"*Connected* could change your life forever."
— DANIEL GILBERT, author of *Stumbling on Happiness*

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Connected

The Surprising Power of Our Social Networks and How They Shape Our Lives

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Notes

For Erika, Sebastian, Lysander, and Eleni

and

for Harla, Lucas, and Jay

to whom our connection is aeonian

LITTLE,
BROWN
SPARK

Preface

Social networks are intricate things of beauty. They are so elaborate and so complex—and so ubiquitous, in fact—that one has to wonder what purpose they serve. Why are we embedded in them? How do they form? How do they work? How do they affect us?

I (Nicholas) have been animated by these questions for the better part of the past ten years. I began by being interested in the simplest social network of all: a pair of people, a dyad. Initially, the dyads I studied were husbands and wives. As a physician caring for terminally ill patients and their families, I noticed the serious toll that a loved one's death had on a spouse. And I became interested in how illness in one person might cause illness in another. For it seemed to me that if people are interconnected, their health must also be interconnected. If a wife falls ill or dies, her husband's risk of death assuredly rises. Eventually, I began to realize that there were all kinds of dyads I might study, such as pairs of siblings or pairs of friends or pairs of neighbors who are connected (*not* separated) by a backyard fence.

But the intellectual heart of the matter was not in these simple arrangements. Instead, the key realization was that

these dyads agglomerate to form huge webs of ties stretching far into the distance. A man's wife has a best friend who has a husband who has a coworker who has a sibling who has a friend, and so on and so forth. These chains branch like lightning bolts, forming intricate patterns throughout human society. The situation, it seemed, was much more complicated. With every step away from an individual in a social network that we take, the number of ties to other humans, and the complexity of the branching, rise very, very fast. As I reflected on this problem, I began to read the work of other social scientists, from lonely German scholars at the turn of the twentieth century to visionary sociologists in the 1970s, who had studied social networks ranging in size from three to thirty people. But my interest lay in social networks of three thousand or thirty thousand or even three million people.

I realized that to study things of such complexity, I would make better progress if I worked with another investigator. As it turned out, James Fowler, also at Harvard, was studying networks from a completely different perspective. James and I did not know each other despite working in adjoining buildings on the same campus for several years. In 2002 we were introduced by a mutual colleague, political scientist Gary King. In other words, we started our journey as friends of a friend. Gary thought we might have common intellectual interests, and he was right. Indeed, the very fact that we met because of our social network illustrates a major point we want to make about how and why social networks operate and how they benefit us.

James had spent a number of years studying the origin of people's political beliefs and examining how one person's attempt to solve a social or political problem influenced others. How did humans come together to accomplish what they could not do on their own? And he shared interests in other topics that were a key part of the story: altruism and goodness, both of which are essential for social networks to grow and endure.

control of their destinies, and those who believe that social forces (ranging from a lack of good public education to the presence of a corrupt government) are responsible for what happens to us.

However, we think that a third factor is missing from this debate. Given our research and our own diverse experiences in life—from meeting our spouses to meeting each other, from caring for terminally ill patients to building latrines in poor villages—we believe that our connections to other people matter most, and that by linking the study of individuals to the study of groups, the science of social networks can explain a lot about human experience. This book focuses on our ties to others and how they affect emotions, sex, health, politics, money, evolution, and technology. But most of all it is about what makes us uniquely human. To know who we are, we must understand how we are connected.

CHAPTER 1

In the Thick of It

In the mountain village of Levie, Corsica, during the 1840s, Anton-Claudio Peretti became convinced that his wife, Maria-Angelina, was having an affair with another man and that, even worse, their daughter was not his child. Maria told Anton that she was going to leave him, and she made preparations to do so with her brother, Corto. That very evening, Anton shot his wife and daughter to death and fled to the mountains. The bereft Corto sorely wanted to kill Anton, but he could not find him. In a bit of violent symmetry that seemed sensible to residents of the area, Corto instead killed Anton's brother, Francesco, and nephew, Aristotelo.

