

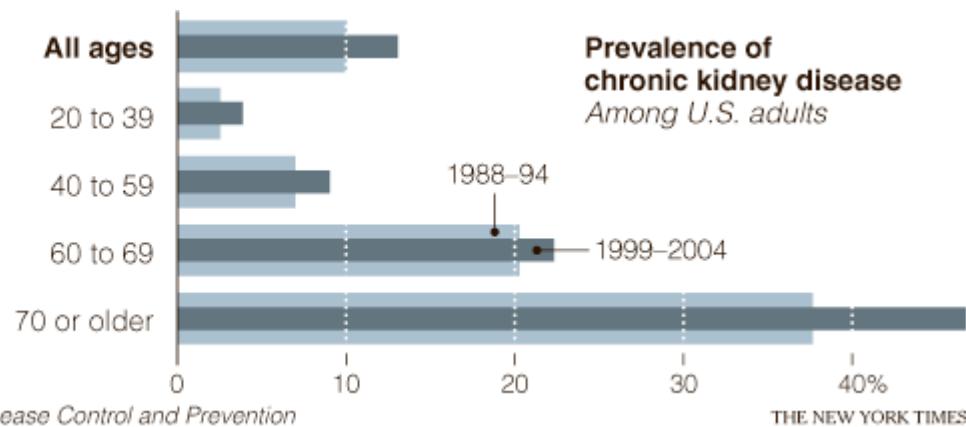
Bar Charts

- Workhorse
- Many variants
- Good for comparing a few items
- Good for revealing patterns in what are essentially tables
- Common mistakes involve:
 - Zero-basing
 - Thoughtful ordering of items

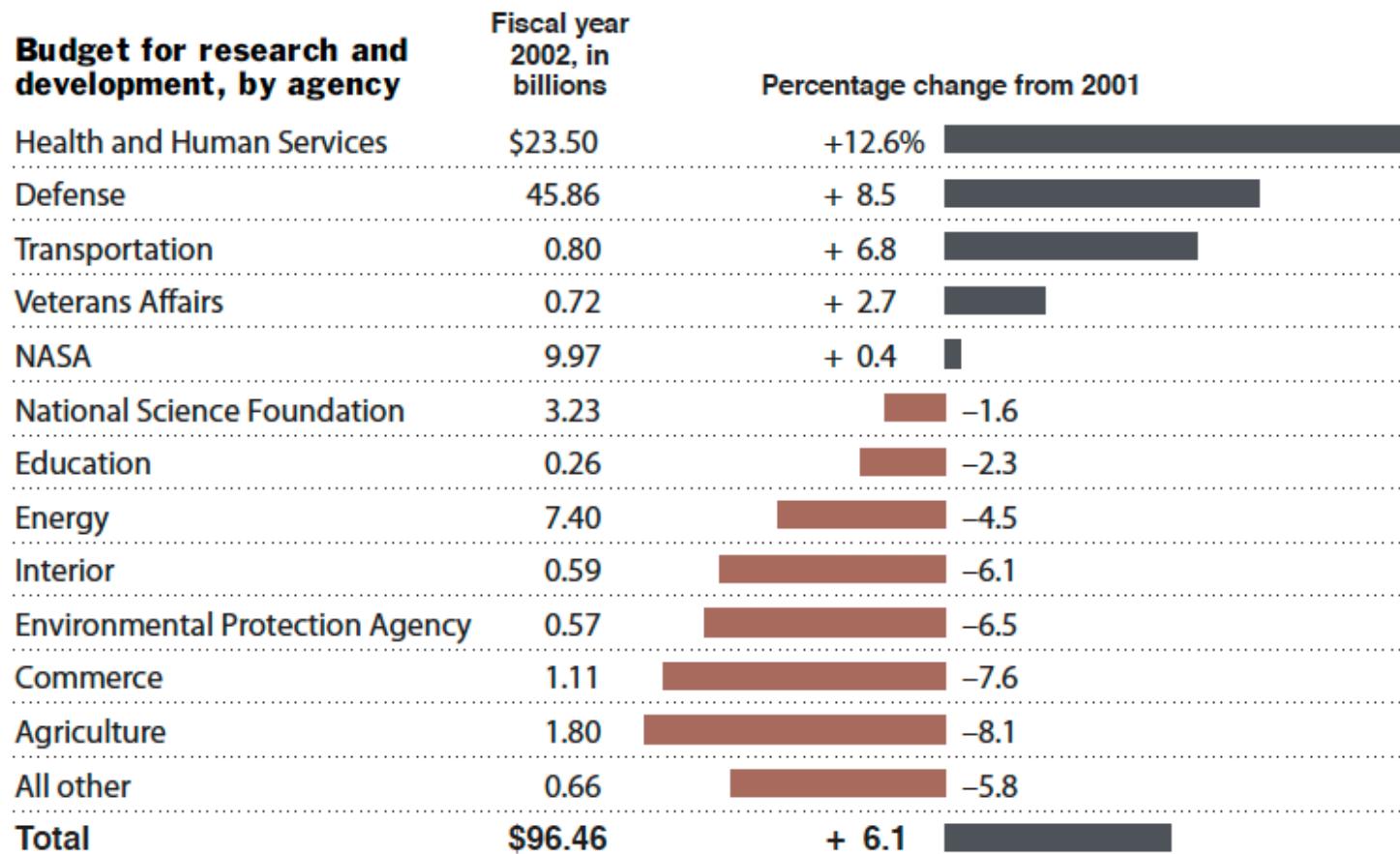
Bar Charts

At All Ages, A Bigger Worry

The number of people with chronic kidney disease has been rising, largely because of increased obesity and the aging of the population.



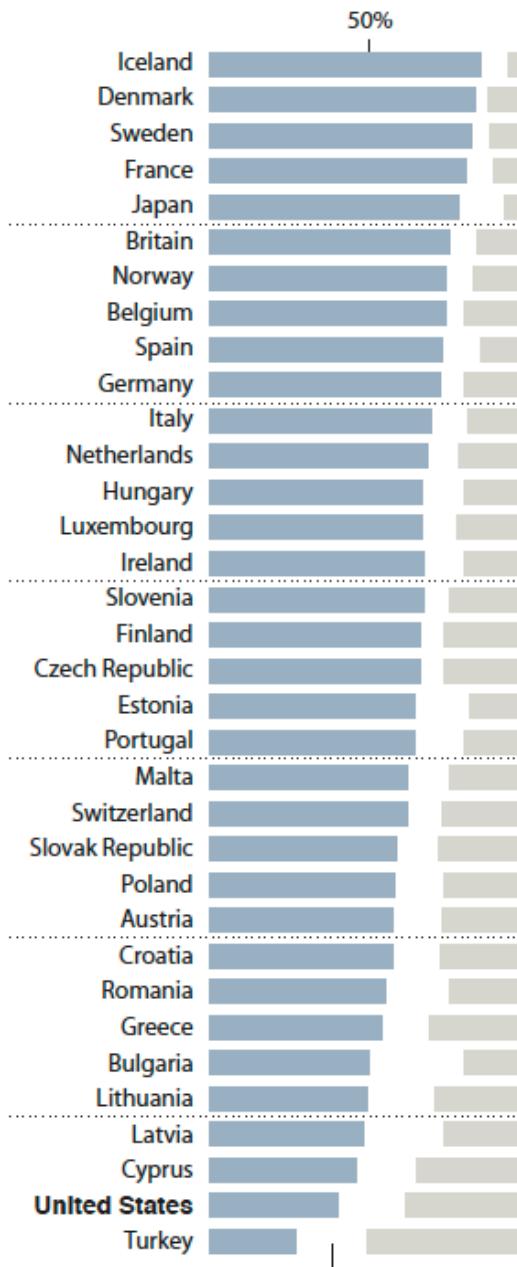
Bar Charts



Source: American Association for the Advancement of Science

Did human beings, as we know them,
develop from earlier species of animals?

Yes (believes in evolution)
No (does not believe in evolution)



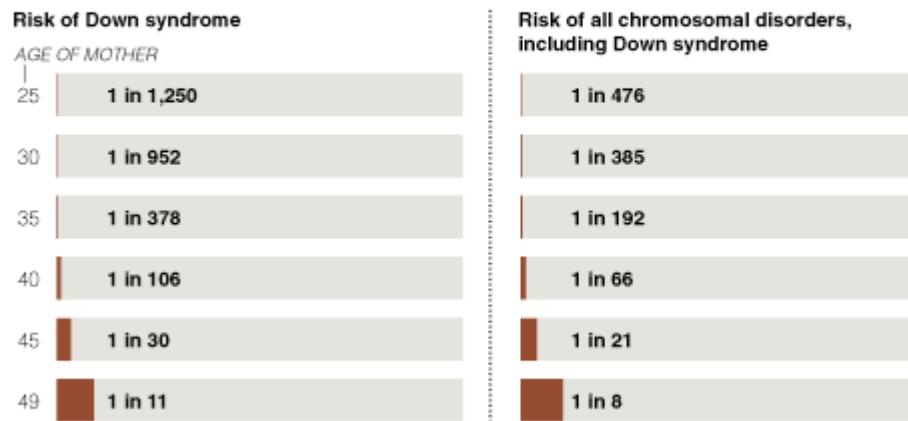
White areas represent an answer of not sure.

Source: Jon D. Miller, Michigan State University

Bar Charts

Weighing the Risk

The risk of pregnancy with Down syndrome and other chromosomal abnormalities increases sharply with the age of the mother. New guidelines urge all pregnant women, not just those over 35, to be screened.



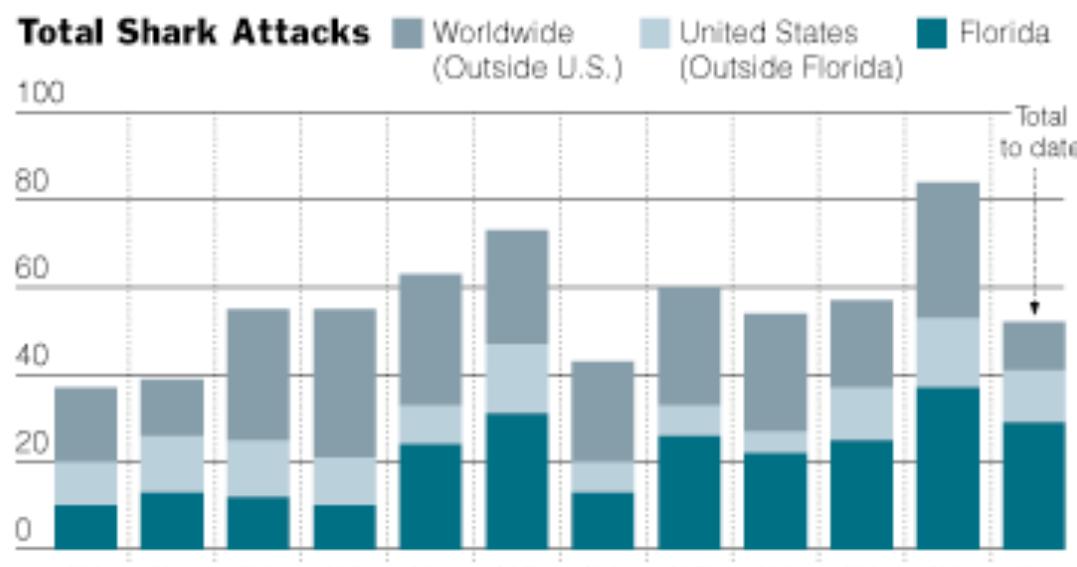
Source: American Society for Reproductive Medicine

The New York Times

Bar Charts

The Ups and Downs of Shark Attacks

Recent shark attacks have intensified debate about the level of risk they pose to people.



