



September 13, 2009

Are Your Friends Making You Fat?

By CLIVE THOMPSON

EILEEN BELLOLI KEEPS very good track of her friends. Belloli, who is 74, was born in Framingham, Mass., which is where she met her future husband, Joseph, when they were both toddlers. (“I tripped her and made her cry,” recalls Joseph, a laconic and beanpole-tall 76-year-old.) The Bellolis never left Framingham, a comfortable, middle-class town 25 miles west of Boston — he became a carpenter and, later, a state industrial-safety official; and after raising four children, she taught biology at a middle school. Many of her friends from grade school never left Framingham, either, so after 60 years, she still sees a half dozen of them every six weeks.

I visited the Bellolis at their home in Framingham last month, and when I asked Eileen about her old friends, she jumped up from her rose-colored rocking chair, ran to her cabinet and pulled down a binder filled with class photos and pictures from her school reunions. Every five years, she told me, she helps organize a reunion, and each time they manage to collect a group of about 30 students she has known since elementary and junior high school. She opened the binder and flipped through the pictures, each one carefully laminated, with a label on the back listing each classmate’s name. “I’m a Type A personality,” she said.

As I leafed through the binder, I could see that the Bellolis and their friends stayed in very good health over the years. As they aged, they mostly remained trim, even as many other Framingham residents succumbed to obesity. The fattening of America annoys Eileen — “people are becoming more and more accustomed to not taking responsibility for their actions,” she said — and she particularly prides herself on remaining active. Almost every day she does a three-mile circuit inside the local mall with her husband and a cluster of friends, though she speed walks so rapidly that some gripe about her breakneck pace. Her one vice used to be smoking, usually right after her teaching day ended. “I would take myself to Friendly’s with a book, and I would sit there and have two cups of coffee and two cigarettes,” she said. At the time, her cigarette habit didn’t seem like a problem; most of her friends also smoked socially. But in the late 1980s, a few of them began to quit, and pretty soon Eileen felt awkward holding a cigarette off to one side when out at a restaurant. She quit, too, and within a few years nobody she knew smoked anymore.

In the reunion photos, there is only one person who visibly degrades in health as the years pass: a boyish-faced man sporting mutton-chop sideburns. When he was younger, he looked as healthy as the rest of the crowd. But each time he showed up for the reunion, he had grown steadily heavier, until the 2003 photograph, when he looked straightforwardly obese, the only one of his size in the entire picture. Almost uniquely among the crowd, he did not remain friends with his old classmates. His only point of contact was the reunions, which he kept attending until he didn't show up last year. It turned out he'd died.

The man's story struck me as particularly relevant because Eileen and Joseph are part of a scientific study that might actually help explain his fate. The Bellolis are participants in the Framingham Heart Study, the nation's most ambitious project to understand the roots of heart disease. Founded in 1948 by the National Heart Institute, the study has followed more than 15,000 Framingham residents and their descendants, bringing them in to a doctor's office every four years, on average, for a comprehensive physical. Each time the Bellolis are examined, every aspect of their health is quantified and collected: heart rate, weight, blood levels and more. Over the decades, the Framingham study has yielded a gold mine of information about risk factors for heart disease; it was instrumental, for instance, in identifying the positive role of "good" cholesterol.

But two years ago, a pair of social scientists named Nicholas Christakis and James Fowler used the information collected over the years about Joseph and Eileen and several thousand of their neighbors to make an entirely different kind of discovery. By analyzing the Framingham data, Christakis and Fowler say, they have for the first time found some solid basis for a potentially powerful theory in epidemiology: that good behaviors — like quitting smoking or staying slender or being happy — pass from friend to friend almost as if they were contagious viruses. The Framingham participants, the data suggested, influenced one another's health just by socializing. And the same was true of bad behaviors — clusters of friends appeared to "infect" each other with obesity, unhappiness and smoking. Staying healthy isn't just a matter of your genes and your diet, it seems. Good health is also a product, in part, of your sheer proximity to other healthy people. By keeping in close, regular contact with other healthy friends for decades, Eileen and Joseph had quite possibly kept themselves alive and thriving. And by doing precisely the opposite, the lone obese man hadn't.

