



Update

October 2008



RESEARCH NEWS

Study refutes Darwinian male dominance theory



A Dani tribesman in West Papua with a mummified male ancestor.

Socially and culturally dominant men in many cultures tend to have more children than average. Scientists have thus surmised that male dominance is a trait subject to strong Darwinian selection. But a new study of several Indonesian communities casts doubt on this notion.

"We found no evidence for strong selection for male dominance," says SFI Professor

Steve Lansing, the study's lead author. "Dominant males do not produce more offspring than other men for long enough to have any evolutionary significance."

The study, "Male dominance rarely skews the frequency distribution of Y chromosome haplotypes in human populations," appeared in the Aug. 19 issue of PNAS (Proceedings of the National Academy of Sciences).

Steve's collaborators include Joseph Watkins, Brian Hallmark, SFI Postdoctoral Fellow Murray Cox, Tatiana Karafet, and Michael Hammer, all from the University of Arizona; and Herawati Sudoyo from the Eijkman Institute for Molecular Biology in Indonesia.

Conventional wisdom holds that social dominance produces fitness effects that [> more on page 3](#)

RESEARCH NEWS

How many politicians do we really need?

SFI External Professor Stefan Thurner has some advice on how to dislodge the logjam in Washington: Keep decisions to a few people.

Stefan, the head of the Complex Systems Research Group of the Medical University of Vienna, has developed a mathematical model that shows that the efficiency of any governing body such as a board or cabinet starts to break down as its membership surpasses 20 people.

In the 1950s, British historian C. Northcote Parkinson studied the British navy and noted that as its bureaucracy got larger, it became less efficient. Stefan decided to put Parkinson's ideas to the test.

He and his colleagues figured that each member of a decision-making group can

influence the decisions of a certain number of others. They also assumed that the decision-makers will indeed feel the influence of their colleagues, so that if some threshold percentage of their colleagues share an opinion, they'll join in.

Beyond around 20 members, they found, the decision-makers increasingly form factions, almost never coming to agreement. The analysis applies to groups that need to make unanimous decisions, not groups that vote.

Stefan himself isn't willing to go so far as



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RESEARCH NEWS

Sustainability science defined

Populations are on the rise. The climate is changing. Biodiversity is waning. Humanity faces an increasing challenge in learning to live sustainably. As a result, a new interdisciplinary field of sustainability science is emerging.

But what exactly is "sustainability science"? What fields does it draw from?

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RESEARCH NEWS

Science and foreign policy converge

Just as researchers in economics and physics have found common ground in recent years, so might experts in international relations and physics.

Although far from being a consensus, that's the initial but optimistic thinking of a small group of participants in a late-August working group at SFI meant to explore international relations as a complex adaptive system. (*SFI Update*, August issue)

The event, "International Affairs and Complexity," involved 15 invited experts from the two seemingly disparate fields. SFI Science Board Co-chair Simon Levin co-organized the meeting with Joshua Cooper Ramo, Managing Director of Kissinger Associates, SFI Professor Doug Erwin, and SFI President and Distinguished Professor Geoffrey West.

Simon opened the event with a primer on complexity science, outlining key concepts — such as individual behaviors combining to form collective behaviors, phase shifts, and scaling laws — and suggested ways they might apply to international relations. The concept of path dependence, for example, might help explain how early policy decisions constrain later choices and lead to outcomes unwanted by all, he said.

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LIT BITS

Hierarchical structure and the prediction of missing links in networks; **Clauset, Aaron [SFI Postdoctoral Fellow]; Moore, Cris [SFI Professor]; Newman, Mark [SFI External Professor];** *Nature* 453, May 1, 2008, pp. 98-101

Hierarchical self-organization in the finitary process soup; Gomerup, O.; **Crutchfield, Jim [SFI External Professor];** *Artificial Life* 14 (3), Summer 2008, pp. 245-254

Computation in finitary stochastic and quantum processes; Wiesner, K.; **Crutchfield, Jim [SFI External Professor];** *Physica D-Nonlinear Phenomena* 237 (9), July 1, 2008, pp. 1173-1195

On a representation of the inverse F-q-transform; Umarov, S.; **Tsallis, Constantino [SFI External Professor];** *Physics Letters A* 372 (29), July 7, 2008, pp. 4874-4876

Exhaustive identification of steady state cycles in large stoichiometric networks; Wright, J.; **Wagner, Andreas [SFI External Professor];** *BMC Systems Biology* 2, July 11, 2008, pp. 1-9