Source: Florida Museum of Natural History

The New York Times

Line Charts

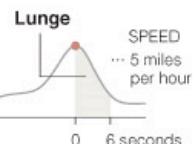
- Workhorse
- Good for comparing over time
- Generally better than bar charts if you are trying to show more than two series.
- Common mistakes include:
 - Legends when they aren't necessary
 - Dual axes when they don't make sense
 - 3D

Lunge Feeding

Scientists tracking fin whales have created the first detailed model of how they feed. After gliding to depths of more than 600 feet in search of krill, a fin whale will repeatedly accelerate and open its mouth wide, engulfing about 20 pounds of krill and more than its own weight in water as it grinds to a halt.



START OF LUNGE
After accelerating into a school of krill, the whale opens its mouth.



2 SECONDS
Grooves in the blubber between the lower jaws begin to expand.



3 SECONDS
Now fully open, the mouth causes massive drag and deceleration.

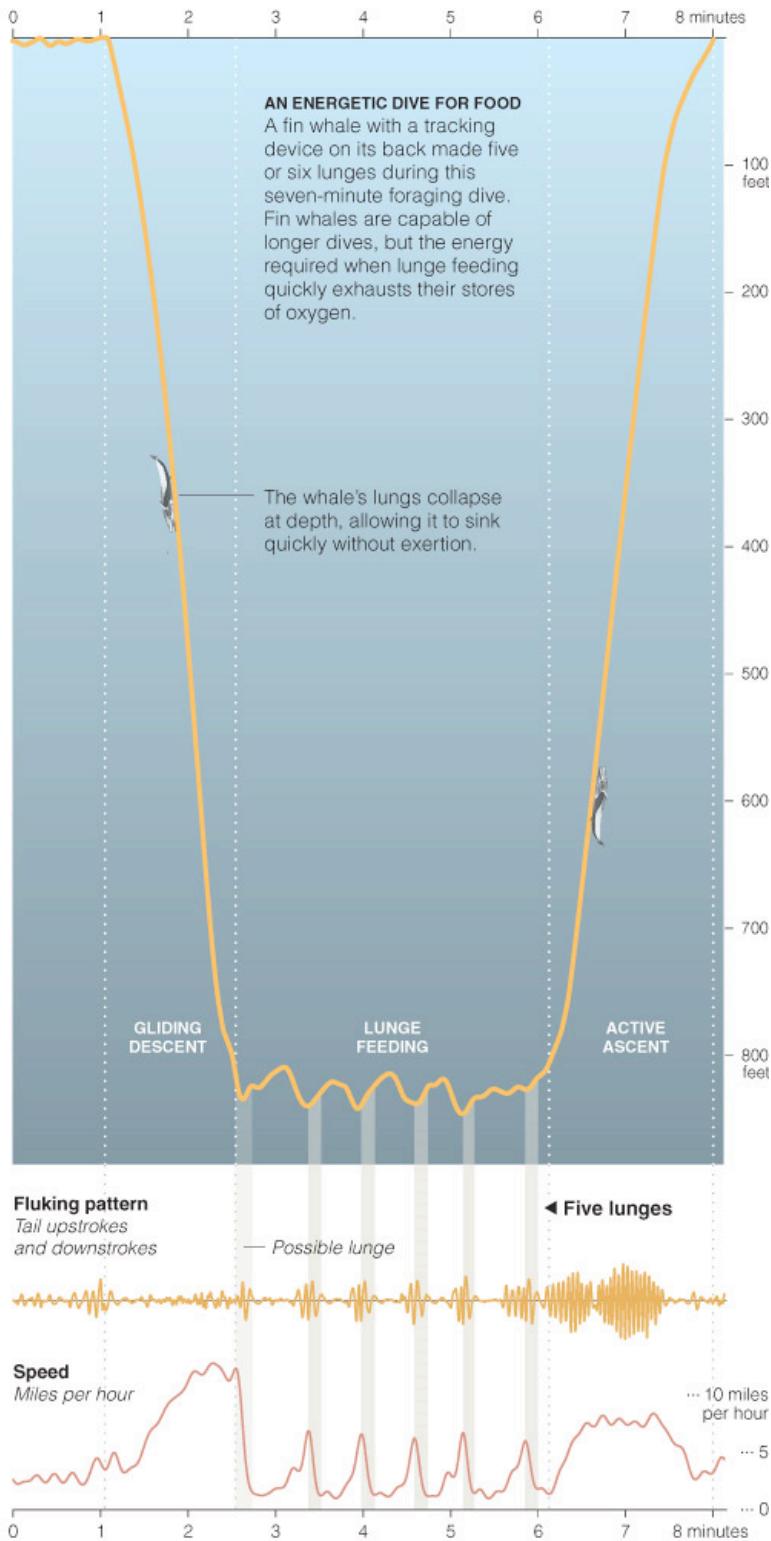


4 SECONDS
The closing mouth continues to drag as the whale pushes forward.



6 SECONDS
The whale starts to filter out the krill and prepare for another lunge.

Sources: Jeremy A. Goldbogen; Nicholas D. Pyenson;

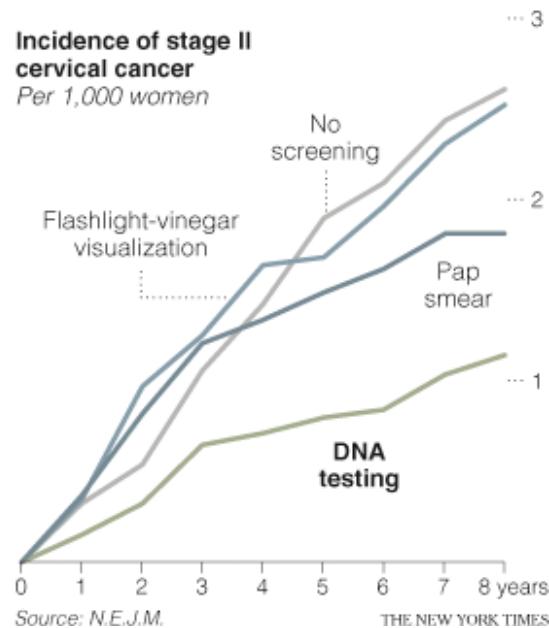


© 2013 Scientific American

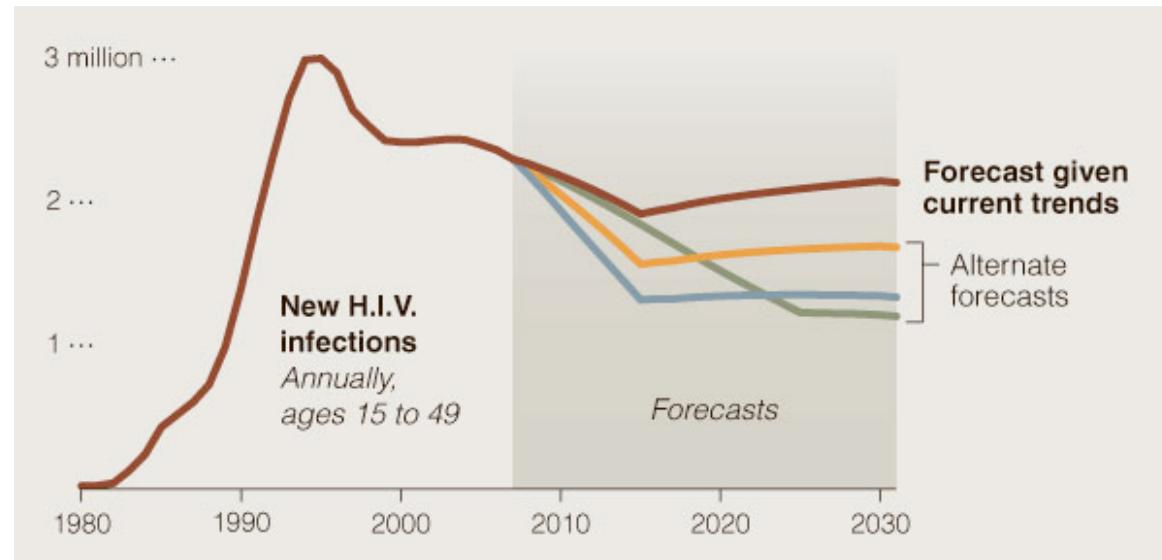
Line Charts

Comparing Screening Methods

A study of 130,000 women in India found that a new DNA test for HPV, the virus that causes cervical cancer, was more effective at preventing advanced cancer than other screening methods.



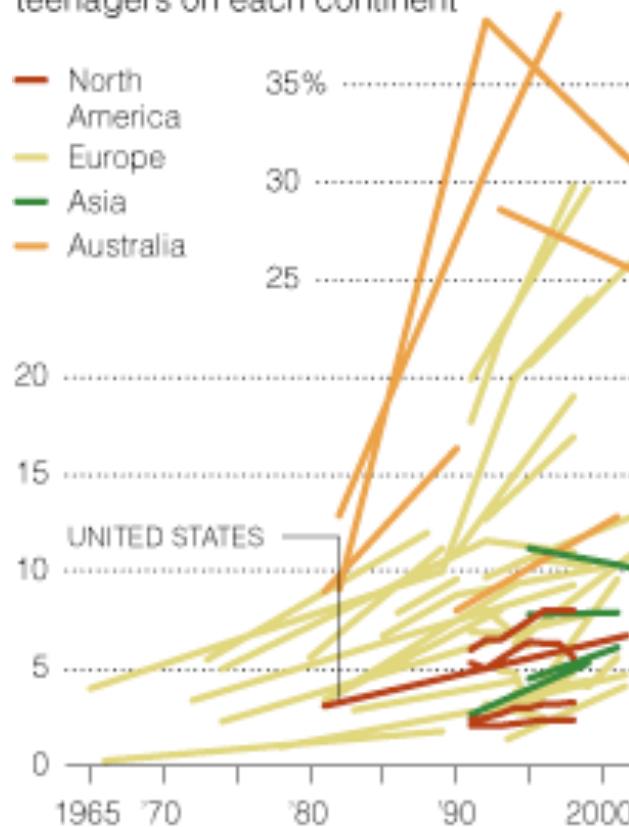
Line Charts



Line Charts

Breathing Trouble

Prevalence of asthma in children and teenagers on each continent*



*Each line represents data for one country. 17 countries shown. Some have more than one line.

Source: New England
Journal of Medicine

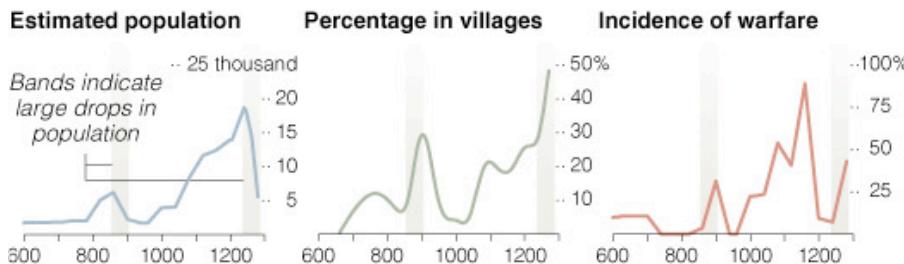
The New York Times



Piecing Together an Ancient Migration

The Village Ecodynamics Project is a detailed study of a large tract of land near Mesa Verde. Using new research and computer simulations, the project points to a combination of causes for the mass migrations of Anasazi in the late 13th century, including climate, population growth, societal changes, warfare and crop failure.

