will lead to a strontium-isotope signature distinct from the local area."

With colleague Kelly Knudson of the University of Wisconsin–Madison, Tung established the strontium-isotope signature for the core of the empire by consulting previous geological studies and testing local animals found there today. By comparing this local signature to that of the trophy heads, they were able to determine that some of the trophy heads likely came from foreign victims. In addition, the artwork on the ceramics found with the heads displayed warriors carrying trophy heads. Both pieces of evidence led Tung and her colleague to suggest that these trophy heads were taken from enemies of the Wari empire.

Tung's work drew the interest of the Discovery Channel when it was putting together a team of bioarchaeologists and forensic anthropologists to study mummies around the globe for the network's series "Mummy Autopsy," which aired last spring.

Over the course of filming, Tung traveled to seven countries. The cases examined included a male and female mummy from southern Peru that may have been victims of the war between Peru and Chile in the early 1880s, a skeleton from Wyoming's Wild West days, and a Romano-British family that may have died a violent death at the hands of invading Anglo-Saxons.

"One of my goals is to bring anthropology and archaeology to the public, which is one of the reasons I agreed to do the show," she says.

Technique Produces Bone Tissue on Demand

2. An international team of biomedical engineers led by Vanderbilt's V. Prasad Shastri has demonstrated it is possible to grow healthy new bone reliably in one part of the body and use it to repair damaged bone elsewhere.

"We have shown that we can grow predictable volumes of bone on demand," says Shastri, assistant professor of biomedical engineering, "and we did so by persuading the body to do what it already knows how to do."

The research, a dramatic departure from current practice in tissue engineering, is described in "*In Vivo* Engineering of Organs: The Bone Bioreactor," published online by the *Proceedings of the National Academy of Sciences*.

Orthopedic surgeons now repair serious bone breaks by removing small pieces of bone from a patient's rib or hip and fusing them to the broken bone. The same method is used to fuse spinal vertebrae to treat serious spinal injuries and back pain. The method works, but the removal operation is extremely painful and there is risk of serious complications.

If the new method is confirmed in clinical studies, new bone can be grown for all types of repairs. For people with serious bone disease, it may be possible to grow replacement bone at an early stage and freeze it so it can be used when needed, Shastri says.

Living bone is continually growing and reshaping, but numerous attempts to coax bone to grow outside the body—*in vitro*—have failed. Recent attempts to stimulate bone growth within the body—*in vivo*—have had limited success but have proven to be complex, expensive and unreliable.

Shastri and his colleagues took a new, simple approach. They took advantage of the body's natural wound-healing response by creating a special zone on the surface of a healthy bone in hopes that the body would respond by filling the space with new bone. The approach lived up to their highest expectations.

Working with mature rabbits, a species with bones very similar to humans, researchers were delighted to find that this zone, which they call the »

"*in vivo* bioreactor," filled with healthy bone in about six weeks. And it did so without having to coax the bone to grow by applying the growth factors required by previous *in vivo* efforts. Furthermore, they found that the new bone can be detached easily before it fuses with the old bone, leaving the old bone scarred but intact.

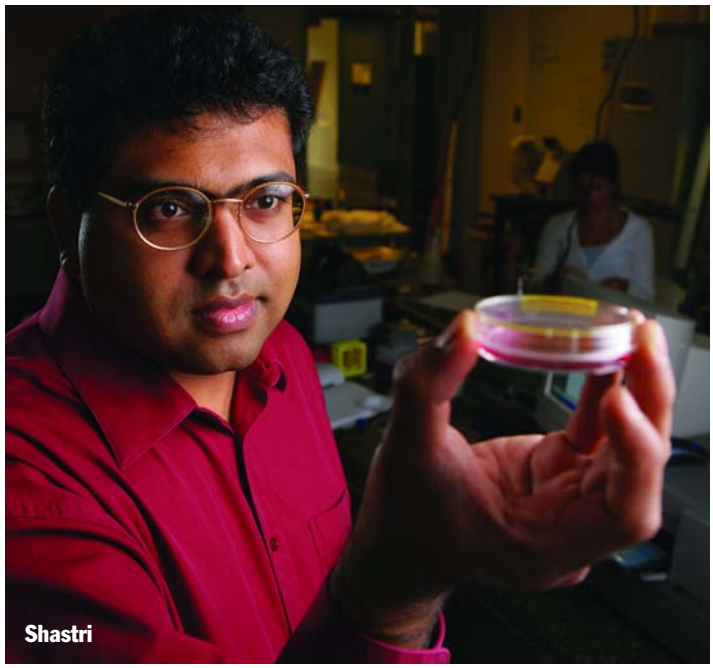
"The new bone actually has comparable strength and mechanical properties to native bone," says Molly Stevens, currently a reader at Imperial College in the United Kingdom who did most of the research as a post-doctoral fellow at MIT. "And since the harvested bone is fresh, it integrates really well at a recipient site."

