HEALTH & SCIENCE

STUDY // NEW EVIDENCE THAT SMOKING POT IN ADOLESCENCE IS HARMFUL PG 3D

BRIEFLY NOTED

QUEEN OF EGYPT

A Johns Hopkins University team discovers an ancient statue.

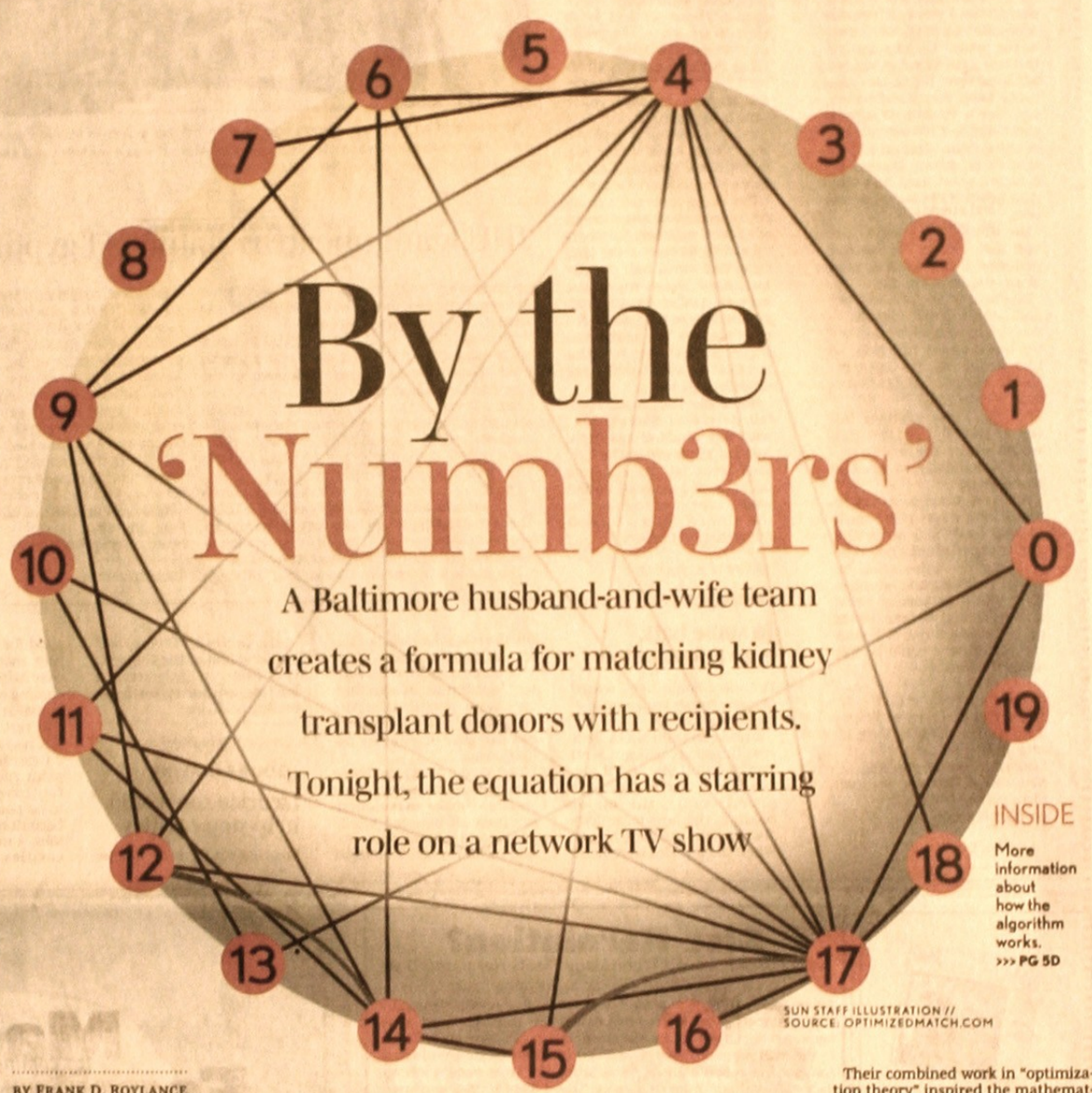
»»» PG 2D

STAY FIT

DOING CARDIO

Start fast or ease into it?