It did not end there. Five years later, Giacomo, brother of the deceased Aristotelo, avenged the deaths of his brother and father by killing Corto's brother. Giacomo wanted to kill Corto's father too, but he had already died of natural causes, denying Giacomo the satisfaction. [1] In this cascade of death, Giacomo and Corto's brother were connected by quite a path: Giacomo was the son of Francesco, who was the brother of

Anton, who was married to Maria, who was the sister of Corto, whose brother was the target of Giacomo's murderous wrath.

Such behavior is not restricted to historically or geographically distant places. Here is another example, closer to home: Not long before the summer of 2002 in St. Louis, Missouri, Kimmy, an exotic dancer, left a purse containing $900 in earnings with a friend while she was busy. When she came back to reclaim it, her friend and the purse were gone. But a week later, Kimmy's cousin spotted the purse thief's partner at a local shop, and she called Kimmy. Kimmy raced over with a metal pole. She viciously attacked this friend of her erstwhile friend. Later she observed with pride that she had "beat her [friend's] partner's ass... . I know I did something... [to get even] that's the closest thing I could [do]." [2]

Cases like these are puzzling. After all, what did Anton's brother and nephew and Kimmy's friend's friend have to do with anything? What possible sense is there in injuring or killing the innocent? Even by the incomprehensible standards of murderous violence, what is the point of these actions, taken one week or five years later? What explains them?

We tend to think of such cases as quaint curiosities, like Appalachian feuds, or as backward practices, like the internecine violence between Shiite and Sunni tribesmen or the cycle of killings in Northern Ireland or the reciprocating gang violence in American cities. But this grim logic has ancient roots. It is not just that the impetus to revenge is ancient, nor even that such violence can express group solidarity ("we are Hatfields, and we hate McCoys"), but that violence—in both its minor and extreme forms—can spread through social ties and has done so since humans emerged from the African savanna. It can spread either in a directed fashion (retaliating against the perpetrators) or in a generalized fashion (harming nondisputants nearby). Either way, however, a single murder can set off a cascade of killings. Acts of aggression typically diffuse outward from a

starting point—like a bar fight that begins when one man swings at another who ducks, resulting in a third man getting hit, and soon (in what has become a cliché precisely because it evokes deep-seated notions of unleashed aggression) punches are flying everywhere. Sometimes these epidemics of violence, whether in Mediterranean villages or urban gangs, can persist for decades. [3]

Notions of collective guilt and collective revenge that underlie cascades of violence seem strange only when we regard responsibility as a personal attribute. Yet in many settings, morality resides in groups rather than in individuals. And a further clue to the collective nature of violence is that it tends to be a public, not a private, phenomenon. Two-thirds of the acts of interpersonal violence in the United States are witnessed by third parties, and this fraction approaches three-fourths among young people. [4]

Given these observations, perhaps the person-to-person spread of violence should not surprise us. Just as it is often said that "the friend of my friend is my friend" and "the enemy of my enemy is my friend," so too the friend of my enemy is my enemy. These aphorisms encapsulate certain truths about animosity and affection, but they also convey a fundamental aspect of our humanity: our connection. While Giacomo and Kimmy acted alone, their actions show just how easily responsibility and retaliation can diffuse from person to person to person across social ties.

In fact, we do not even have to search for complicated paths across which violence spreads, because the initial step, from the very first person to the next, accounts for most of the violence in our society. In trying to explain violence, it is myopic to focus solely on the perpetrator—his frame of mind, his finger on the trigger—because murder is rarely a random act between strangers. In the United States, 75 percent of all homicides involve people who knew each other, often intimately, prior to the murder. If you want to know who might take your life, just look at the people around you.