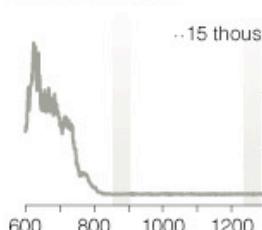
POPULATION CYCLES The study area shows evidence of two major cycles of population growth and decline. Both cycles appear linked to an increase in the percentage of people living in villages, and an increase in violence and conflict.



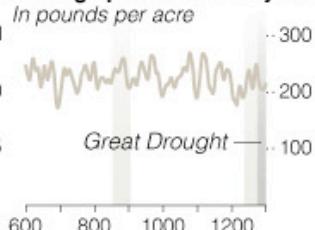
FOOD RESOURCES

With wild deer largely depleted by 1100, the Anasazi had to rely on corn-fed domesticated turkeys for protein, making the population even more dependent on the corn harvest.

Number of deer



Average potential corn yield In pounds per acre



Sources: Timothy A. Kohler, Washington State University; "Themes in Southwest Prehistory," edited by George J. Gumerman

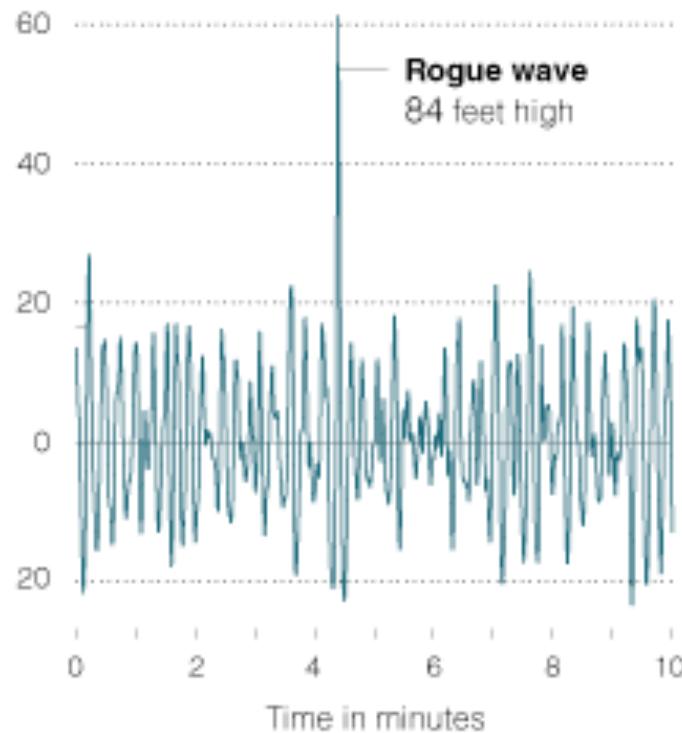
THE NEW YORK TIMES

Line Charts

A Real Phenomenon

On Jan. 1, 1995, a 84-foot wave hit the Draupner oil platform in the North Sea off Norway. The Draupner wave is the first measured and confirmed rogue wave.

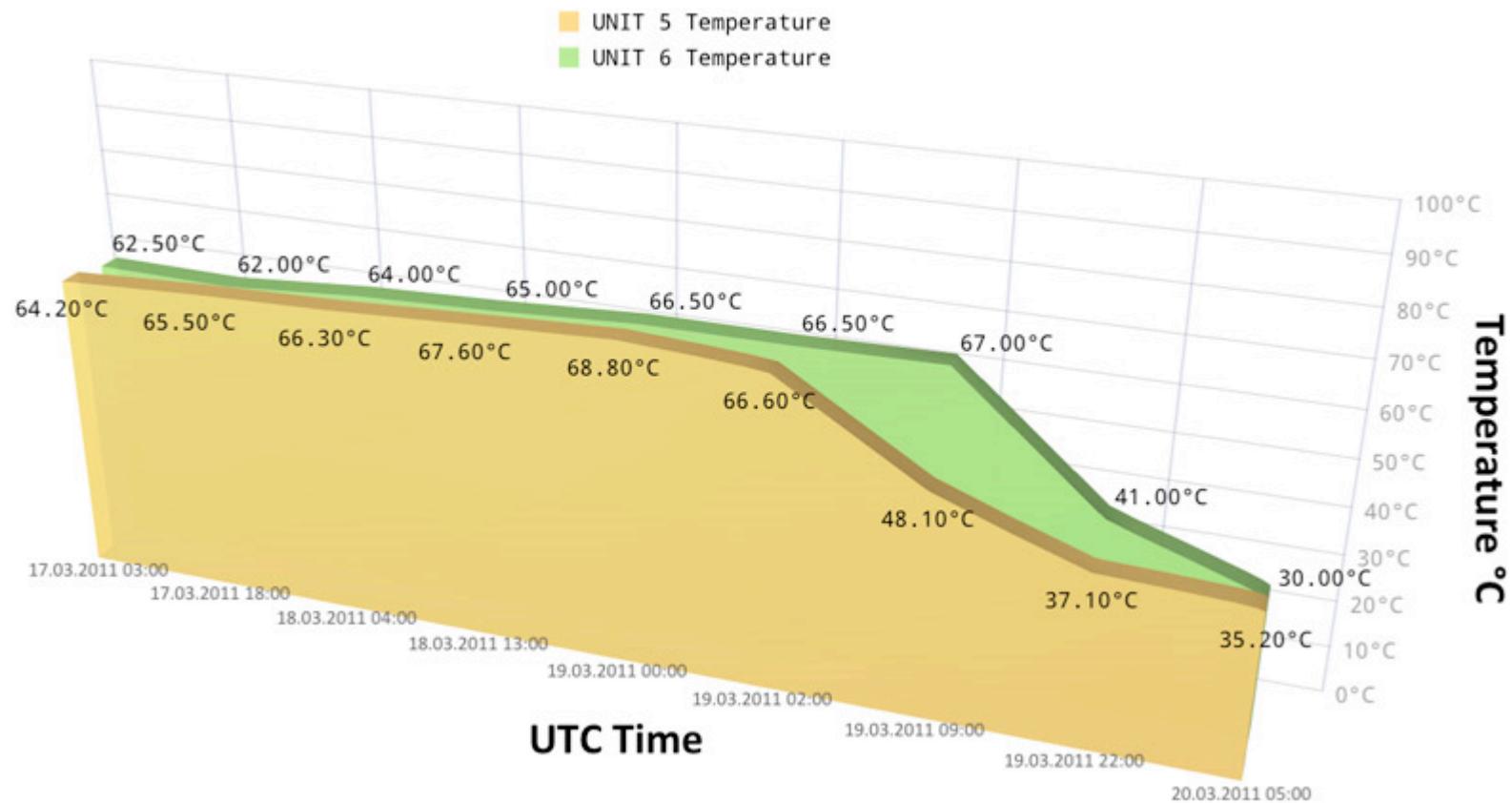
Wave height in feet



Source: Norwegian Meteorological Institute

Line Charts

Spent Fuel Pool Temperatures at Fukushima Daiichi Units 5 and 6



Scatterplots

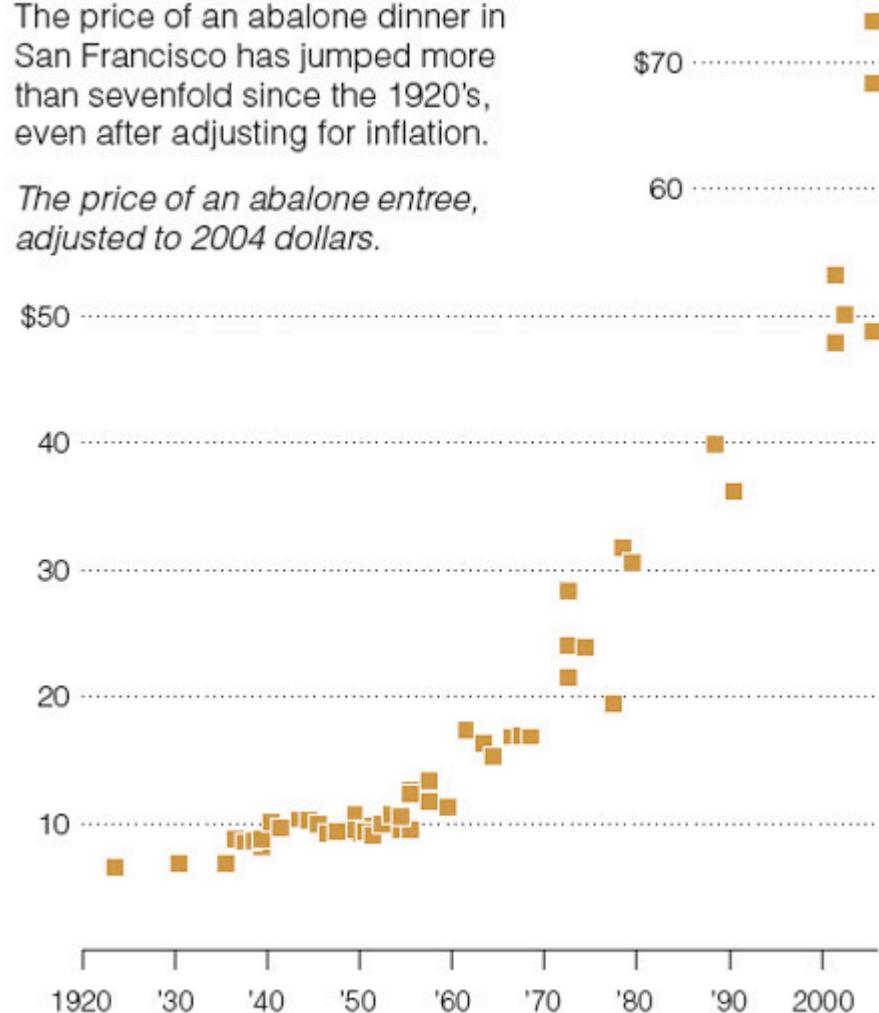
- Best for showing relationships
- Great for showing individual data points
- Common mistakes include:
 - Drawing dubious conclusions
 - Forgetting to show some kind of trend line, even when there's an obvious one to show

Scatterplots

Can We Share the Entree?

The price of an abalone dinner in San Francisco has jumped more than sevenfold since the 1920's, even after adjusting for inflation.

The price of an abalone entree, adjusted to 2004 dollars.