FOR DECADES, SOCIOLOGISTS and philosophers have suspected that behaviors can be "contagious." In the 1930s, the Austrian sociologist Jacob Moreno began to draw sociograms, little maps of who knew whom in friendship or workplace circles, and he discovered that the shape of social connection varied widely from person to person. Some were sociometric "stars," picked by many others as a friend, while others were "isolates," virtually friendless. In the 1940s and 1950s, social scientists began to analyze how the shape of a social network could affect people's behavior; others examined the way information, gossip and opinion flowed through that network. One pioneer was Paul Lazarsfeld, a sociologist at [Columbia University](#), who analyzed how a commercial product became popular; he argued it was a two-step process, in which highly connected people first absorbed the mass-media ads for a

product and then mentioned the product to their many friends. (This concept later bloomed in the 1990s and in this decade with the rage for “buzz marketing” — the attempt to identify thought-leaders who would spread the word about a new product virally.) Lazarsfeld also studied how political opinions flowed through friendship circles; he would ask a group of friends to identify the most influential members of their group, then map out how a political view or support for a candidate spread through and around those individuals.

By the 1980s and 1990s, alarmed by the dangers of smoking among young Americans, health care workers began to do the same work on groupings of teenagers to discover exactly how each individual was influenced to pick up the habit. The language of contagion is part of pop culture today, thanks in part to the influence of Malcolm Gladwell’s best-selling book “The Tipping Point.” It’s now common to speak of social changes as epidemics (like the “obesity epidemic”) and to talk about “superconnectors” who are so promiscuously well linked that they exert an outsize influence in society, ushering trends into existence almost single-handedly.

Yet the truth is, scientists have never successfully demonstrated that this is really how the world works. None of the case studies directly observed the contagion process in action. They were reverse-engineered later, with sociologists or marketers conducting interviews to try to reconstruct who told whom about what — which meant that people were potentially misrecalling how they were influenced or whom they influenced. And these studies focused on small groups of people, a few dozen or a few hundred at most, which meant they didn’t necessarily indicate much about how a contagious notion spread — if indeed it did — among the broad public. Were superconnectors truly important? How many times did someone need to be exposed to a trend or behavior before they “caught” it? Certainly, scientists knew that a person could influence an immediate peer — but could that influence spread further? Despite our pop-cultural faith in social contagion, no one really knew how it worked.

Sociologists began hunting for ongoing, real-life situations in which better data could be found. A 2000 study of dorm mates at [Dartmouth College](#) by the economist Bruce Sacerdote found that they appeared to infect each other with good and bad study habits — such that a roommate with a high grade-point average would drag upward the G.P.A. of his lower-scoring roommate, and vice versa. A 2006 Princeton study found that having babies appeared to be contagious: if your sibling has a child, you’re 15 percent more likely to have one yourself in the next two years. These were tantalizing findings, but again, each was too narrow to really indicate whether and how the effect worked in the mass public. What was needed was something more ambitious, some way of mapping out the links between thousands of real-life people for years — decades, even — to see whether, and how, behaviors spread.

NICHOLAS CHRISTAKIS BEGAN taking a new look at this question in 2000 after an experience visiting terminally ill patients in the working-class neighborhoods of Chicago. Christakis is a medical doctor and sociologist at [Harvard](#); back then, he was posted at the

[University of Chicago](#) and, at the age of 38, he had made a name for himself studying the “widowhood effect,” the well-known propensity of spouses to die soon after their partners’ deaths. One of his patients was a terminally ill elderly woman with dementia who lived with her daughter as her main caregiver. The daughter was exhausted from caring for her mother for months; the daughter’s husband, in turn, was becoming ill from coping with his wife’s extreme stress. One night after visiting the dying mother, Christakis arrived back at his office and got a phone call from a friend of the husband, asking for help, explaining that he, too, was feeling overwhelmed by the situation. The mother’s sickness had, in effect, spread outward “across three degrees of separation,” Christakis told me. “This illness affects the daughter, who spreads to the husband, who spreads to the friend, the guy who calls me up,” he added. He began talking to colleagues, wondering how he could further study the phenomenon.

In 2002, a common friend introduced him to James Fowler, at the time a Harvard political-science graduate student. Fowler was researching the question of whether the decision to vote in elections could spread virally from one person to another. Christakis and Fowler agreed that social contagion was an important area of inquiry and decided the only way to settle the many unanswered questions surrounding it was to find or compile a huge data set, one that tracked thousands of people. At first, they figured they would mount their own survey. They asked for \$25 million from the [National Institutes of Health](#) to track 31,000 adults for six years, but the N.I.H. said they had to find some preliminary evidence first. So they went on the hunt for an existing collection of data. They weren’t optimistic. While several large surveys of adult health exist, medical researchers have no tradition of thinking about social networks, so they rarely bother to collect data on who knows whom — which means there’s no way to track whether behaviors are spreading from person to person. Christakis and Fowler examined study after study, discarding each one.