»»» PG 4D



By the 'Numb3rs'

A Baltimore husband-and-wife team creates a formula for matching kidney transplant donors with recipients. Tonight, the equation has a starring role on a network TV show

INSIDE

More information about how the algorithm works.

»»» PG 5D

SUN STAFF ILLUSTRATION // SOURCE: OPTIMIZEDMATCH.COM

BY FRANK D. ROYLANCE
[SUN REPORTER]

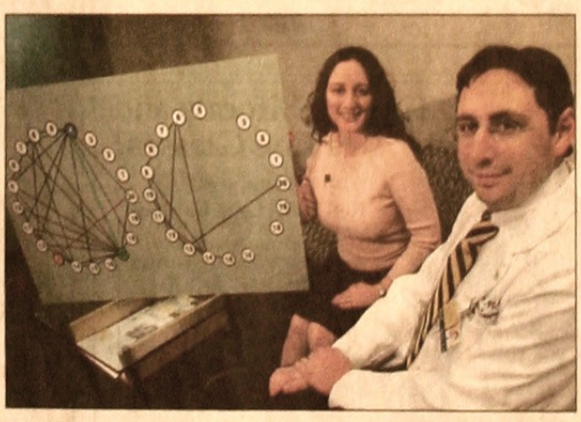
In the real world, organ transplant physicians use sophisticated computer programs to find scarce donors of medically compatible kidneys for desperately ill patients.

It's math saving lives.

But in Hollywood, writers for the hit CBS crime drama *Numb3rs* wondered whether the FBI could use the same organ-matching mathematics in reverse — to track down the most likely recipient of a black-market kidney, so they can nab the criminals behind the scheme.

That's math catching crooks, and it's the premise of tonight's episode of *Numb3rs*, with a script inspired by organ-pairing mathematics done at the Johns Hopkins University School of Medicine.

Hopkins gets a mention in the script, but not Hopkins transplant surgeon Dr. Dorry Segev, nor his wife and collaborator, Sommer Gentry, a Naval Academy math professor and Hopkins researcher.



Dorry Segev, a Johns Hopkins transplant surgeon, and his wife, Sommer Gentry, a professor of math at the U.S. Naval Academy, teamed up to discover an algorithm to help match organ donors with recipients.
JED KIRSCHBAUM [SUN PHOTOGRAPHER]

Their combined work in "optimization theory" inspired the mathematical solution to tonight's mystery.

"It's much more important for me that the concepts and excitement behind organ donation and saving lives through mathematics are reaching a national audience," Segev said. "I hope it creates more interest for this program, and any other programs that increase organ donation and awareness."

Math teachers, too, are thrilled by the success of *Numb3rs*, and by the positive light it has cast on math and mathematicians.

"Most of the math teachers I know who watch TV latched on to this right away as something [they] can use to motivate students," said Cathy Seeley, president of the National Council of Teachers of Mathematics, which represents 100,000 math instructors in the United States.

More than 25,000 teachers across the country are downloading classroom materials linked to each new *Numb3rs* episode. They've been prepared with help from the teacher's council and Texas Instruments

[Please see NUMB3RS, 5D]

»» ON TV *Numb3rs* airs at 10 tonight on CBS (WJZ, Channel 13)

'Numb3rs' solution

NUMB3RS [From Page 1D]

(which makes the gee-whiz calculator that math students favor).

While the week's script may not always fit in with a teacher's lesson plans, many will take five or 10 minutes to discuss the math that solves the crime.

"The overall impact is, it's clear that math is useful in some pretty interesting settings," Seeley said. "I think we're seeing that students are getting excited about mathematics."

Math teachers can get pretty excited, too. At a council convention last year, they mobbed *Numb3rs* actor David Krumholtz. He plays math genius Charlie Eppes, who is recruited from academia by his brother, FBI agent Don Eppes (Rob Morrow), to help solve crimes.

"The teachers actually rushed the stage," said Cheryl Heuton, a senior producer who created the show with her husband, Nick Falacci.