The amphioxus Hox cluster: Characterization, comparative genomics, and evolution; Amemiya, C.T.; Prohaska, S.J.; Hill-Force, A.; Cook, A.; Waserscheid, J.; Ferrier, D.E.K.; Pascual-Anaya, J.; Garcia-Fernandez, J.; Dewar, K.; **Stadler, Peter [SFI External Professor];** *Journal of Experimental Zoology Part B-Molecular and Developmental Evolution* 310B (5), July 15, 2008, pp. 465-477

Web-based design and evaluation of T-cell vaccine candidates; Thurmond, J.; Yoon, H.; Kuiken, C.; Yusim, K.; Perkins, S.; Theiler, J.; **Bhattacharya, Tanmoy [SFI Professor]; Korber, Bette [SFI External Professor];** *Bioinformatics* 24 (14), July 15, 2008, pp. 1639-1640

The evolution and distribution of species body size; **Clauset, Aaron [SFI Postdoctoral Fellow]; Erwin, Doug [SFI Professor];** *Science* 321 (5887), July 18, 2008, pp. 399-401

Protein robustness promotes evolutionary innovations on large evolutionary time-scales; Ferrada, E.; **Wagner, Andreas [SFI External Professor];** *Proceedings of the Royal Society B-Biological Sciences* 275 (1643), July 22, 2008, pp. 1595-1602

A centralized gene-based HIV-1 vaccine elicits broad cross-clade cellular immune responses in rhesus monkeys; Santra, S.; **Korber, Bette [SFI External Professor];** Muldoon, M.; Barouch, D.H.; Nabel, G.J.; Gao, F.; Hahn, B.H.; Haynes, B.F.; Letvin, N.L.; *Proceedings of the National Academy of Sciences of the United States of America* 105 (30), July 29, 2008, pp. 10489-10494

A simple spin glass perspective on martensitic shape-memory alloys; **Sherrington, David [SFI External Professor];** *Journal of Physics-Condensed Matter* 20 (30), July 30, 2008, pp. 116-120

What is man ...; **Gintis, Herbert [SFI External Professor];** *Commentary* 126 (1), July-August 2008, pp. 4-6

Social preferences and public economics: Mechanism design when social preferences depend on incentives; **Bowles, Sam [SFI Professor];** Hwang, S.H.; *Journal of Public Economics* 92 (8-9), August 2008, pp. 1811-1820

Genes; Prohaska, S.J.; **Stadler, Peter [SFI External Professor];** *Theory in Biosciences* 127 (3), August 2008, pp. 215-221

> Sustainability science continued from page 1

What are the questions and problems it addresses? Who are the players?

The National Science Foundation needs more information about the field to most effectively support its development. SFI External Professor Luis Bettencourt (Los Alamos National Laboratory) and Katy Borner (Indiana University) have won a two-year, \$100,000 grant from the NSF to better understand the field.

Sustainability science is unusual in that it is bound together by its goals rather than its methods, says Luis, and it draws together fields as diverse as agriculture, ecology, oceanography, climate, economics, many social sciences, energy, and several aspects of physics and chemistry.

"It becomes an interesting problem as to how all these different points of view can come together," he says.

Luis is working on a "science of science" – the structure and evolution of scientific fields. He published a paper in June in *Scientometrics* showing that scientific ideas spread in much the same way a contagion does.

Borner specializes in the cartography of science. Together the two will study the growth and relationships of papers and patents in the realm of sustainability science and will create maps showing how the disciplines are related and how the development of the field is progressing. ■