Christakis knew about the Framingham Heart Study and arranged a visit to the town to learn more. The study seemed promising: he knew it had been underway for more than 50 years and had followed more than 15,000 people, spanning three generations, so in theory, at least, it could offer a crucial moving picture. But how to track social connections? During his visit, Christakis asked one of the coordinators of the study how she and her colleagues were able to stay in contact with so many people for so long. What happened if a family moved away? The woman reached under her desk and pulled out a green sheet. It was a form that staff members used to collect information from every participant each time they came in to be examined — and it asked them to list all their family and at least one of their friends. “They asked you, ‘Who is your spouse, who are your children, who are your parents, who are your siblings, where do they live, who is your doctor, where do you work, where do you live, who is a close friend who would know where to find you in four years if we can’t find you?’” Christakis said. “And they were writing all this stuff down.” He felt a jolt of excitement: he and Fowler could use these thousands of green forms to manually reconstruct the social ties of Framingham — who knew whom, going back decades.

Over the next few years, Christakis and Fowler managed a team that painstakingly sifted through the records. When they were done, they had a map of how 5,124 subjects were connected, tracing a web of 53,228 ties between friends and family and work colleagues. Next they analyzed the data, beginning with tracking patterns of how and when Framingham residents became obese. Soon they had created an animated diagram of the entire social network, with each resident represented on their computer screens as a dot that grew bigger or smaller as he or she gained or lost weight over 32 years, from 1971 to 2003. When they ran the animation, they could see that obesity broke out in clusters. People weren't just getting fatter randomly. Groups of people would become obese together, while other groupings would remain slender or even lose weight.

And the social effect appeared to be quite powerful. When a Framingham resident became obese, his or her friends were 57 percent more likely to become obese, too. Even more astonishing to Christakis and Fowler was the fact that the effect didn't stop there. In fact, it appeared to skip links. A Framingham resident was roughly 20 percent more likely to become obese if the friend of a friend became obese — even if the connecting friend didn't put on a single pound. Indeed, a person's risk of obesity went up about 10 percent even if a friend of a friend of a friend gained weight.

“People are connected, and so their health is connected,” Christakis and Fowler concluded when they summarized their findings in a July 2007 article in [The New England Journal of Medicine](#), the first time the prestigious journal published a study of how social networks affect health. Or as Christakis and Fowler put it in “Connected,” their coming book on their findings: “You may not know him personally, but your friend's husband's co-worker can make you fat. And your sister's friend's boyfriend can make you thin.”

Obesity was only the beginning. Over the next year, the sociologist and the political scientist continued to analyze the Framingham data, finding more and more examples of contagious behavior. Smoking, they discovered, also appeared to spread socially — in fact, a friend taking up smoking increased your chance of lighting up by 36 percent, and if you had a three-degrees-removed friend who started smoking, you were 11 percent more likely to do the same. Drinking spread socially, as did happiness and even loneliness. And in each case one's individual influence stretched out three degrees before it faded out. They termed this the “three degrees of influence” rule about human behavior: We are tied not just to those around us, but to others in a web that stretches farther than we know.

WHEN I FIRST MET Christakis and Fowler last spring, at a downtown Manhattan cafe, they seemed like a living example of their theory: even their conversational style appeared to be contagious, each of them bursting in in the middle of a sentence to complete the other's thought. Christakis, an intense and jovial man with bristling eyebrows and a booming voice, wore a suit with no tie and sipped a coffee. Fowler, who is 39, looked like a boyish wunderkind, wearing a T-shirt and jeans and a constant broad smile. In the

two years since they published their first work, they had become relatively famous and highly controversial. People — and late-night comics — were drawn to a theory that seemed to offer a scientific basis for some exquisitely calculating behavior, like avoiding your friends if they get fat. (Or avoiding your friends merely because some of their friends' friends gained a couple of pounds.) Newspapers splashed Christakis and Fowler's obesity findings across front pages, and the study penetrated into corners of the popular culture generally untouched by social-science research. "My favorite was the 'Cathy' cartoon," Fowler told me; in it, Cathy and two friends sit in a restaurant, chatting about the obesity paper; when the waiter comes, each woman points to another and says, "She'll have a small dry salad and a cup of water."

Fowler told me their work had inspired him to lose five pounds and to listen to upbeat music before he arrives home from work so he will be in a good mood when he greets his family. "I try to get myself in a mental space where I'll be happy," he says. "Because I know that I'm not just having an impact on my son, I'm potentially having an impact on my son's best friend's mother."