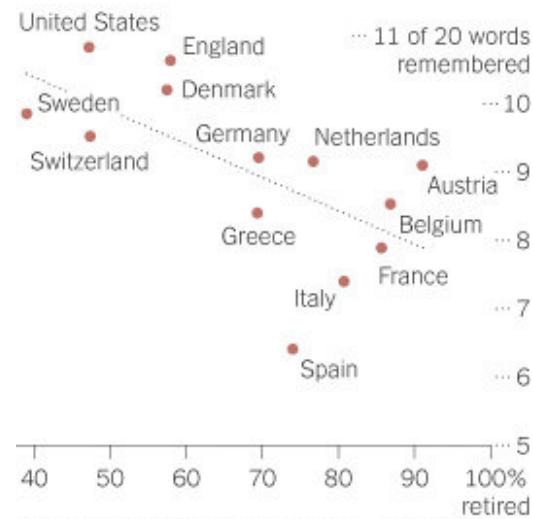
*Source: Glenn A. Jones,
Texas A&M University at Galveston*

Scatterplots

Work and Cognition

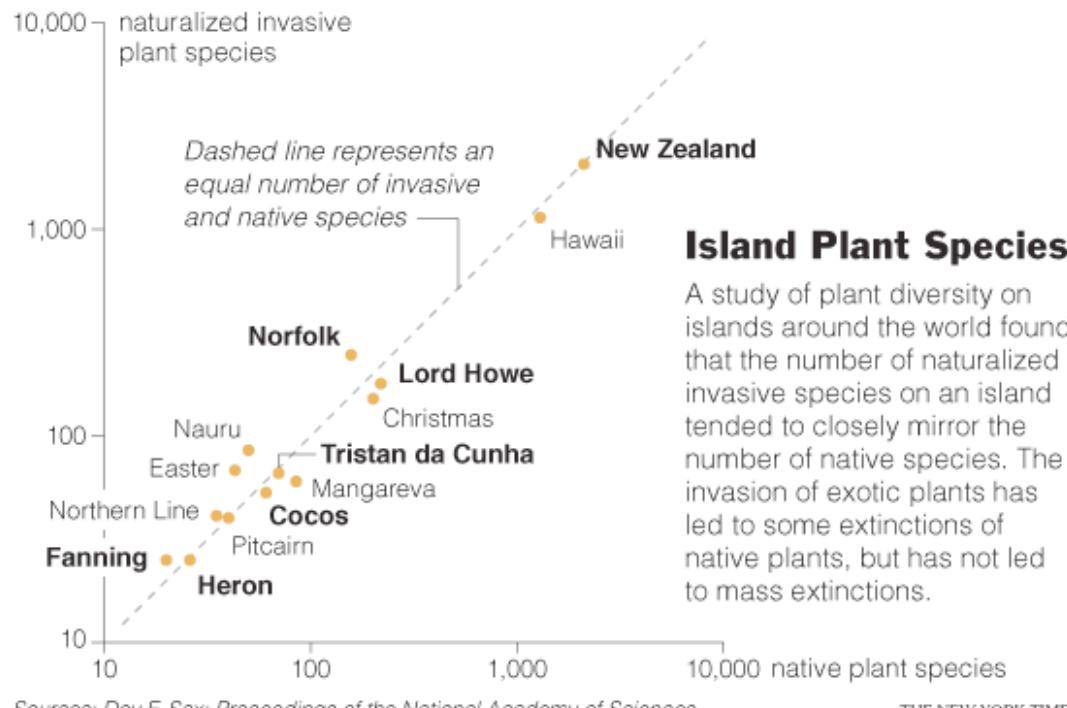
Men and women in their early 60s were asked to repeat and later recall a list of 10 words in a simple test. Memory was generally worse in countries with an early retirement age, and better in those with a later retirement.

Average cognitive score
Men and women ages 60 to 64

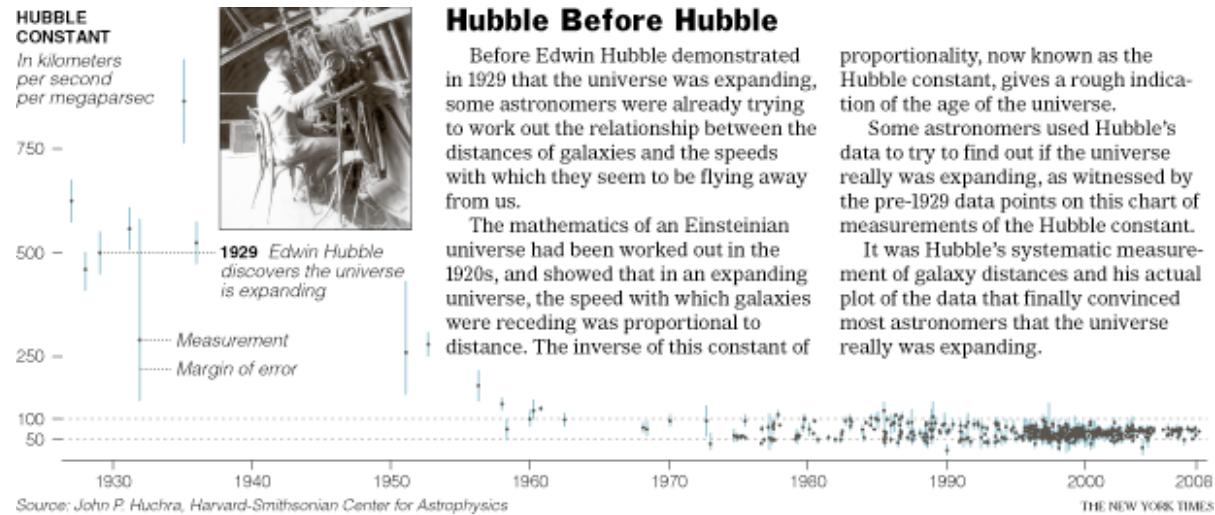


Source: Journal of Economic Perspectives THE NEW YORK TIMES

Scatterplots

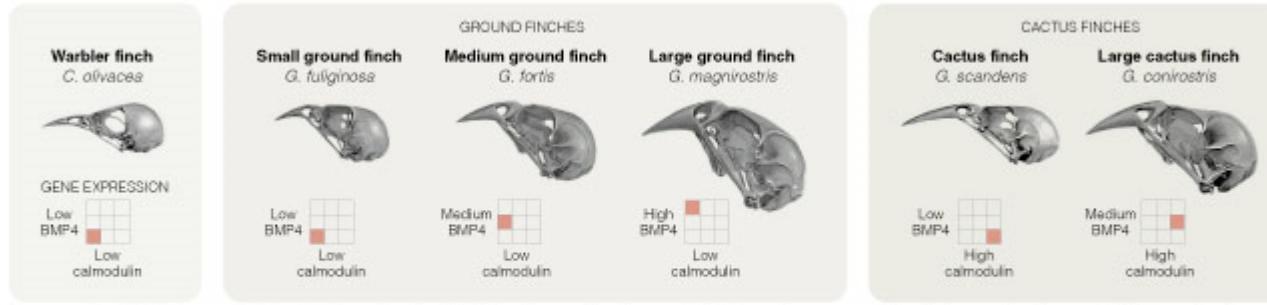


Scatterplots



Scatterplots

How Darwin's Finches Grew Their Beaks



The ancestor of Galápagos Island finches had a short, thin beak like that of the warbler finch.

Sources: Arhat Abzhanov; Harvard University; Nature

Adapting to the new foods of the islands, some finches evolved taller and broader bills for cracking nuts. Researchers have found that broader bills are touched off in early development by the gene BMP4.

Other finches evolved longer bills that are ideal for drilling holes into cactus fruits. The expression of a different gene, calmodulin, regulates beak length.

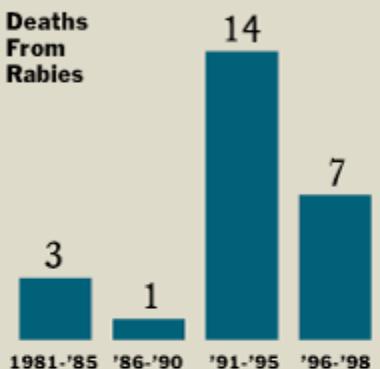
The New York Times; skull images by Margaret Bowman

Pie/waffle

- Good for showing composition
- Common mistakes include:
 - Putting too many pieces in a pie chart
 - Being gratuitous
 - Overly complex legends
 - Unthoughtful colors

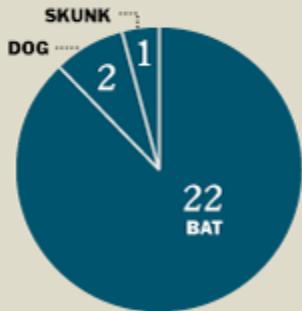
Rabies, Rare But Deadly

Cases of rabies in the United States increased in the 1990's over the 1980's.



Animal Transmission of the Disease

The 25 cases of rabies since 1981 have been the result of contact with the following animals:



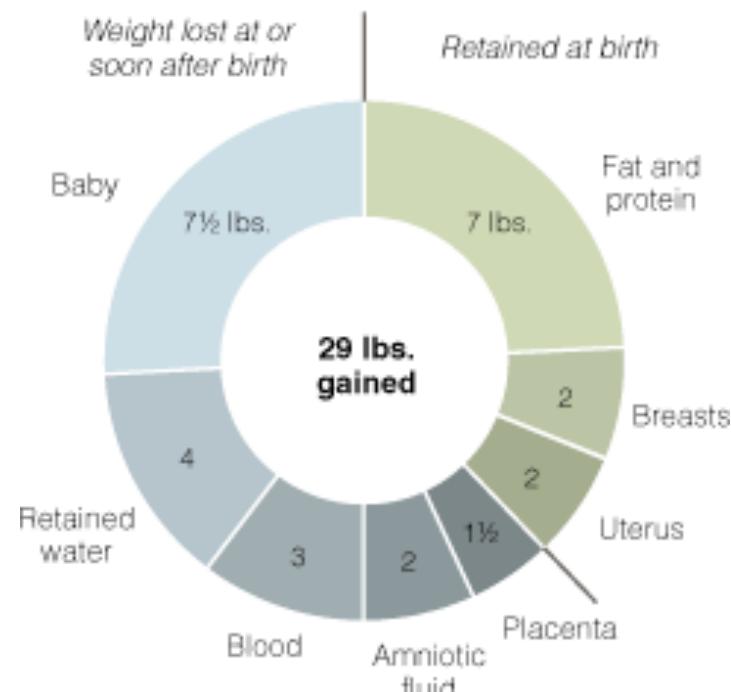
Sources: "Re-emergence of Rabies" from the *Infectious Diseases Journal*; Centers for Disease Control and Prevention

The New York Times

Pie/waffle

Weight Gain During Pregnancy

The March of Dimes suggests that normal-weight women should gain between 25 and 35 pounds during pregnancy. Below, how a normal weight gain of 29 pounds would be distributed.



Source: March of Dimes

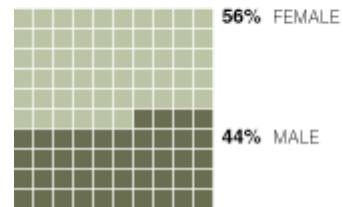
The New York Times

Pie/waffle

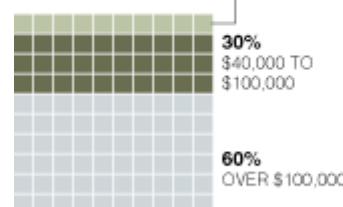
On the Couch

In one survey conducted in 2001 by the American Psychoanalytic Association, 950 psychoanalysts from 36 states answered general questions about 2,791 of their patients.