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RESEARCH NEWS

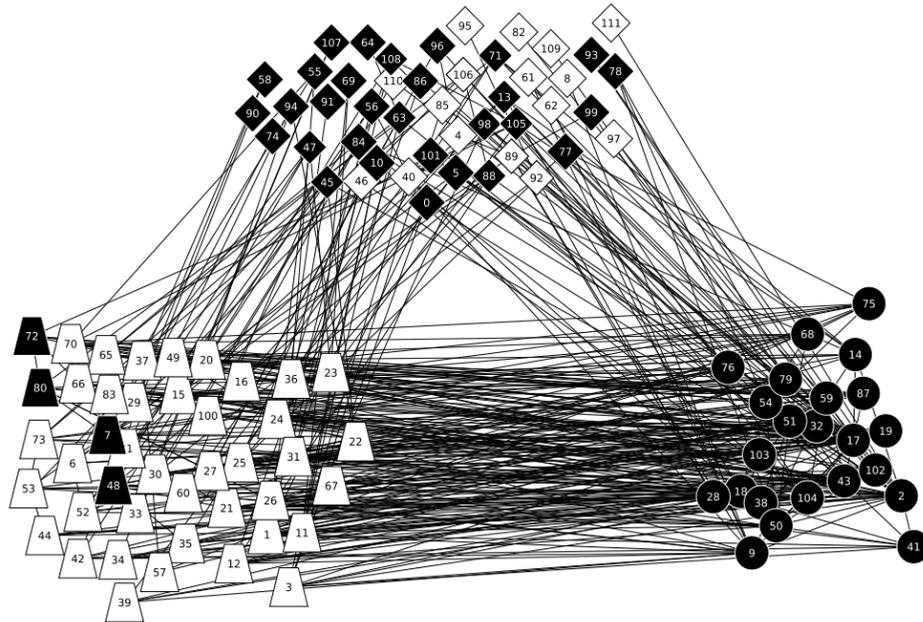
Understanding networks through machine learning

Networks have two great virtues: They can describe interactions between lots of objects, and those objects can be different. No classical theory meets both of those challenges.

But merely describing something as a network doesn't gain you much. Plot almost any complex network and you'll end up with

(University of Michigan) have been applying machine learning tools to networks, with powerful results.

For example, Cris's student Tiffany Pierce studied the network formed by all the words in the novel *David Copperfield*, with two words being connected if they appear next to each other.



A computer algorithm automatically sorted the words from *David Copperfield* into three categories. (Image: Cris Moore and Tiffany Pierce)

something that looks like a plate of spaghetti. Realizing the potential of network theory requires building new tools to sort that spaghetti.

Three SFI researchers have won a three-year, \$417,000 grant from the James S. McDonnell Foundation to attempt to do just that.

The best way to understand networks, the collaborators have found, is to get computers to figure out the networks for themselves. SFI Professor Cris Moore (University of New Mexico), Postdoctoral Fellow Aaron Clauset, and External Professor Mark Newman

"We told the computer, go and find an explanation of this network in terms of three types of vertices," Cris says. "We didn't tell it anything else."

The machine learning algorithms managed to sort them into nouns, adjectives, and words like "light" that can play both roles.

Now the team wants to extend its work to more complicated situations, for example when the edges connecting nodes are of varying types, or where their locations play a crucial role in how they connect. ■

> Science and foreign policy continued from page 1

He noted that the world is increasingly complex due to a rise in the number of actors and intentions, combined with a new degree of world interconnectedness. U.S.-China relations, for example, cannot be conceptualized without an understanding of U.S.-Russia and China-Russia relations, or without an understanding of world energy, economic growth, and security issues.

What this implies, he says, is that the existing tools of international relations, which tend to treat problems more linearly as sets of inputs and outputs or that define stability narrowly as prevention of conflict, are not sufficient to address today's world problems.

Ramo addressed the group from the international relations (IR) perspective, describing a half-dozen widely accepted theories in foreign policy that guide decision makers. Although a few participants from the science side found some of the IR principles – such as the notion that democracies don't fight each other – too anecdotal for scientific purposes, they found others to be a natural fit with complexity principles. The expectation that a nation's foreign policy is largely determined by domestic concerns, for example, could potentially be addressed through scaling analysis.

Participants had an insightful discussion about the meaning of stability in IR and found potential common ground in the idea of system robustness, says Simon.

"As we listened to the different viewpoints, it became clear that in international relations, you really can't view any one issue by itself," he says. "Any decision you make is coupled to other decisions and issues. All together, the multitude of actors, issues, and intentions are part of a highly complex system."

"I think we'll move forward on various fronts," he says. A lively post-working group email discussion is under way, as is planning for follow-up collaborations.

Simon already has visited Stockholm to discuss a similar meeting in 2009 to be hosted by the Tallberg Foundation (www.tallbergfoundation.org/).