But how, exactly, could obesity or happiness spread through so many links? Between one immediate peer and another, some contagious behaviors — like smoking — seem pretty commonsensical. If lots of people around you are smoking, there's going to be peer pressure for you to start, whereas if nobody's smoking, you'll be more likely to stop. But the simple peer-pressure explanation doesn't work as well with happiness or obesity: we don't often urge people around us to eat more or implore them to be happier. (In any case, simply telling someone to be happier or unhappier isn't likely to work.) Instead, Christakis and Fowler hypothesize that these behaviors spread partly through the subconscious social signals that we pick up from those around us, which serve as cues to what is considered normal behavior. Scientists have been documenting this phenomenon; for example, experiments have shown that if a person is seated next to someone who's eating more, he will eat more, too, unwittingly calibrating his sense of what constitutes a normal meal. Christakis and Fowler suspect that as friends around us become heavier, we gradually change our mental picture of what "obese" looks like and give ourselves tacit permission to add pounds. With happiness, the two argue that the contagion may be even more deeply subconscious: the spread of good or bad feelings, they say, might be driven partly by "mirror neurons" in the brain that automatically mimic what we see in the faces of those around us — which is why looking at photographs of smiling people can itself often lift your mood.

"In some sense we can begin to understand human emotions like happiness the way we might study the stampeding of buffalo," Christakis said. "You don't ask an individual buffalo, 'Why are you running to the left?' The answer is that the whole herd is running to the left. Similarly, you can see pockets of unhappy and happy people clustered in the network. They don't even know each other necessarily," but their moods rise and fall together.

The subconscious nature of emotional mirroring might explain one of the more curious findings in their research: If you want to be happy, what's most important is to have lots of friends. Historically, we have often thought that having a small cluster of tight, long-term friends is crucial to being happy. But Christakis and Fowler found that the happiest people in Framingham were those who had the most connections, even if the relationships weren't necessarily deep ones.

The reason these people were the happiest, the duo theorize, is that happiness doesn't come only from having deep, heart-to-heart talks. It also comes from having daily exposure to many small moments of contagious happiness. When you frequently see other people smile — at home, in the street, at your local bar — your spirits are repeatedly affected by your mirroring of their emotional state. Of course, the danger of being highly connected to lots of people is that you're at risk of encountering many people when they are in bad moods. But Christakis and Fowler say their findings show that the gamble of increased sociability pays off, for a surprising reason: Happiness is more contagious than unhappiness. According to their statistical analysis, each additional happy friend boosts your good cheer by 9 percent, while each additional unhappy friend drags you down by only 7 percent. So by this logic, adding more links to your network should — mathematically — add to your store of happiness. "If you're at the center of a network, you are going to be more susceptible to anything that spreads through it," Fowler said. "And if happiness is spreading more reliably, then on average you're going to be catching happy waves more often than you catch sad waves."

The Framingham findings also suggest that different contagious behaviors spread in different ways. For example, co-workers did not seem to transmit happiness to one another, while personal friends did. But co-workers did transmit smoking habits; if a person at a small firm stopped smoking, his or her colleagues had a 34 percent better chance of quitting themselves. The difference is based in the nature of workplace relationships, Fowler contends. Smokers at work tend to cluster together outside the building; if one of them stops smoking, it reduces the conviviality of the experience. (If you're the last smoker outside on a freezing afternoon, your behavior can seem completely ridiculous even to yourself.) But when it comes to happiness, Fowler said, "people are both cooperative and competitive at work. So when one person gets a raise, it might make him happy, but it'll make other people jealous."

Obesity had its own quirk: Spouses didn't appear to have as big an effect on each other as friends. If a male Framingham subject had a male friend who became fat, his risk doubled, but if his wife became obese, his risk was increased by only 37 percent. This, Christakis and Fowler say, is because when it comes to body image, we compare ourselves primarily to people of the same sex (and in the Framingham study, all spouses were of the opposite sex). In fact, different-sexed friends didn't transmit any obesity to one another at all. If a man became fat, his female friends were completely unaffected, and vice versa. Similarly, siblings of the same sex had a bigger impact on one another's weight than siblings of the opposite sex.