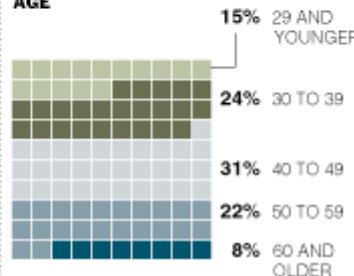
GENDER



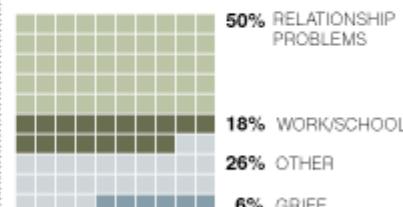
ANNUAL INCOME



AGE



REASONS FOR REFERRAL TO THERAPIST



The New York Times

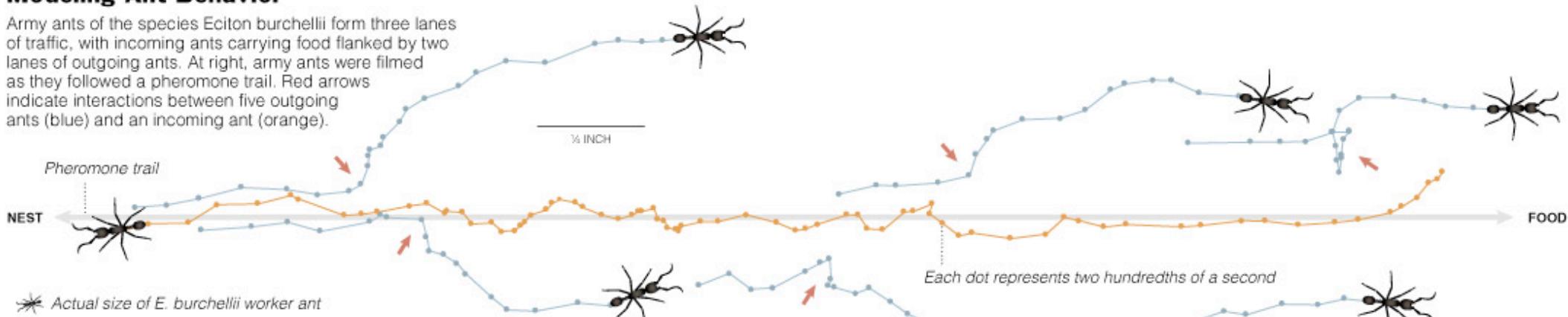
Histograms

- Good for showing distributions / variability.
- Common mistakes include:
 - Using icons that are more noisy than illuminating
 - Perhaps thinking people understand them immediately?

Histograms

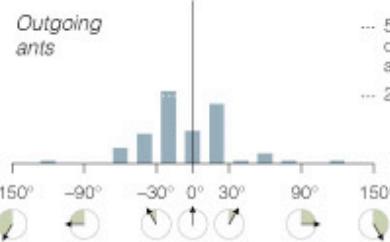
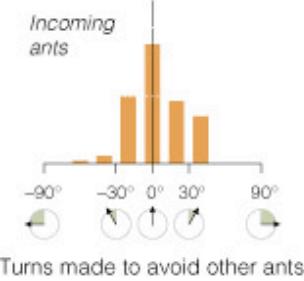
Modeling Ant Behavior

Army ants of the species *Ecton burchellii* form three lanes of traffic, with incoming ants carrying food flanked by two lanes of outgoing ants. At right, army ants were filmed as they followed a pheromone trail. Red arrows indicate interactions between five outgoing ants (blue) and an incoming ant (orange).



Incoming ants turn less than outgoing ants ...

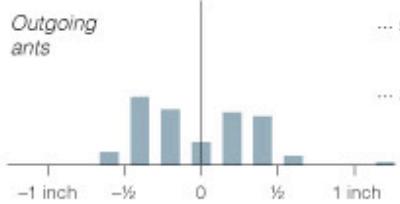
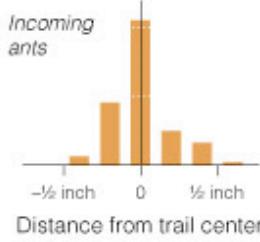
Researchers tracked 226 ants and discovered that incoming ants made fewer, narrower turns than outgoing ants when they sensed or bumped into another ant.



... 50% of observed ants
... 25%

... and stay closer to the trail

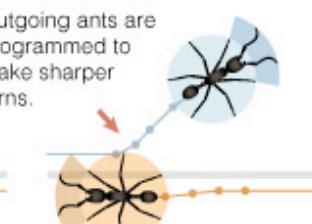
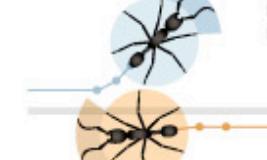
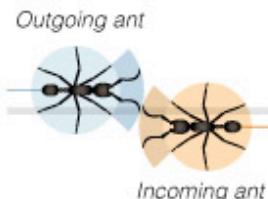
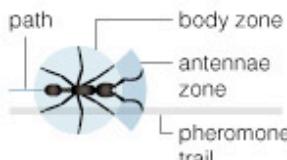
Because incoming ants turn less, they tend to remain closer to the center of the pheromone trail. Outgoing ants that turn away from the center naturally form flanking lanes.



... 50%
... 25%

Simulating army ants

Computer models use a few simple rules to simulate army ant behavior. If the body or antenna of a virtual ant touches another ant, the ant slows and turns away.



Sources: Iain D. Couzin; *Proceedings of the Royal Society*

JONATHAN CORUM/THE NEW YORK TIMES

Histograms



Other: Tables

Running the Numbers

These tables, developed by the economist Dr. Ray C. Fair, allow runners to continue racing against themselves even as they age and slow down. Using the fastest marathon times ever run by people of a given age, Mr. Fair calculated an "age factor" for every age after 35, which is the last time many people are able to set a personal best.

If a **50-year-old** woman ran a marathon in 4 hours when she was 35, she multiplies:

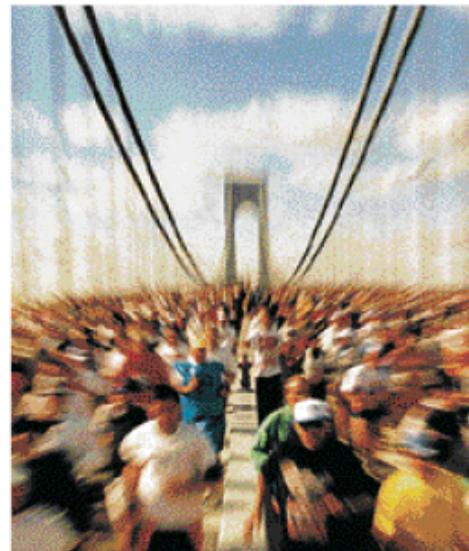
$$4 \text{ HOURS} \times 1.098 = 4.392 \text{ HOURS}$$

To convert to minutes: $.392 \times 60 = 23.52$.

So her goal is **4:23:30**.

If she beats that time at age 50, she is actually running a better race than she did 15 years earlier.

Because the body appears to slow down at a different pace for shorter distances, Mr. Fair created a separate table for the middle distances, those from 400 to 10,000 meters.



MARATHONS

AGE	FACTOR	61	1.178
35	1.000	62	1.189
36	1.006	63	1.202
37	1.013	64	1.216
38	1.019	65	1.232
39	1.025	66	1.249
40	1.032	67	1.269
41	1.038	68	1.290
42	1.045	69	1.313
43	1.051	70	1.338
44	1.058	71	1.365
45	1.064	72	1.395
46	1.071	73	1.427
47	1.078	74	1.462
48	1.084	75	1.499
49	1.091	76	1.538
50	1.098	77	1.581
51	1.105	78	1.628
52	1.112	79	1.677
53	1.119	80	1.730
54	1.126	81	1.787
55	1.133	82	1.848
56	1.140	83	1.913
57	1.147	84	1.983
58	1.154	85	2.058
59	1.161	86	2.138
60	1.169		

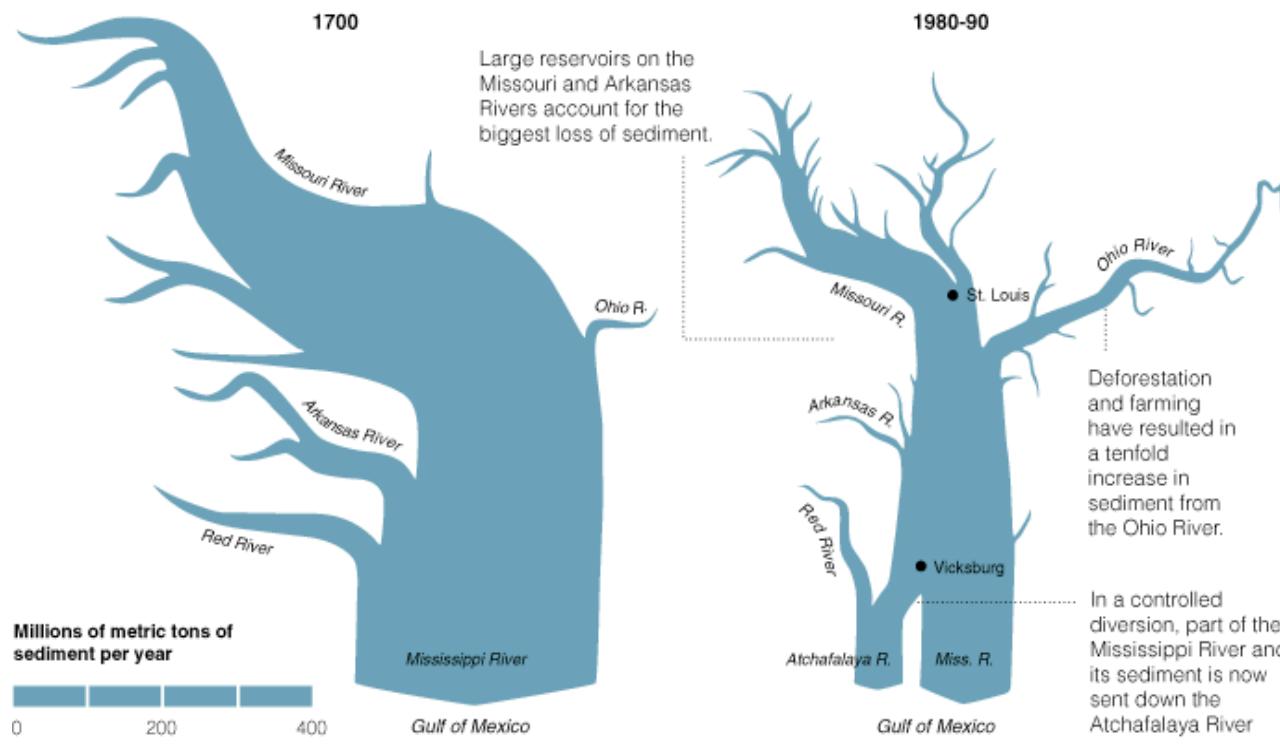
400-10,000-METER RACES

AGE	FACTOR	61	1.235
35	1.000	62	1.247
36	1.008	63	1.260
37	1.016	64	1.273
38	1.025	65	1.288
39	1.033	66	1.303
40	1.041	67	1.319
41	1.050	68	1.337
42	1.058	69	1.355
43	1.067	70	1.374
44	1.075	71	1.395
45	1.084	72	1.416
46	1.093	73	1.439
47	1.102	74	1.463
48	1.111	75	1.488
49	1.120		

Other: flow diagrams

A LOSS OF SEDIMENT

The Mississippi River transports 200 million tons of sediment per year to the Gulf of Mexico. But that is half of what the river carried three centuries ago, before European colonists first moved to the area and built levees and dams to protect themselves from floods.



David Constantine, Joe Burgess/The New York Times

Other: network diagrams

A Chain Reaction of Proliferation

"The Nuclear Express," a new book on the history of the atomic age, describes the interlocking web of influence and espionage behind the proliferation of nuclear technology.