Ultimately, he hopes, such collaborations will suggest promising methodologies for guiding foreign policy decisions. ■



PEOPLE

Josh West and Great Britain rowing team take silver in Beijing

Institute President and Distinguished Professor Geoffrey West (back) celebrates with son Josh (center), wife Jacqueline (left), and daughter Devorah after Josh won a silver medal in eight-man rowing during the 2008 Summer Olympic Games in Beijing. To win the silver, Great Britain surpassed strong teams from the United States and China. Canada took the Gold. Josh is a two-time Olympian. ■

LIT BITS (continued)

HLA-DRBI*0401 and HLA-DRBI*0408 are strongly associated with the development of antibodies against interferon-beta therapy in multiple sclerosis; Hoffmann, S.; Cepok, S.; Grummel, V.; Lehmann-Horn, K.; Hackermueller, J.; **Stadler, Peter [SFI External Professor]**; Hartung, H.P.; Berthele, A.; Deisenhammer, F.; Wasmuth, R.; Hemmer, B.; *American Journal of Human Genetics* 83 (2), Aug. 8, 2008, pp. 219-227

Microbes on mountainsides: Contrasting elevational patterns of bacterial and plant diversity; Bryant, J.A.; Lamanna, C.; Morlon, H.; Kerkhoff, A.J.; **Enquist, Brian [SFI External Professor]**; Green, J.L.; *Proceedings of the National Academy of Sciences of the United States of America* 105, Aug. 12, 2008, pp. 11505-11511

Extinction as the loss of evolutionary history; **Erwin, Doug [SFI Professor]**; *Proceedings of the National Academy of Sciences of the United States of America* 105, Aug. 12, 2008, pp. 11520-11527

Inapparent infections and cholera dynamics; King, A.A.; Ionides, E.L.; **Pascual, Mercedes [SFI External Professor]**; Bouma, M.J.; *Nature* 454 (7206), Aug. 14, 2008, p. 877

Male dominance rarely skews the frequency distribution of Y chromosome haplotypes in human populations; **Lansing, Steve [SFI Professor]**; Watkins, J.C.; Hallmark, B.; **Cox, Murray [SFI Postdoctoral Fellow]**; Karafet, T.M.; Sudoyo, H.; Hammer, M.F.; *Proceedings of the National Academy of Sciences of the United States of America* 105 (33), Aug. 19, 2008, pp. 11645-11650

Cancer stem cells as the engine of unstable tumor progression; **Solé, Ricard [SFI External Professor]**; Rodriguez-Caso, C.; Deisboeck, T.S.; Saldana, J.; *Journal of Theoretical Biology* 253 (4), Aug. 21, 2008, pp. 629-637

Guesstimation: Solving the world's problems on the back of a cocktail napkin; Weinstein, L.; Adam, J.A.; **Mertens, Stephan [SFI External Professor]**; *Science* 321 (5893), Aug. 29, 2008, p. 1160

Arthropod 7SK RNA; Gruber, A.R.; Kilgus, C.; Mosig, A.; Hofacker, I.L.; Hennig, W.; **Stadler, Peter [SFI External Professor]**; *Molecular Biology and Evolution* 25 (9), September 2008, pp. 1923-1930

Biology's gift to a complex world; **Holland, John [SFI External Professor]** *Scientist* 22 (9), September 2008, pp. 36-43

Robust hypothesis tests for independence in community assembly; **Ladau, Joshua [SFI Postdoctoral Fellow]**; Schwager, S.J.; *Journal of Mathematical Biology* 57 (4), October 2008, pp. 537-555

Mesa Verde migrations; **Kohler, Timothy [SFI External Professor]**; Varien, M.; Wright, A.; Kuckelman, K.; *American Scientist*, 2008 (Vol. 96), pp. 146-153

Maps of random walks on complex networks reveal community structure; Rosvall, M.; **Bergstrom, Carl [SFI External Professor]**; *Proceedings of the National Academy of Sciences of the United States of America* 105 (4), 2008, pp. 1118-1123

Mathematical estimates of recovery after loss of activity: Long-range connectivity facilitates rapid functional recovery; Hubler, M.J.; **Buchman, Timothy [SFI External Professor]**; *Critical Care Medicine* 36 (2), 2008, pp. 489-494

INSIDE SFI

Institute presidential search under way

SFI's Executive Committee, with input from the Board of Trustees and the broader Institute community, is beginning its search to replace SFI President Geoffrey West, who announced in April that he plans to step down in late 2009.

Details about the search process were described in a Sept. 11 letter from SFI Board of Trustees Chair Bill Miller.

Two committees will work in concert to identify a new President. The Search Advisory Committee (SAC), comprising six representatives from the SFI community, will define search criteria, vet candidates, and recommend top candidates to the Decision Committee.