When it came to drinking, Christakis and Fowler found a different kind of gender effect. Framingham women were considerably more influential than Framingham men. A woman who began drinking heavily increased the heavy-drinking risk of those around her, whereas heavy-drinking men had less effect on other people. Why? In the age of frat-party binge drinking, you might imagine that hard-partying men are the most risky people to be around. But Fowler says he suspects women are more influential precisely because they tend to drink less. When a woman starts drinking heavily, he says, it sends a strong signal to those around her that it's O.K. to start boozing too.

Christakis and Fowler's strangest finding is the idea that a behavior can skip links — spreading to a friend of a friend without affecting the person who connects them. If the people in the middle of a chain are somehow passing along a social contagion, it doesn't make sense, on the face of it, that they wouldn't be affected, too. The two researchers say they don't know for sure how the link-jumping works. But they theorize that people may be able to pass along a social signal without themselves acting on it. If your friends at work become obese, even if you don't gain weight yourself, you might become more accepting of obesity as a normal state — and unconsciously transmit that signal to your family members, who would then feel a sort of permission to gain weight themselves, knowing they wouldn't face any sort of censure from you.

Christakis and Fowler postulate that our ability to affect people three degrees away from us may have evolutionary roots — and so may the very shape of human social networks. Tribal groups that were tightly connected were likely more able to pass along positive behaviors than those that weren't. Christakis and Fowler say social contagion could even help explain the existence of altruism: if we can pass on altruism to distant points in a network, it would help explain why altruistic people aren't simply constantly taken advantage of by other members of their community. Last year, to test this theory, they conducted a laboratory experiment in which participants played a “cooperation game.” Each participant was asked to share a sum of money with a small group and could choose to be either generous or selfish. Christakis and Fowler found that if someone was on the receiving end of a generous exchange, that person would become more generous to the next set of partners — until the entire larger group was infected, as it were, with altruistic behavior, which meant the altruist would benefit indirectly.

CHRISTAKIS AND FOWLER'S work has produced a variety of reactions from other scientists. Many health care experts are thrilled. After years of observing patients, they suspected that behaviors spread socially; now there was data that appeared to prove it. “It was an aha! moment,” James O. Hill, a pioneering obesity researcher at the [University of Colorado](#), Denver, said about the time in 2007 when he read the researchers' first obesity paper. Tom Valente, the director of the master's of public health program at the [University of Southern California](#) and an early investigator of the role of social networks in smoking behavior, was similarly excited. “The Christakis and Fowler work is fantastic,” he told me. Among public-health practitioners, he said, their theories have “had amazing

acceptance.”

But many of those who study networks are more cautious in their reactions. Unlike medical experts, these scientists specialize in the study of networks themselves — anything ranging from neighborhoods linked via the power grid to teenagers linked on [Facebook](#) — and they are familiar with the difficulty of ascertaining cause and effect in such complex constructs. As they point out, the Framingham study has found intriguing correlations in people’s behavior. Christakis and Fowler can show what appear to be waves of obesity or smoking moving across the map. But that doesn’t prove social contagion is causing the spread.

There are at least two other possible explanations. One is “homophily,” the tendency of people to gravitate toward others who are like them. People who are gaining weight might well prefer to hang out with others who are also gaining weight, just as people who are happy might seek out others who are happy. The other possible explanation is that the shared environment — and not social contagion — might be causing the people of Framingham to change in groups. If a McDonald’s opens up in a Framingham neighborhood, it could cause a cluster of people living nearby to gain weight or become slightly happier (or sadder, depending on what they think about McDonald’s). The cluster of people would appear as though they are sharing a contagious form of behavior, but it would be an illusion.

Because of the confounding factors, as they are called, of homophily and the environment, many social scientists find themselves caught in an emotional bind when it comes to Christakis and Fowler’s work. As Alex Pentland, former academic head of the [M.I.T. Media Lab](#) and an expert in unconscious social signals, told me, “You couldn’t prove what they say, but I happen to believe it.” I heard precisely the same thing from many of Pentland’s peers. They have all long suspected that human behavior is widely contagious; they just don’t think Christakis and Fowler have proved their case.