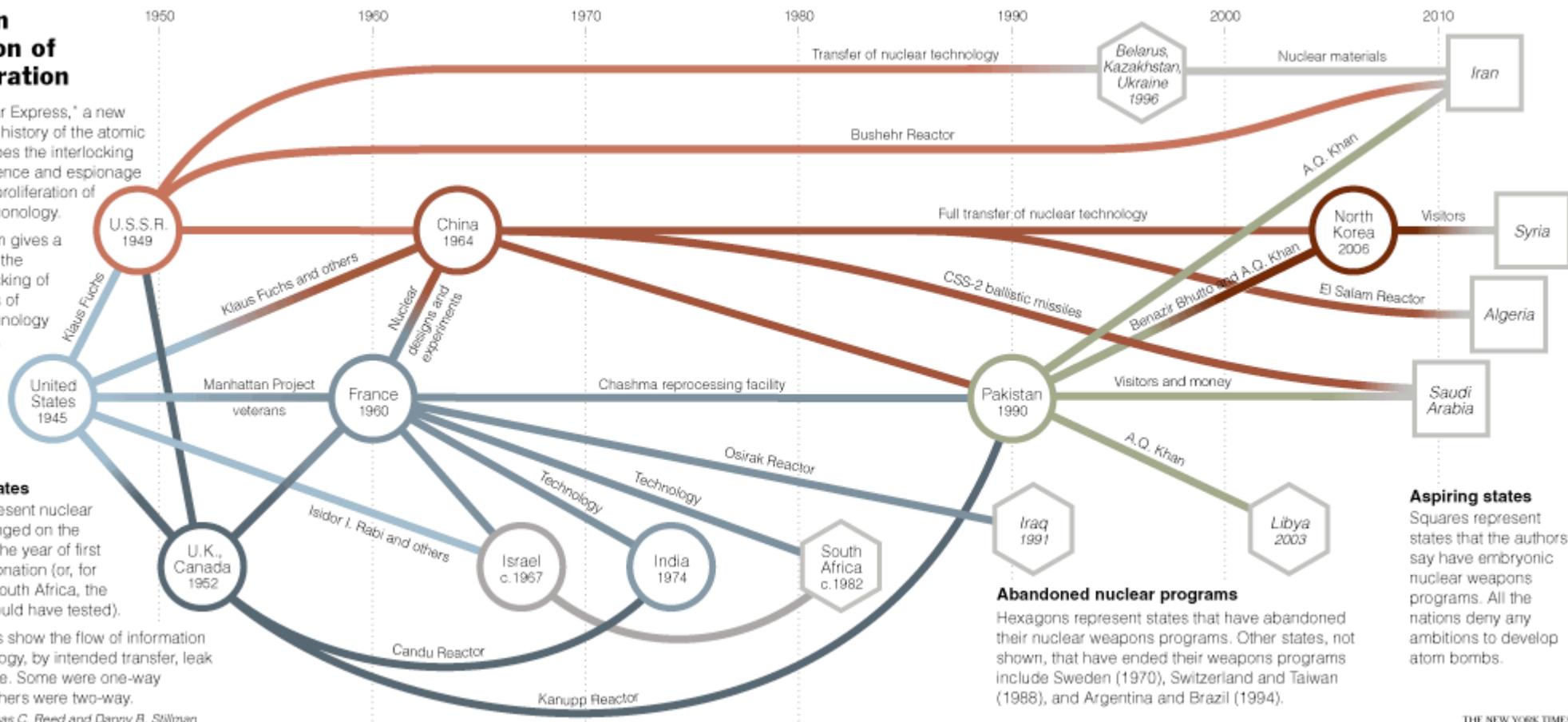
This diagram gives a summary of the authors' tracking of the transfers of nuclear technology and secrets.

Nuclear states

Circles represent nuclear states, arranged on the timeline by the year of first nuclear detonation (or, for Israel and South Africa, the year they could have tested).

Connections show the flow of information and technology, by intended transfer, leak or espionage. Some were one-way transfers; others were two-way.

Sources: Thomas C. Reed and Parry B. Shuman

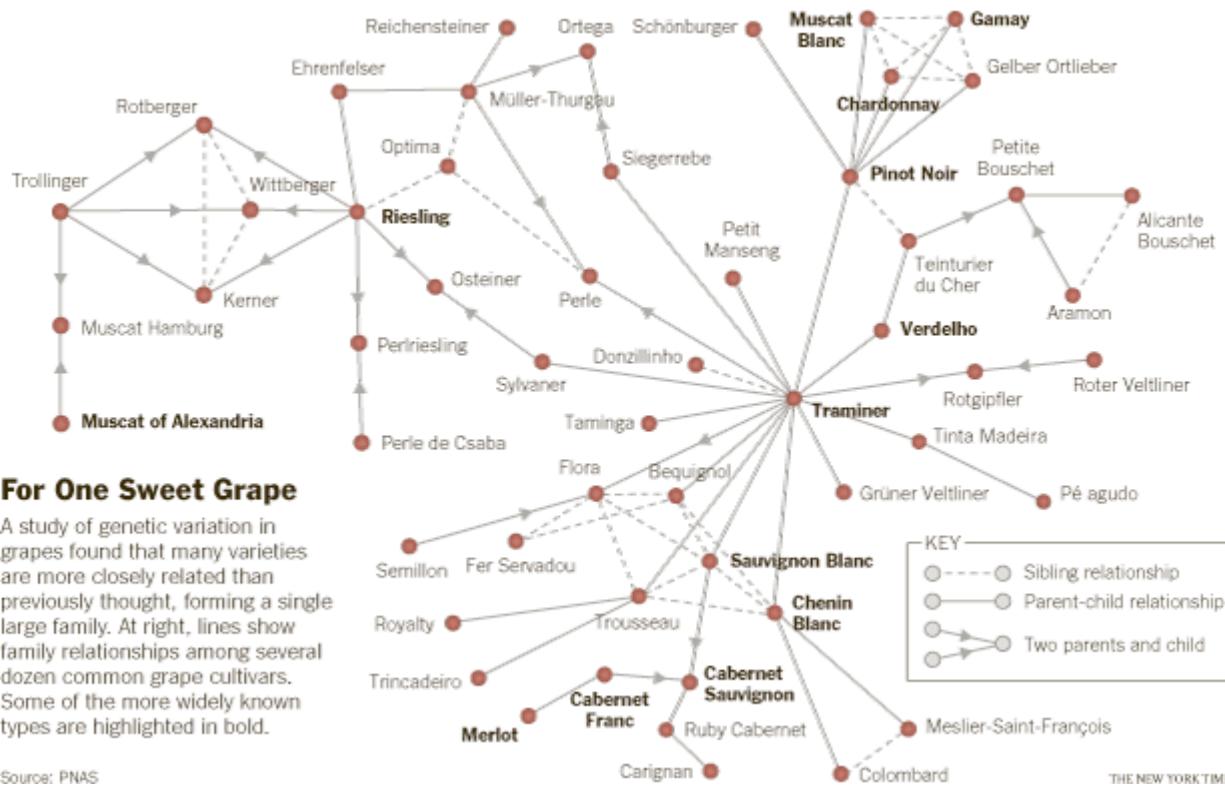


Abandoned nuclear programs

Hexagons represent states that have abandoned their nuclear weapons programs. Other states, not shown, that have ended their weapons programs include Sweden (1970), Switzerland and Taiwan (1988), and Argentina and Brazil (1994).

Aspiring states
Squares represent states that the authors say have embryonic nuclear weapons programs. All the nations deny any ambitions to develop atom bombs.

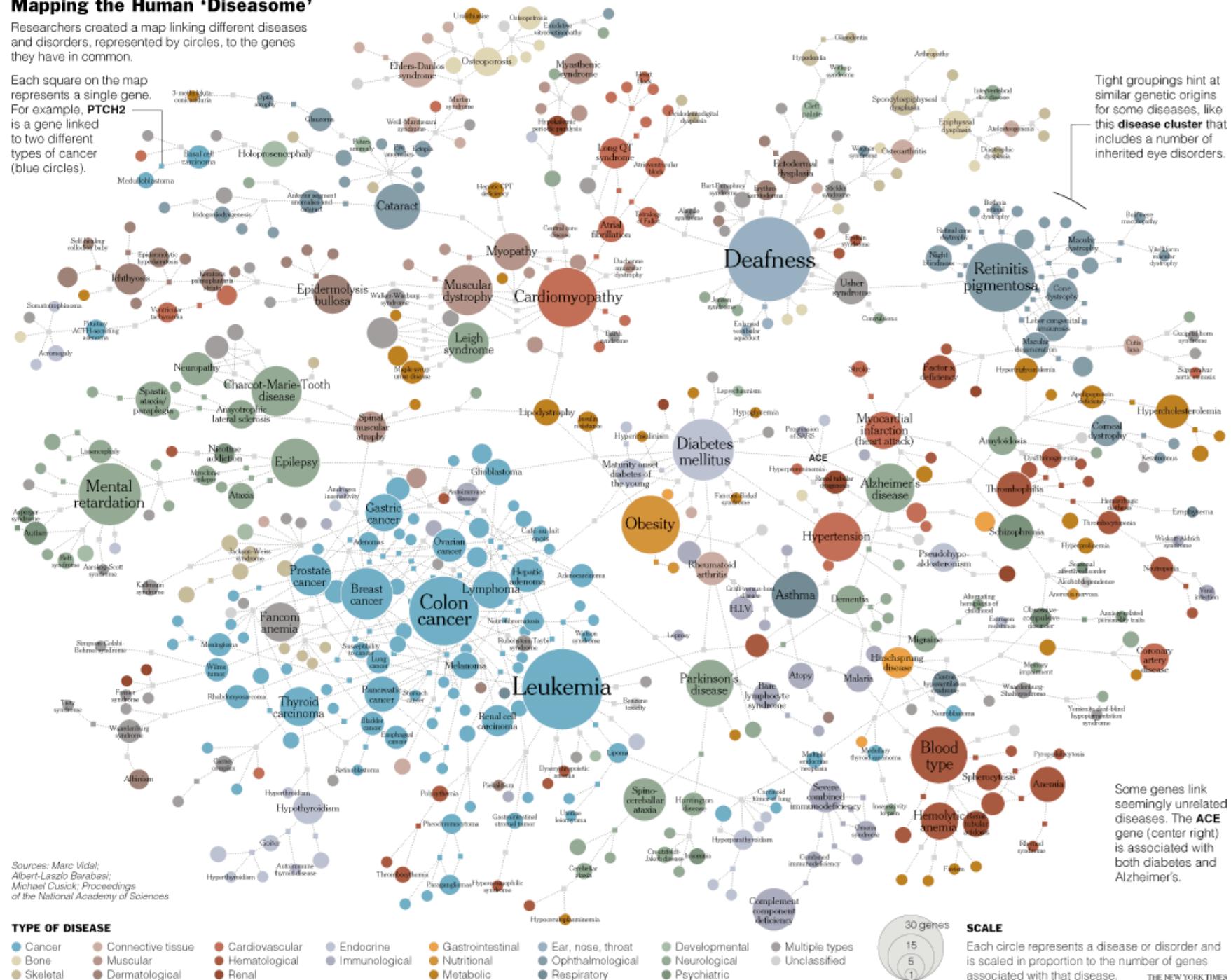
Other: network diagrams



Mapping the Human 'Diseasome'

Researchers created a map linking different diseases and disorders, represented by circles, to the genes they have in common.

Each square on the map represents a single gene. For example, **PTCH2** is a gene linked to two different types of cancer (blue circles).