Numb3rs has made it to a second season with a surprisingly successful formula based on high-level mathematics in the service of justice.

"One of the delights of this show is to come up with these problems, and say, 'Gee, I wonder if math can be used with this?' " Heuton said. "And then we find out it's already been developed."

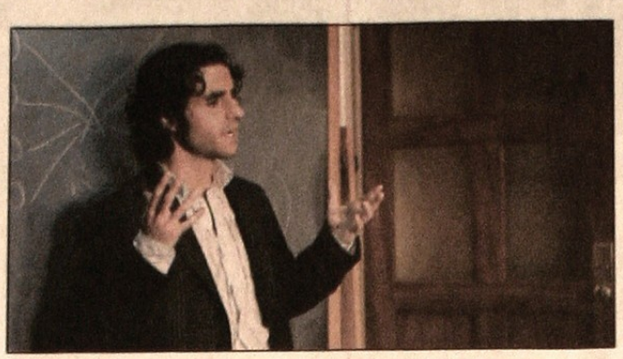
The show's characters have located a serial killer by mapping the murder sites and analyzing them with probability equations developed by a real Canadian mathematician. The technique helped solve a real case in Louisiana.

They've also found a missing aviator by using math developed to bring out a weak echo in radar data. Heuton said future scripts may incorporate such math esoterica as fractals, the Heisenberg uncertainty principle and "flock theory."

As unlikely as it seems, the show's mathematical solutions to crimes are drawing as many as 14 million viewers to *Numb3rs*' Friday night time slot. The show has TV's biggest Friday-night audience among the sought-after 18-to-49 age group.

"Ratings have been going up consistently every year," Falacci said. "Reruns are doing well, and it's doing very well overseas. ... It turns out that math has a bigger following in other countries than here."

Math? The subject so many of us squeaked through, or avoided whenever we could?



David Krumholtz is genius Charlie Eppes, who uses math to help his brother solve crimes on "Numb3rs," which airs on CBS.
CLIFF LIPSON [CBS]

Heuton and Falacci had their doubts, too. She was an English literature major. He studied film. But they were intrigued by the popularity of best-selling books based on math and science, including volumes by Stephen W. Hawking (*A Brief History of Time*), Timothy Ferris (*Coming of Age in the Milky Way*) and Dava Sobel (*Longitude*).

"We just thought, 'We're not the only science geeks who've read these books,' " Heuton said.

Another plus: the popularity of the procedural crime franchise *CSI: Crime Scene Investigation*, which turned forensic scientists into superheroes.

Even so, when Heuton and Falacci met with CBS Entertainment president Nina Tassler to pitch their idea, "we were prepared to have to put on a big show," Heuton said. "We were worried they would say math is intrinsically boring."

They needn't have worried. "About halfway through the pitch, she bought it," Falacci said. "She said this show would do for math what *CSI* has done for science."

Numb3rs producers have worked hard to get the math right. They've hired Gary Lorden, chairman of the math department at the California Institute of Technology, to help them find the right papers, experts, explanations and visuals to make the show look and sound authentic.

"In some episodes, it's much easier than in others," Lorden said. But "they don't feel comfortable with junk science or fake math."

The only beef that real Caltech mathematicians have with the show is that the fictional math whiz Charlie Eppes "is a superhero," Lorden said.

"He can do things with practically no data, and if it's epidemiology or earthquake engineering or aerodynamics — you name it and Charlie knows it. ... He can do things mere mortals at universities can't."

The math concepts that figure in their plots are snatched from the news, academic journals, popular articles and books, and then researched by the show's writers.

Tonight's episode was born when writer J. David Harden was exploring reports of a growing overseas black market in human organs.

What if someone brought poor people here from the Third World, took their kidneys and sold them to desperate Americans willing to pay a price to sidestep the long wait for donated organs?

While researching immune system compatibility, along with the many factors of age, location, blood type and tissue proteins that must be matched to find suitable organs for desperate patients, Harden happened across the work done by Segev and Gentry.

The couple had tackled a problem that arises when a healthy person volunteers to donate one kidney to an ailing friend or family member, only to find their tissues are incompatible. In such cases, the donor can't help, and the patient remains without an organ.