One of Christakis and Fowler’s most prominent critics is Jason Fletcher, an assistant professor of public health at [Yale University](#). Last year, he and an economist named Ethan Cohen-Cole published two papers arguing that Christakis and Fowler had not successfully stripped out all possible homophily effects from their calculations. Fletcher initially wanted to replicate Christakis and Fowler’s analysis of the data, but he didn’t have access to their source; Christakis and Fowler have not published their network data, arguing that doing so would violate the privacy rights of the participants in the Framingham Heart Study. Faced with that obstacle, Fletcher and his colleague decided instead to test Christakis and Fowler’s mathematical techniques on a different set of data: the Add Health study, a federal-government project that tracked the health of 90,118 students at 144 high schools and middle schools between 1994 and 2002. Among the questionnaires the researchers distributed was one that asked students to list up to 10 of their friends. This allowed Fletcher to build maps of how the friends at each school were linked, school by school, giving them a set of

small social networks upon which to test Christakis and Fowler's math. (Before they stumbled upon the Framingham data, Christakis and Fowler themselves had considered using the Add Health surveys to look for social contagion. But they decided the data sets were too limited — each of the schools had only several hundred students interlinked — to produce results in which they could have confidence. They also wanted to study adults, figuring that the peer effects among teenagers are qualitatively different.)

When Fletcher analyzed the student cliques using statistical tools that he says are similar to those used by Christakis and Fowler, he found that social contagion indeed existed. But the behaviors and conditions that were apparently contagious were entirely implausible: they included acne, height and headaches. How could you become taller by hanging around with taller people? This, Fletcher concluded, called into doubt whether Christakis and Fowler's statistical techniques really removed homophily or environmental effects — and he says this means the Framingham results are just as dubious. When I spoke to Fletcher, he said that he, too, believes social-contagion effects are real. “We are on board with the idea that they exist and they're important,” he added. But he simply isn't impressed by Christakis and Fowler's evidence.

Other scientists have pointed out another important limitation in Christakis and Fowler's work, which is that their map showing connections between the people of Framingham is necessarily incomplete. When the Framingham participants checked in every four years, they were asked to list all their family members — but only one person they considered a close friend. This could arguably mean that those eerie three-degree effects might be an illusion. For example, if John lists Allison as his friend, and Allison lists Robert as her friend, and Robert lists Samantha as his friend, then Christakis and Fowler could conclude that John is three links away from Samantha. But what if John and Samantha actually know each other from church, but didn't have a way to indicate this on the Framingham forms? Then if John and Samantha both become slightly fatter, it might look like a social contagion is spreading through three social ties, via Allison and Robert, when in fact it's only spreading through one link, via church.

When I raised this concern with Christakis and Fowler, they agreed that their map of friendships isn't perfect. “This is a general problem with our study and with any similar study,” Christakis said. But he said he believes their map of the Framingham connections has far fewer holes than critics charge. When he and Fowler tallied up the green sheets, they often were able to deduce relationships between two people who didn't explicitly list each other as acquaintances — reducing the number of false three-degree links. (One helpful fact was that many participants listed more than one friend, despite the instructions on the green sheets.) “We are not overreaching our data,” Christakis insisted.

He and Fowler also acknowledged that it is impossible to completely remove the problems of homophily and environmental effects. This doesn't mean they agree with Fletcher; in fact, they point out that in his height-and-acne paper, he used a somewhat looser

mathematical model, one that makes it easier to produce spurious correlations between people — which is why, they say, Fletcher found that acne and height were contagious. When they ran their own statistical technique on the Add Health data, they found that obesity followed precisely the same three-degree pattern of contagion as they found in Framingham.

And Christakis and Fowler point to two other findings to bolster their case for social contagion over environmental effects. One is that in the Framingham study, obesity seemed to be able to jump from friend to friend even over great distances. When people moved away, their weight gain still appeared to influence friends back in Massachusetts. In such cases, the local environment couldn't be making both gain weight, Christakis and Fowler say.

Their other finding is more intriguing and arguably more significant: They discovered that behaviors appear to spread differently depending on the type of friendship that exists between two people. In the Framingham study, people were asked to name a close friend. But the friendships weren't always symmetrical. Though Steven might designate Peter as his friend, Peter might not think of Steven the same way; he might never designate Steven as a friend. Christakis and Fowler found that this “directionality” mattered greatly. According to their data, if Steven becomes obese, it has no effect on Peter at all, because he doesn't think of Steven as a close friend. In contrast, if Peter gains weight, then Steven's risk of obesity rises by almost 100 percent. And if the two men regard each other as mutual friends, the effect is huge — either one gaining weight almost triples the other's risk. In Framingham, Christakis and Fowler found this directionality effect even among people who lived and worked very close to each other. And that, they argue, means it can't be the environment that is making people in Framingham fatter, since the environment ought to affect each of these friends equally.

“If a McDonald's opens up nearby, it should make both of us gain weight simultaneously,” Christakis adds. “It shouldn't matter whether I nominate you as a friend or you nominate me.” In fact, though, the directionality effect seems to matter very much, and that fact, in turn, buttresses the case for social contagion.