Sources: Marc Vidal; Albert-Laszlo Barabasi; Michael Cusick; *Proceedings of the National Academy of Sciences*

SCALE

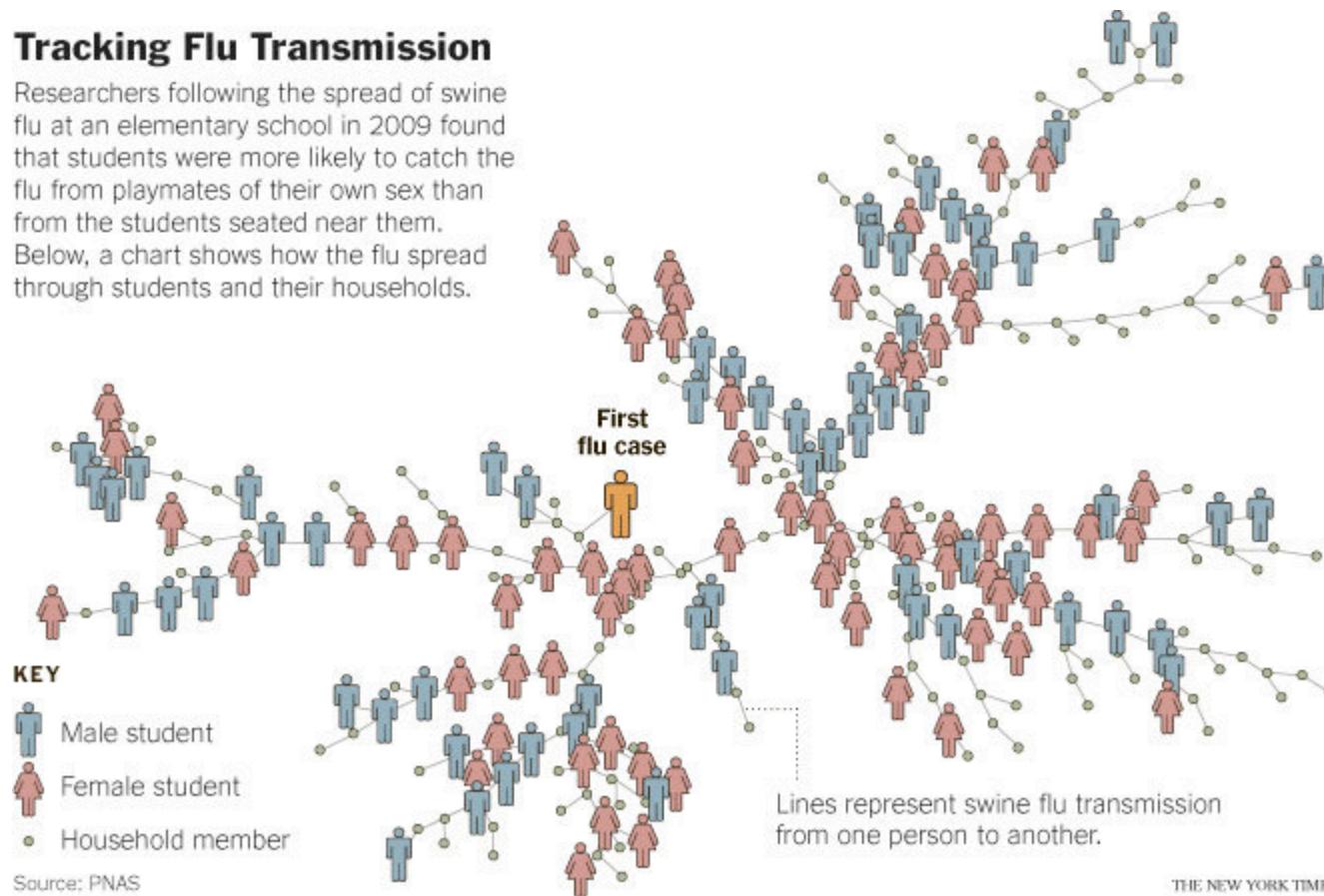
Each circle represents a disease or disorder and is scaled in proportion to the number of genes associated with that disease.

THE NEW YORK TIMES

Other: network diagrams

Tracking Flu Transmission

Researchers following the spread of swine flu at an elementary school in 2009 found that students were more likely to catch the flu from playmates of their own sex than from the students seated near them. Below, a chart shows how the flu spread through students and their households.

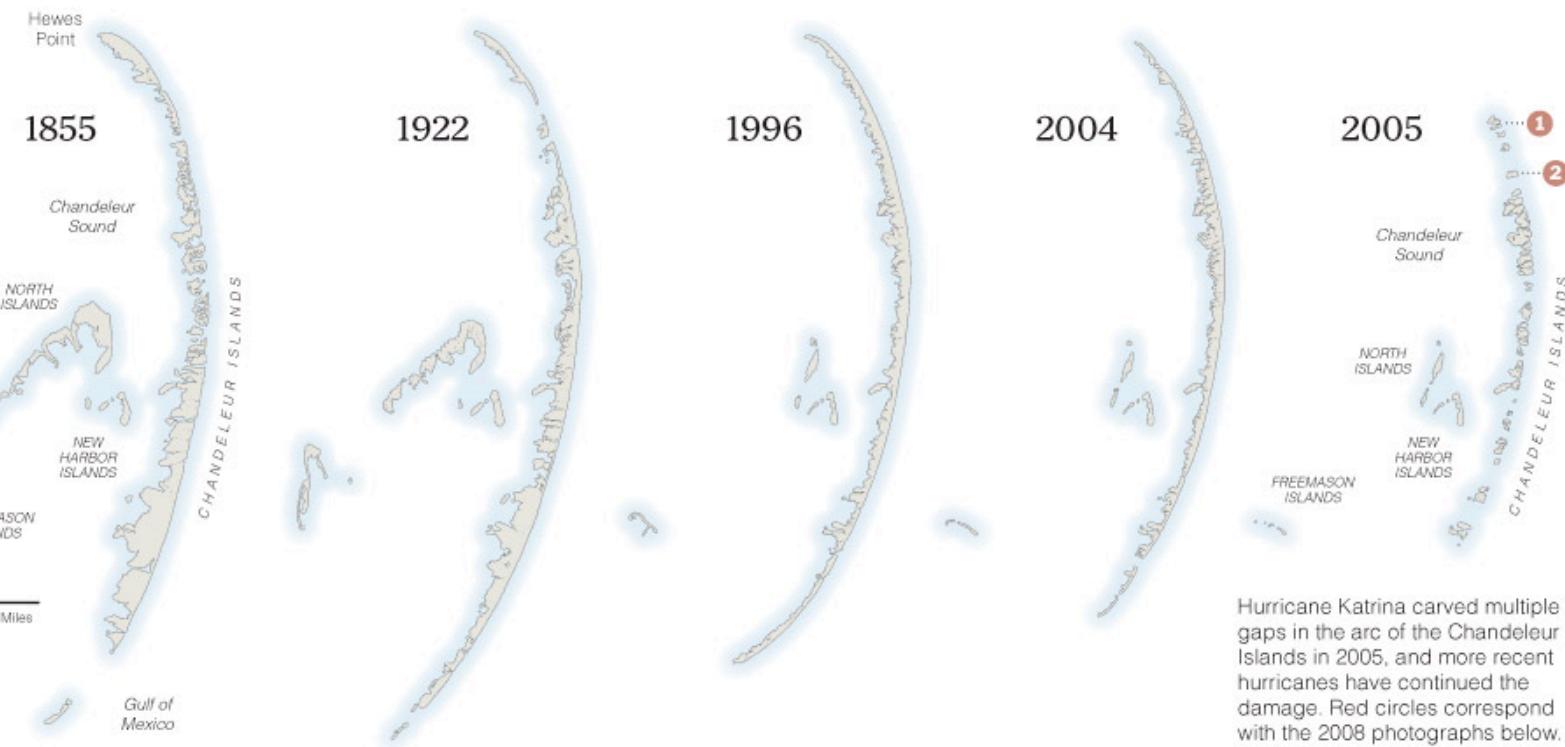
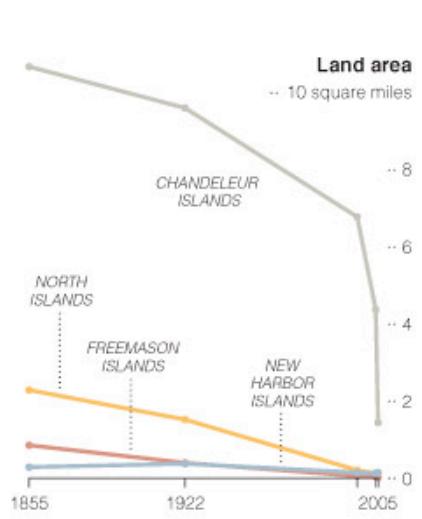


Two ideas independent of form

- Small multiples
- Annotation layer

Lost to the Sea

The Chandeleur Islands formed thousands of years ago in a now-defunct delta of the Mississippi River. Over the past 150 years, subsiding land, climate change, erosion and storm damage have reduced the barrier islands to a chain of island remnants.



AFTER THE STORMS

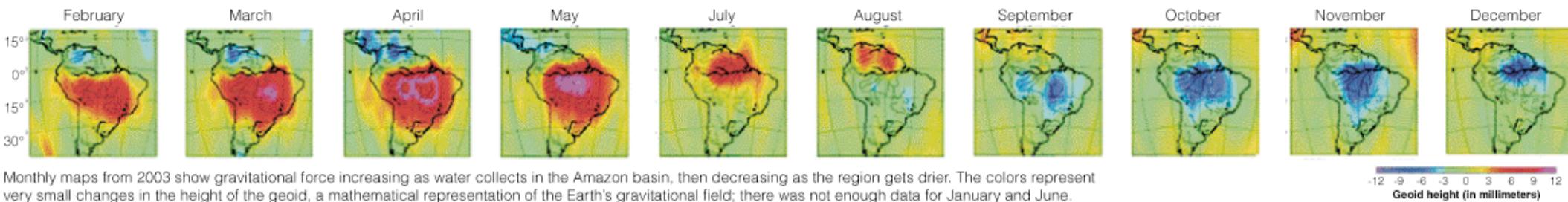
Two sets of photographs taken during aerial surveys this summer show the continued erosion of two of the Chandeleur Islands from Hurricane Gustav and Hurricane Ike. Red circles show the location of these islands on the map above.



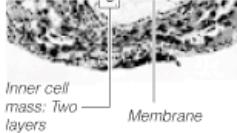
Two photographs of the eastern part of Ship Island show hurricane damage sustained this summer. Much of the eastern part of the island is now underwater.



Small multiples



The New York Times; Images courtesy of University of Texas Center for Space Research



Inner cell mass: Two layers
Membrane

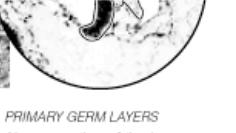
Cells migrate around the embryonic region, forming membranes around the inner cells.



PRIMITIVE STREAK

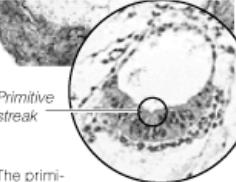
A small group of cells called the primitive streak appears, and it will determine the embryo's main body axes, top and bottom, front and back, and left and right.

Most abnormal embryos that spontaneously abort do so by this time.

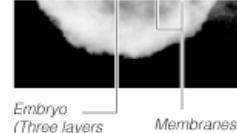


PRIMARY GERM LAYERS

Also, a portion of the inner cell mass differentiates into three layers: ectoderm, mesoderm and endoderm. These three layers of cells will give rise to the body's tissues and organs.

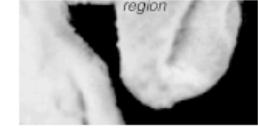


Primitive streak
The primitive streak is visible, and the embryo's main body axes are established.



Embryo (Three layers of cells)
Membranes

The images from this point forward are not sections of the embryonic interior. Rather, the entire embryo and surrounding membranes are shown.



region
Heart and brain regions become apparent.



Somites
Brain
The heart begins to beat. Small blocks, called somites, develop and will give rise to the vertebral column and body muscles.



This is the last day that research is allowed on embryos in Britain, Canada, Sweden and Finland, where, with the permission of the couple, unused embryos can be donated for research purposes.



France and Germany prohibit embryonic stem cell research, but are reviewing their laws. They have proposed a joint resolution of the United Nations General Assembly to ban human cloning in all member countries.