The SAC is chaired by SFI External Professor Chuck Stevens, a 20-year Institute veteran and member of the Institute's Science Board and Science Steering Committee. He is Professor and Vincent J. Coates Chair in molecular neurobiology at the Salk Institute.

Search Advisory Committee members include SFI Science Board and Science Steering Committee member John Geanakoplos (Yale University); Science Board Co-Chair and Ex-Officio Trustee Simon Levin (Princeton University); SFI Director of Education and Outreach Ginger Richardson; SFI Board of Trustees Vice-Chair Jim Rutt (Proteus Foundation); and SFI Professor Jon Wilkins.

Says Chuck: "SFI is in good shape, but we need an outstanding leader to continue what Geoffrey has accomplished. I hope we can do as well as the last search committee."

The Decision Committee, to be chaired by Bill Miller, will include the Board of Trustees Executive Committee plus one representative of SFI's scientific community, yet to be selected.

In his letter, Bill asked the SFI community for input. "Finding an effective successor to be our President is no simple matter," he wrote. "Each of you has a network of colleagues and friends who may be appropriate candidates or could help in recommending appropriate candidates; indeed some of you may be interested in taking the helm at SFI. Chuck and his SAC will be communicating with the SFI community to solicit input, and I want to also encourage direct suggestions at any point to me."

Suggestions and other communications to the Search Advisory Committee may be submitted by email to presidentialexec@sanatafe.edu. ■



Meryanne Tumonggor (left), a graduate student in anthropology at the University of Arizona, interviews two men in the origin village of Wunga on the island of Sumba in eastern Indonesia.

> **Dominance theory** continued from page 1

are subject to cultural selection. If such evolutionary effects really existed, Steve and his collaborators argued, they would skew the distribution of paternally-transmitted genetic markers in a population.

Using this principle, the researchers studied a sample of 1,269 men from a wide range of Indonesian communities that included hunter-gatherers, rice farmers, horticulturalists, and others. Surprisingly, in 36 of the 41 populations studied, the distribution of genetic markers showed no evidence of the long-term evolutionary impact of male dominance.

Evidence from the remaining five communities was inconclusive.

"We conclude that heritable traits or behaviors that are passed paternally, be they genetic or cultural, are unlikely to be under strong selection," Steve says. ■

PEOPLE

New SFI International Fellow Somdatta Sinha

A widely traveled childhood free of the social norms of any one place, along with teenage years growing up in Santiniketan, India, a center renowned for its artistic and literary environment and value of knowledge, set the tone for the future interests and work of Somdatta

Sinha, SFI's newest International Fellow.

"Reading about scientists like the Curies, who dedicated their lives to solving scientific problems despite many obstacles, inspired me greatly," she says.

endless robust elaboration of all these over and over in time," she says.

That led to her diversion from pure physics to join a new course in Theoretical and Environmental Sciences at Jawaharlal Nehru University in New Delhi, marking her first step toward the interface between physics and biology – now her chosen field.

"I find SFI a great place to defocus from a single line of thinking, as I like to hear and discuss the ways systems work across disciplines – biological, social, economic, and financial," she says.

"I have worked in different areas in biology – intracellular processes, collective behavior of cells, ecological and epidemiological systems – using different theoretical formalisms such as networks and differential and discrete equations – and have found the ideas discussed at SFI always influencing my thoughts and work." ■



Pursuing advanced studies in physics in the 1970s and '80s, Somdatta says she came across many physicists wondering how nature weaves such beautiful patterns.

"I looked around and saw the shapes and arrangements of the leaves and flowers, the symmetry in the body plan of organisms, and above all the

Mertens, Moore book to explore the nature of computation

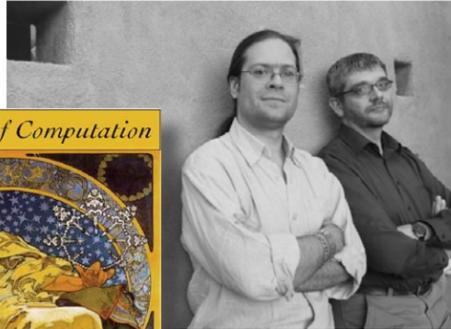
SFI Professor Cris Moore and External Professor Stephan Mertens are collaborating on a book, *The Nature of Computation*, to explore what makes a computational problem difficult, how one can prove it is difficult, and what mathematical tricks might be available to solve it. It is to be published in 2009 by Oxford University Press.