Duncan Watts, a social-network pioneer and a researcher for Yahoo, has reservations about some of Christakis and Fowler's findings — for example, he thinks the fact that most of the Framingham participants listed only one friend “really casts some doubt” on the three-degrees theory. But he told me that the directionality effect is one finding that none of Christakis and Fowler's critics have been able to rebut. It is, for him, the strongest evidence that the Framingham results aren't just caused by the environment or by people flocking to others like them. “I don't see how that can be explained any other way,” he said.

IF YOU LOOK AT A CHART showing the change in smoking rates in the United States since the 1970s, it is a picture of early public-

health success that soon tails off. In 1970, the smoking rate for adults was 37 percent. It fell to 33 percent by 1980 and then fell even more precipitously between 1980 and 1990. But after that, the rate at which people quit smoking began to slow. Between 2004 and 2005, in fact, the smoking rate stayed steady; on balance, nobody quit smoking those years. Antismoking forces successfully pushed the number of smokers down to one in five people, but they now seem stuck. Smoking-cessation experts have debated why it has become so hard to get the final holdouts to quit. Perhaps, some said, it was because the average cost of a pack of cigarettes remains largely unchanged nationally since 2002.

But there might be another, hidden reason: the shape of a smoker's social ties. When Christakis and Fowler mapped out the way Framingham people quit smoking during roughly the same period — 1971 to 2003 — they found that the decline was not evenly distributed across the town. Instead, clusters of friends all quit smoking at the same time, in a group. It was like a ballroom emptying out one table at a time. But this meant that by 2003, the remaining smokers were also not evenly distributed: instead, they existed in isolated, tightly knit clusters of like-minded nicotine fiends. Worse, those clusters had migrated to the edges of the social network, where they were less interlinked with the mass of Framingham participants. In their everyday social lives, Christakis and Fowler say, the town's remaining smokers are thus mostly surrounded by people who still smoke, and they rarely have strong connections with nonsmokers. Nonsmoking may be contagious, but the smokers don't appear to be close to anyone from whom they could catch the behavior.

The federal government has officially set a goal of reducing the number of smokers in the country to 12 percent of the population by 2010. But the very shape of our social networks is working against that goal, Fowler says, and this poses a potential public-health challenge. Meanwhile, public-health strategists who want to counteract obesity face the opposite problem. Since the country is gradually becoming more and more obese, when individual people do lose weight, they are more likely to be surrounded by people who are still heavy. If it's true that obesity can affect people even three links away, that may be one reason that people have such trouble keeping weight off. Even if they form a weight-loss group to lose weight with their close friends, they will still be influenced by obese people two or three links away — people they barely know. "We know that people are wildly successful in losing weight and wildly unsuccessful in keeping it off," Hill, the obesity researcher, says; he believes Framingham offers an important explanation of why this is.

In essence, Christakis and Fowler's work suggests a new way to think about public health. If they're right, public-health initiatives that merely address the affected individuals are doomed to failure. To really grapple with bad behaviors that spread, you have to simultaneously focus on individuals who are so distant they don't even realize they're affecting one another. Hill says this is possible with obesity. Last year, he collaborated with David Bahr, a physicist at Regis University in Denver, to construct a computer model of

society that replicates the way obesity spreads. They created a simulation of hundreds of thousands of individuals, each programmed to influence one another in precisely the same way that Christakis and Fowler documented in Framingham. To test whether their model accurately mimicked reality, they seeded it with a few obese people and set it running. The virtual society slowly became obese in the same pattern and at the same rate as Framingham. If they could accurately copy the way Framingham became obese, they figured, they could then use the model to test different ways that the spread might be halted. They began trying different experiments — like focusing on specific individuals and seeing whether or not they could use them to create a counterepidemic of skinniness.

One solution jumped out at them. In theory, the best way to fight obesity, the model predicted, isn't to urge people to diet with a cluster of close friends. It is to encourage them to skip a link and to diet with friends of friends. That way, in your immediate social network, everyone would be surrounded on at least one side by people who are actively losing weight, and this would in turn influence those other links to begin losing weight themselves. When Hill and Bahr ran the simulation with this sort of staggered dieting, it worked: the virtual society began slimming down, and the obesity epidemic reversed itself. "It's like you have bridging dams to try and stop the flow," Bahr told me. (Bahr also found that the obesity epidemic could be reversed quickly, with only 1 percent of the entire population losing weight, so long as the dieters were placed in precisely the right spots. "You don't need a lot of people, but you do need the right ones," he said.)