C Abdulaziz Sachedina, professor of Islamic studies at the University of Virginia: "It is correct to suggest that a majority of the Sunni and Shiite jurists will have little problem endorsing ethically regulated research on stem cells that promises potential therapeutic value, provided that the expected therapeutic benefits are not simply speculative."



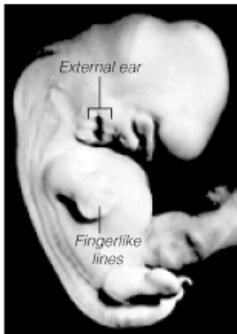
C While many religious traditions equate sentience and the start of life, they differ on when it begins. Some Buddhist and Hindu thinkers believe that "transmigration of consciousness" happens at conception, and therefore research on stem cells is wrong. Historically, however, some Buddhists believed that life began in the third or fourth month of pregnancy.



A 1994 National Institutes of Health advisory panel weighed the importance of biological markers other than the formation of the primitive streak: "The onset of a heartbeat at Day 22, for example, marks the first time the embryo can be perceived (through ultrasound) by the outside world. Thus it marks a moment when the relational element increases. Also, despite experience with brain death, it is the beating heart that is most strongly perceived to be the difference between life and death."

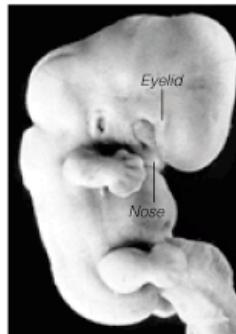
Embryonic images courtesy of the National Museum of Health and Medicine, Armed Forces Institute of Pathology. Photo by Associated Press (Popes John Paul II, President Bush); Reuters (Orrin Hatch)

DAY 42



The main axis of the trunk straightens.

DAY 44



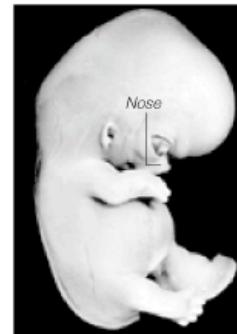
Eyelids appear, and the nose can be distinguished.

DAY 48



Various parts in arm and leg can be identified.

DAY 51



Arms increase in length and bend slightly at the elbows.

DAY 52



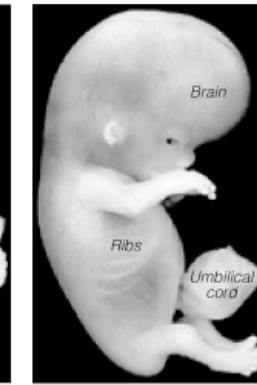
ACTUAL SIZE

DAY 54



ACTUAL SIZE

DAY 56



From this point until birth, the embryo is known as a fetus.

Later stages of embryonic growth

"Part of our identification with this entity is that it looks human," said LeRoy Walters, a bioethicist at Georgetown University. He also pointed out that the ability to see the embryo *in utero* through ultrasound has enhanced the bonding that takes place between parent and child.



The Greek Orthodox Church sees human beings "as still possessing a strong residue of the God-given likeness which is the essence of our humanity," said the Rev. Stanley Harakas of the Holy Cross School of Theology. "In my view, the establishment of embryonic stem cell lines was done at the cost of human lives. Even though not yet a human person, an embryo should not be used for or sacrificed in experimentation, no matter how noble the goal may seem."

Sources: U.N. Report: "The Use of Embryonic Stem Cells in the Therapeutic Research"; National Bioethics Advisory Commission: "Ethical Issues in Human Stem Cell Research"; Elizabeth Lockett, National Museum of Health and Medicine; Dr. Raymond F. Gasser, Louisiana State University; Dr. Brigid Hogan, Vanderbilt University; "The Developing Human," by Keith L. Moore and T.V.N. Persaud

STEVE DUNES and KRIS GOODFELLOW/The New York Times

Annotation layer

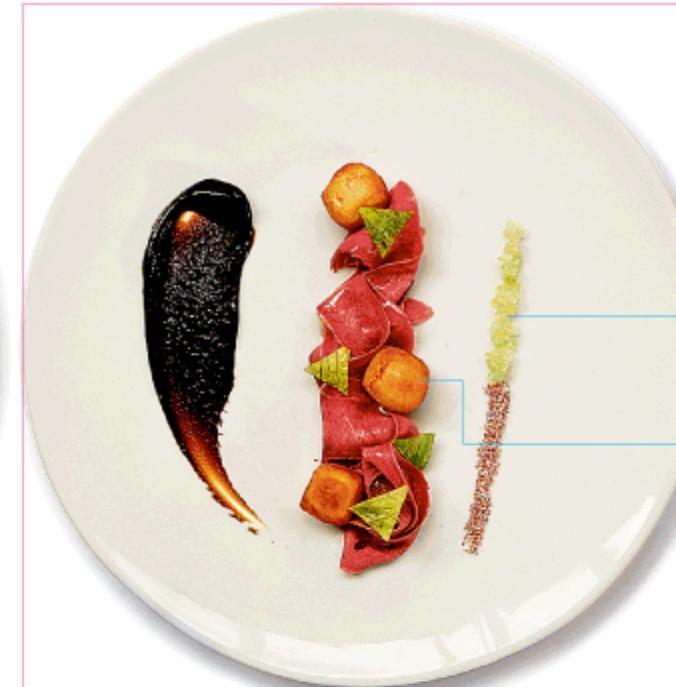
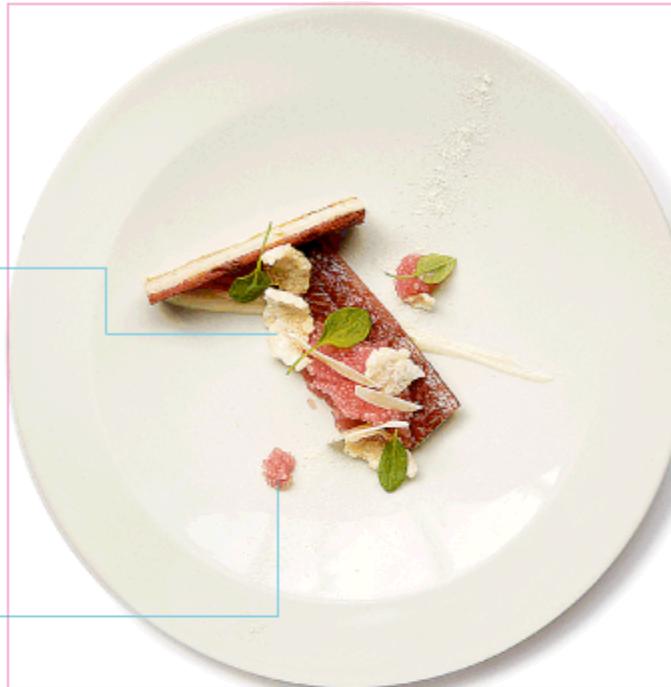
Nouvelle Chimie

Chefs learn from the lab how to fry mayonnaise, congeal coconut milk and tie foie gras in a knot.

SMOKED EEL

Slices of eel are served with **puffed yuzu**, inspired by airy puffed snacks like Cheez Doodles. The dough, flavored with juice from yuzu, a citrus fruit, contains two hydrocolloids. One, a waxy maize, expands significantly when fried. The other, a modified tapioca flour, expands more modestly and provides structure.

The dish is garnished with **guava roe** and slivers of the vegetable salsify. The roe is made by adding agar and locust bean gum to guava juice and simmering, then adding drops of the modified juice to 60-degree oil. The guava mixture gels into spheres that resemble fish roe.



BEEF TONGUE

Framed by a reverse comma of tomato molasses and an exclamation point of minced romaine lettuce and powdered onions, the beef tongue is accompanied by small pieces of lettuce and a high-tech version of **fried mayonnaise**.

The mayonnaise contains no eggs, but gelatin and gellan, a hydrocolloid produced by the bacterium *Sphingomonas elodea*. If eggs were used the proteins would be scrambled by the heat of frying, ruining the creamy texture.

WAGYU BEEF

A plate of Waygu flat iron beef, coffee gnocchi, cipollini onions and sylvestra arugula, also known as wild arugula, is adorned with a brushing of **coconut gel**.

The coconut gel is made by blending coconut milk and gellan together and adding calcium lactate. The calcium ions and gellan react to form a gel.

KNOT FOIE

A **flexible foie gras terrine** is made pliant with the addition of xanthan gum, a sugar fermented by the bacterium *Xanthomonas campestris*, and konjac flour from an Asian tuber.

The knot foie is dressed with rice crackers and dollops of puréed golden raisins and puréed

Annotation layer

Don't Forget to Chew

The star-nosed mole, native to eastern United States wetlands, has developed a super-efficient feeding system that allows it to grab and eat food in roughly a fifth of a second.

Nose: Twenty-two tentacles covered by 25,000 sensory receptors probe potential prey.

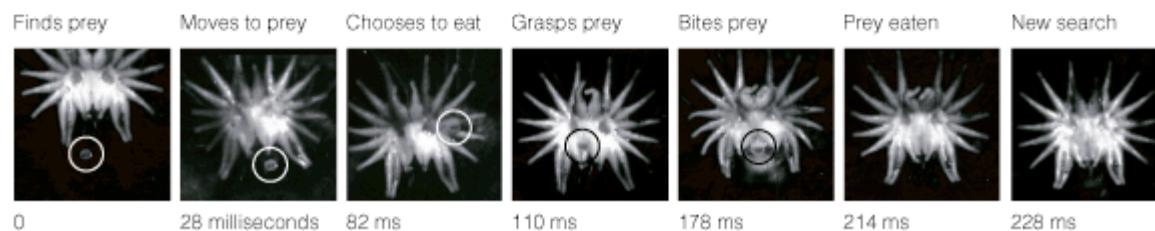


Teeth: Tweezer-like to help the mole quickly and precisely grasp small prey.

Mole width two inches, length four to five inches.

EATING

It takes the mole around 82 milliseconds (0.082 second) to decide whether to eat small prey it encounters and 146 milliseconds more to eat and begin a new search. Its diet includes earthworms, insect larvae and small fish.



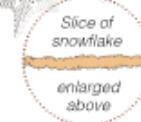
Annotation layer



The word snowflake can refer to a single ice crystal, a small cluster or a large aggregation.

Hundreds or perhaps thousands of crystals can come together to form a giant snowflake like the one above.

Fernlike stellar dendrites and **stellar dendrites** are ideal crystals for creating large snowflakes; branches of the crystals interlock and fuse together.



A spherical snowflake three-quarters of an inch across can contain more than 1,000 crystals from • 0.04 inch to ☰ 0.12 inch.

Mika Gröndahl/The New York Times

fabric offered protection from the life-support backpack, which weighed 100 pounds on Earth.

Prevented the shoulder's from collapsing under the weight of the backpack.

ARM BEARING
Allowed the arm to rotate freely.

PRESSURE GAUGE

COUPLINGS
The upper left port was for communications, and the upper right port fed water to the suit's water-cooled undergarment. The four lower couplings were for good air and exhaled air.

SNAP CLOSURES
and velcro were used to secure external flaps and pockets.

URINE TRANSFER CONNECTOR
A small port for draining collected urine.

MEDICAL INJECTION PATCH
A small area on the right thigh was designed for emergency injections.

TETHER BAR
An attachment point for tethers that kept the astronauts in place while flying the lunar module to and from the Moon's surface.

CONVOLUTES
Accordionlike folds allowed the suit's flexible joints to move when pressurized. Hand-dipped from latex, the folds contained nylon tricot and flexible restraining rings to retain their