Long bones in the body are covered by a thin outer layer called the periosteum. The outside is tough and fibrous, but the inside is covered with a layer of special pluripotent cells which, like marrow cells, are capable of transforming into the different types of skeletal tissue.

Shastri and collaborators created a bioreactor zone just under this outer layer. They made a tiny hole in the periosteum and injected saline water underneath. This loosened the layer from the underlying bone and inflated it slightly. When they had created a cavity the size and shape they wanted, the researchers removed the water and replaced it with a gel containing calcium, a trigger for bone growth. Their major concern was that the bioreactor would fill with scar tissue instead of bone, but that didn't happen. Instead, it filled with bone that is indistinguishable from the original.

The scientists intend to proceed with large-animal studies and clinical trials necessary to determine if the procedure will work in humans and, if it does, to get it approved for human treatment. At the same time, they hope to test the approach with the liver and pancreas, which have outer layers similar to the periosteum.

The research was funded by a grant from Smith and Nephew, Endoscopy.



Shastri

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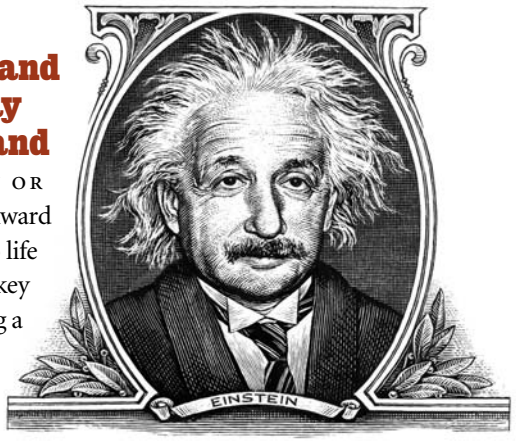
3. Odd Behavior and Creativity May Go Hand in Hand



ANTAR DAYAL / GETTY IMAGES

A quirky or socially awkward approach to life may be the key to becoming a great artist, composer or inventor.

New research on individuals with schizotypal personalities—people characterized by odd behavior and language who are not psychotic or schizophrenic—offers the first neurological evidence that these individuals are more creative than normal or fully schizophrenic people and rely more heavily on the right sides of their brains than the general population to access their creativity.

The research by Vanderbilt psychologists Brad Folley and Sohee Park was published online Aug. 26 by the journal *Schizophrenia Research*.

Famous creative luminaries believed to have had schizotypal personalities include Vincent Van Gogh, Albert Einstein, Emily Dickinson and Sir Isaac Newton.

"The idea that schizotypes have enhanced creativity has been out there for a long time, but no one has investigated the behavioral manifestations and their neural correlates experimentally," Folley says. "Our paper is unique because we investigated the creative process experimentally, and we also looked at the blood flow in the brain while research subjects were undergoing creative tasks."

Folley and Park conducted two experiments to compare the creative-thinking processes of schizotypes, schizophrenics and normal control subjects. In the first experiment the research subjects were shown a variety of household objects and asked to invent new functions for them. The results showed that the schizotypes were better able to creatively suggest new uses for the objects, while the schizophrenics and average subjects performed similarly to one another.

"Thought processes for individuals with schizophrenia often are very disorganized, almost to the point where they can't really be creative because they cannot get all their thoughts coherent enough to do that," says Folley. "Schizotypes, on the other hand, are free from the severe, debilitating symptoms surrounding schizophrenia and also have an enhanced creative ability."

In the second experiment the three groups again were asked to identify new uses for everyday objects, as well as to perform a basic control task while the activity in their prefrontal lobes was monitored using a brain-scanning technique called near-infrared optical spectroscopy. The brain scans showed that all groups used both brain hemispheres for creative tasks, but the activation of the right hemispheres of the schizotypes' brains was dramatically greater than that of the schizophrenic and average sub-

jects' brains, suggesting a positive benefit of schizotypy.

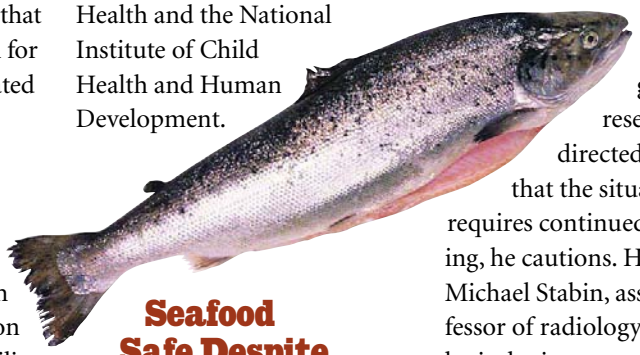
"In the scientific community the popular idea that creativity exists in the right side of the brain is thought to be ridiculous, because you need both hemispheres of your brain to make novel associations and to perform other creative tasks," Folley says. "We found that all three groups—schizotypes, schizophrenics and normal controls—did use both hemispheres when performing creative tasks. But the brain scans of the schizotypes showed a hugely increased activation of the right hemisphere compared to the schizophrenics and the normal controls."