The 770-page book is an introduction to the fundamental concepts of computational complexity. Cris and Stephan go beyond the usual discussion of P, NP, and NP-completeness to explore the deeper meaning of the P vs. NP question, with discussion of parallel computation, randomized algorithms, and higher complexity classes. Hot areas of collaboration

across disciplines, such as phase transitions and quantum computing, are presented as well.

Cris says the book is written in an informal style that provides depth with a minimum of mathematical formalism, exposing core concepts rather than belaboring technical details. He says it is intended to be accessible to graduate students and advanced undergrads.

"Anyone with some knowledge of linear algebra, complex numbers, and Fourier analysis will be able to understand it,



Cris Moore (left) and Stephan Mertens

and most chapters can be understood without even these," he says. "It is for

anyone interested in understanding the rapidly changing field of theoretical computer science and its relationship with other sciences."

Much of the recent research presented has not appeared in textbooks before, he says.

More information at <http://www.nature-of-computation.org/>.

Cris, a part-time SFI Professor, is a professor in the Computer Science Department at the University of New Mexico; he has a joint appointment in UNM's Physics and Astronomy Department. Stephan is an assistant professor at the Institute of Theoretical Physics, Otto von Guericke University of Magdeburg, Germany. ■

PEOPLE

Efferson leaves SFI for Sweden

SFI Postdoctoral Fellow Charles Efferson's last day at the Institute was Aug. 27. He is now an assistant professor at the Institute for Empirical Research in Economics at the University of Zurich, where he plans to do experimental work on social learning, in-group favoritism, inter-temporal choice, and belief formation. ■



SFI IN THE NEWS

The John S. and James L. Knight Foundation awarded this year's \$10,000 Grand Prize in the Knight-Batten Awards for Innovations in Journalism to Wired.com's WikiScanner coverage. WikiScanner, developed by SFI Visiting Researcher Virgil Griffith, is a search tool that uses publicly available records of IP address ownership to trace Wikipedia edits to the institutions doing the editing, essentially holding Wikipedia editors accountable for their changes (*SFI Update*, October 2007). Wired.com invited readers to use the new technology to track anonymous edits back to their originators. Their reports, on the site's "Threat Level" blog, "insert an air of accountability to those who edit Wikipedia to fit their own agendas," the judges said. www.knightfoundation.org/programs/national/news/news_release_detail.dot?id=336093

SFI Postdoctoral Fellow Michael Gastner appeared in the Sept. 11 issue of *The Economist*: "Hyejin Youn and Hawoong Jeong, of the Korea Advanced Institute of Science and Technology, and Michael Gastner, of the Santa Fe Institute,

analysed the effects of drivers taking different routes on journeys in Boston, New York, and London. Their study, to be published in a forthcoming edition of *Physical Review Letters*, found that when individual drivers each try to choose the quickest route it can cause delays for others and even increase hold-ups in the entire road network." www.economist.com/science/displaystory.cfm?story_id=12202559

The Aug. 18 *New York Times* includes a Q&A interview with SFI Science Steering Committee member Nina Fedoroff, who is the Science and Technology Advisor to the U.S. Secretary of State. To the question "why can science create cooperation in places where everything else fails," Nina replied: "Because science is more collaborative than other types of endeavors. It aspires to more democratic principles than many political systems because we have an external reference. People can have different theories, but we form an experiment to test it. It's the evidence that matters. So in science, we can have differences of opinion, but we

can't have two sets of facts. There is an in-built process that says, 'You and I may have different religions, different politics, but we can talk about science across chasms.'" www.nytimes.com/2008/08/19/science/19conv.html

The Sept. 8 *Tucson Citizen* includes a feature of SFI External Professor John Pepper, who in 2002 had emergency brain surgery to repair damage caused by a stroke. "The Santa Fe Institute volunteered to extend Pepper's contract so he would have medical coverage, and faculty and staff donated sick time and vacation hours so his salary could continue. Pepper spent about four months in Colorado, returning to Tucson once to have [part of] his skull — which was still in a freezer at Northwest Medical Center — reattached. During that time, he went from wheelchair to walker to walking with a cane... He considers himself 'close to 90 percent back' to normal. [Says Pepper's daughter Delia:] 'He does stuff with part of his brain gone that most normal people can't do with a whole brain.'" www.tucsoncitizen.com/daily/local/96034.php



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