But what if doctors could find a second mismatched pair whose tissues would provide matches to the first pair? Both kidney patients would get suitable organs from strangers, and each donor would help two sick people get well.

The mathematical model by Segev and Gentry demonstrated that an optimized, national system for paired organ donations could produce thousands of additional matches annually. It would save hundreds of lives and hundreds of millions of dollars spent on kidney dialysis as patients wait for organs.

Efforts are under way to build such a national system. But for now, only a handful of regional centers are doing paired donations, limiting the results. Segev said about 60 transplants from paired donations have been done nationally, half of them at Hopkins.

That's out of 16,000 kidney transplants performed each year, most from deceased donors. About 61,000 U.S. patients are on waiting lists.

"The organ shortage is the primary issue facing transplantation right now," said Gentry.

What Harden's fictional FBI agents ask in tonight's episode of *Numb3rs* is whether such a matching system could enable them to take the unique blood and tissue types of a rescued black-market donor, and use them to identify the most likely recipient on the organ waiting list.

"Their feeling is if they can find who [the organ] is going to, they are going to find the person who's doing this," Heuton said.

Segev said the idea "makes reasonable sense," provided the FBI could gain access to the information, which is protected by federal privacy rules.

The script was already finished when the writers called Hopkins and asked to consult with Segev and Gentry to make sure they got the details right.

Gentry used a holiday visit with her parents in Los Angeles to talk to the show's writers. "Of course they had to work within the constraints of their story line," she said. So it "ends up dealing with something that happens very seldom, if ever — black-market organs."

But the producers wanted to make their filmed shots of computer screens look as much like the real tissue-matching system as possible. (Sometimes, they even use real mathematicians as stand-ins for the actors as they scrawl equations on a blackboard.)

"They wanted to represent the mathematics of what we were doing faithfully," Gentry said. "That is important for their show. There are a lot of math-savvy people watching."

What's more, she said, "I think it's wonderful to make math something glamorous, because in the real world I think it is. I do math that might save someone's life. ... Math is not just equations in a book."

So does that put Segev and Gentry among *Numb3rs*' many devotees? Not exactly.

"We don't own a television," Segev confessed. "We don't have time to watch."

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HOW IT WORKS

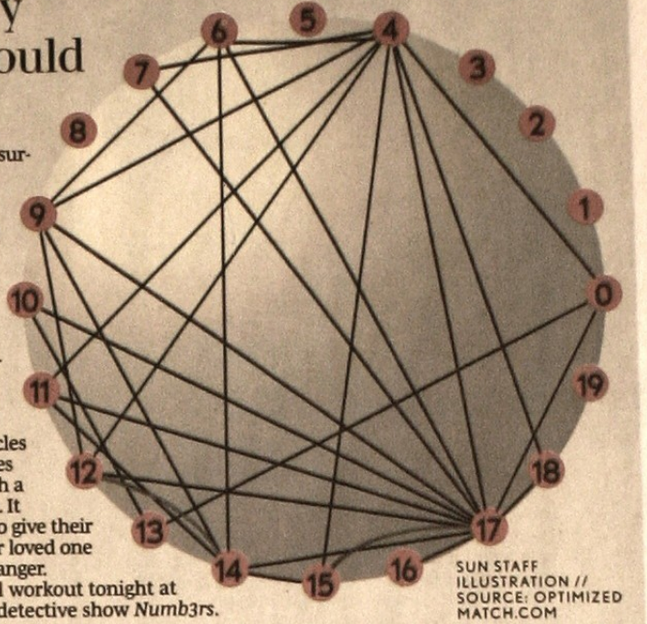
Paired kidney donations would save lives

Work by Hopkins transplant surgeon Dorry Segev and mathematician Sommer Gentry demonstrates that a paired organ matching system would increase the number of successful donations.

Each numbered circle here represents a kidney patient and a friend or relative willing to donate one of their kidneys. But their tissues don't match, preventing a life-saving operation.

The lines connecting two circles represent all the tissue matches that would be possible through a paired organ donation system. It would enable willing donors to give their organ to a stranger, while their loved one receives one from another stranger.

Their system gets a fictional workout tonight at 10 on Channel 13 in the CBS detective show *Numb3rs*.



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