The researchers believe that the results offer support for the idea that schizotypes and other psychoses-prone populations draw on the left and right sides of their brains differently than the average population, and that this bilateral use of the brain for a variety of tasks may be related to their enhanced creativity.

In support of this theory, Folley points to research by Swiss neuroscientist Peter Brugger, who found that everyday associations—such as recognizing your car key on your keychain and verbal abilities—are controlled by the left hemisphere, and novel associations—such as finding a new use for an object or navigating a new place—are controlled by the right hemisphere. Brugger hypothesizes that schizotypes are better at accessing both hemispheres for novel associations, enabling them to make these associations faster. His theory is supported by research showing that a disproportional number of schizotypes and schizophrenics are neither right- nor left-hand dominant, but instead use both hands for a variety of tasks, suggesting they recruit both sides of their brains for a variety of tasks more so than the average person.

"The lack of specialization for certain tasks in brain hemispheres could be seen as a liability, but this increased communication between the hemispheres actually could provide added creativity," Folley says.

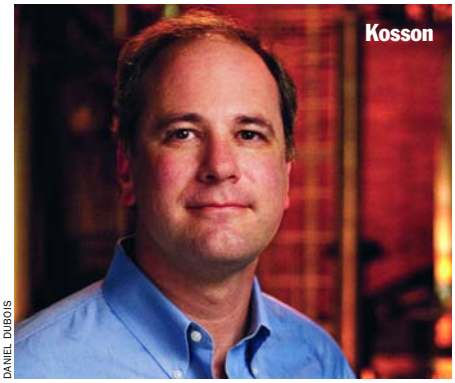
Folley is in the process of completing his dissertation at Vanderbilt and is pursuing a clinical internship and research at the University of California in Los Angeles. Park is an associate professor of psychology and an investigator in the Vanderbilt Kennedy Center for Research on Human Development. The research was supported by grants from the National Institute of Mental Health and the National Institute of Child Health and Human Development.



Seafood Safe Despite Nuclear Tests

Seafood from water near the Aleutian Islands in Alaska is not significantly contaminated by radiation despite underground nuclear tests done in the area at Amchitka Island between 1965 and 1971. The news was released Aug. 1 by a study group that includes two Vanderbilt researchers.

"The results are very reassuring, not only because approximately one-third of the fish sold commercially in the U.S. comes from the broader marine region affected by the area we studied, but because our evidence showed no indications of damage to the ecosystem in the area," says David S. Kosson, chair of the Department of Civil and Environmental Engineering.


Kosson

DANIEL DUBOIS

Kosson directed geophysical research for the independent study, which was commissioned by the U.S. Department of Energy along with the State of Alaska, the U.S. Fish and Wildlife Service, and the Aleutian/Pribilof Islands Association. The research was planned and conducted by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP), an independent university consortium.

The geophysical research Kosson directed suggests that the situation requires continued monitoring, he cautions. He and Michael Stabin, assistant professor of radiology and radiological sciences, conducted much of the laboratory analysis, which revealed that the levels of radionuclides in the area are presently far below any human health food-safety standard. Radionuclides are atoms that emit radiation and can accumulate in the muscle tissue and bones.

"Our remote-sensing studies of the island's rock substructure show that any nuclear material from the nuclear test-shot cavities will actually take longer to travel through the substructure than we anticipated," Kasson says. "That means that the area should continue to be monitored well into the future."

Kosson and Stabin, working with graduate student Derek Favret and research staff member Rossane Delapp, spent a good part of the past year in their Vanderbilt laboratory evaluating samples from Alaska for the presence of radionuclides.

A significant challenge of the research was to analyze samples for a sufficiently long period of time to determine what levels of radionuclides were present, since some degree of radioactivity is always present. Researchers then had to determine whether the radionuclides resulted from the nuclear tests or perhaps came from fallout or naturally occurring sources.

"I am excited by the fact that we were able, within the very short single season of work, to add so significantly to the geophysical understanding of Amchitka and its marine department," Kosson says.

In addition to Vanderbilt, researchers participating in the study came from Rutgers University, the University of Alaska, the University of Alberta, the University of Medicine and Dentistry of New Jersey, the University of Pittsburgh, and the University of Washington.