In reality, of course, this sort of intervention would be quite difficult to pull off. You would have to figure out some way to persuade friends of friends to form dieting groups together. But other scientists have used Christakis and Fowler's work to inspire more potentially practical public-health projects, some of which are now being implemented. Nathan Cobb, a smoking-cessation expert and researcher at the Schroeder Institute for Tobacco Research and Policy Studies, is designing an application that Facebook users can install on their pages when they're trying to quit smoking. The application will publicly display how long they've gone without cigarettes, whether they are using a nicotine patch and how much money they have saved by not smoking. The idea, Cobb says, is to take your invisible, internal battle to quit smoking and make it visible so that it can influence your friends (and friends of friends) who are still puffing away.

IT'S TEMPTING TO think, confronted by Christakis and Fowler's work, that the best way to improve your life is to simply cut your ties to people with bad behavior. And obviously this is possible; people change their friends often, sometimes abruptly. But reshaping your social network may be more challenging than altering your behavior. There's also compelling evidence in their research that we do not have as much control as we might think we do over the way we're linked to other people: our location in a social network, say, or how many of our friends know each other. These patterns in our life are relatively stable, and they might, weirdly, be partly innate.

Christakis and Fowler first noticed this effect when they examined their happiness data. They discovered that people who were deeply enmeshed in friendship circles were usually much happier than “isolates,” those with few ties. But if an isolate did manage to find happiness, she did not suddenly develop more ties and migrate to a position where she was more tightly connected to others. The reverse was also true: if a well-connected person became unhappy, he didn’t lose his ties and become an isolate. Your level of connectedness appears to be more persistent than even your overall temperament. “If you picked up someone who’s well connected and dropped them into another network, they’d migrate toward the center,” Christakis said. Your place in the network affects your happiness, in other words, but your happiness doesn’t affect your place in the network.

Christakis and Fowler began to wonder if a person’s connectedness is to some degree fated from birth — a product, at least in part, of DNA. To test the idea, they conducted a study of twins. Using the Add Health school data, they located more than 500 sets of twins and analyzed where they were located in their friendship clusters. Employing statistical techniques traditionally used to parse out how much of twins’ lifestyles are attributable to their genes as opposed to their environment, they found that almost half — 46 percent — of the difference between two twins’ levels of connectedness could be explained by DNA. “On average,” they wrote, “a person with five friends has different genes than a person with one friend.” More oddly still, twins also tended to have the same “transitivity”: their friendship groupings had a strikingly similar degree of interlinking, which is the number of friends who knew one another. By and large, the people who were most tightly clustered in Framingham tended to be better off — healthier, happier and even wealthier. (Several other economic studies have also found that better-connected people make more money.) But if half the reason these people were so well positioned is related to the accident of DNA, then you could consider connectedness a new form of inequality: lucky and unlucky cards, dealt out at birth.

Social-network science ultimately offers a new perspective on an age-old question: to what extent are we autonomous individuals? “If someone does a good thing merely because they’re copying others, or they do something bad merely because they’re copying others, what credit do they deserve, or what blame do they deserve?” Christakis asks. “If I quit smoking because everyone around me quits smoking, what credit do I get” for demonstrating self-control? If you’re one of the people who are partly driven by his DNA to hang out on the periphery of society, well, that’s also where the smokers are, which means you are also more likely to pick up their habit.

To look at society as a social network — instead of a collection of individuals — can lead to some thorny conclusions. In a column published last fall in *The British Medical Journal*, Christakis wrote that a strictly utilitarian point of view would suggest we should give better medical care to well-connected individuals, because they’re the ones more likely to pass on the benefits contagiously to others. “This conclusion,” Christakis wrote, “makes me uneasy.”

Yet there is also, the two scientists argue, something empowering about the idea that we are so entwined. “Even as we are being influenced by others, we can influence others,” Christakis told me when we first met. “And therefore the importance of taking actions that are beneficial to others is heightened. So this network thing can cut both ways, subverting our ability to have free will, but increasing, if you will, the importance of us having free will.”

As Fowler pointed out, if you want to improve the world with your good behavior, math is on your side. For most of us, within three degrees we are connected to more than 1,000 people — all of whom we can theoretically help make healthier, fitter and happier just by our contagious example. “If someone tells you that you can influence 1,000 people,” Fowler said, “it changes your way of seeing the world.”

Clive Thompson, a contributing writer for the magazine, writes frequently about technology and science.

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