But your social network also includes those who might

save your life. "On March 14, 2002, I gave my right kidney to my best friend's husband," Cathy would later note in an online forum that chronicles the experiences of people who become "living donors" of organs. The summer before, during a heartfelt chat, Cathy had learned that her friend's husband's renal failure had worsened and that he needed a kidney transplant in order to survive. Overcome with the desire to help, Cathy underwent a series of medical and psychological evaluations, getting more and more excited as she passed each one and moved closer to her goal of donating one of her kidneys. "The experience has been the most rewarding of my life," she wrote. "I am so grateful that I was able to help my best friend's husband. His wife has her husband back. His sons have their dad back... . It's a win-win situation. We all win. I gave the gift of life." [5]

Similar stories abound, and such "directed donations" of organs can even come to involve people who have rather tenuous connections, a Starbucks clerk and his longtime customer, for example. There can even be organ-donation cascades that loosely resemble the Perettis' murder cascade. John Lavis, a sixty-two-year-old resident of the town of Mississauga, Ontario, father of four and grandfather of three, was dying of heart failure in 1995. His heart had failed during triple-bypass surgery, and he was placed on a temporary artificial heart. In a stroke of unbelievable good fortune, a donor heart was transplanted into him just eight days later when he was on the brink of death. His daughter recalled: "We were a family of immense gratitude... . [My father] received the biggest gift he will ever receive—his life was given back to him." Motivated by this experience, Lavis's children all signed organ-donor cards, thinking that this symmetrical act was the least they could do. Then in 2007, Lavis's son Dan died in a work-related accident. Eight people benefited from Dan's decision to donate his organs. The woman who received his heart later wrote to the Lavis family, thanking them for "giving her a new life." [6] The same year in the United States, a similar cascade an amazing ten links long

them able to do more things and different things than the individuals themselves?

To answer these questions, and before we get to the fun stuff, we first need to explain a few basic terms and ideas of network theory. These basic concepts set the stage for the individual stories and the more complicated ideas we will soon explore as we investigate the surprising power of social networks to affect the full spectrum of human experience.

We should first clarify what we mean by a group of people. A *group* can be defined by an attribute (for example, women, Democrats, lawyers, long-distance runners) or as a specific collection of individuals to whom we can literally point ("those people, right over there, waiting to get into the concert"). A social network is altogether different. While a network, like a group, is a collection of people, it includes something more: a specific set of connections between people in the group. These ties, and the particular pattern of these ties, are often more important than the individual people themselves. They allow groups to do things that a disconnected collection of individuals cannot. The ties explain why the whole is greater than the sum of its parts. And the specific pattern of the ties is crucial to understanding how networks function.

The bucket brigade that saves a house is a very simple social network. It is linear and has no branches: each person (except the first and last) is connected to two other people, the one in front and the one behind. For moving something like water long distances, this is a good way to be organized. But the optimal organization of one hundred people into a network depends very much on the task at hand. The best pattern of connections between a hundred people to put out a fire is different from the best pattern for, say, achieving a military objective. A company of one hundred soldiers is typically organized into ten tightly interconnected squads of ten. This allows each soldier to know all of his squad mates rather than just the grunt in front of him and the grunt behind him. The military goes to great lengths to help squad

members know each other very well, so well in fact that they are willing to give their lives for one another.

Consider still another social network: the telephone tree. Suppose you need to contact a hundred people quickly to let them know that school is canceled. Before modern communications and the Internet, this was a challenge because there was no public source of up-to-the-minute information that everyone could access from their homes (though the ringing of church bells in the town square comes to mind). Instead, each person needed to be contacted directly. The telephone made this task much easier, but it was still a burden for one person to make all one hundred calls. And even if someone set out to do this, it might take quite a while to get to the people at the end of the list, by which time they may have already left home for school. Having a single person make all the calls is both inefficient and burdensome.

Ideally, one person would set off a chain reaction so that everyone could be reached as quickly as possible and with the least burden on any particular individual. One option is to create a list and have the person at the top of the list call the next person, the second person call the third, and so on until everyone gets the message, as in a bucket brigade. This would distribute the burden evenly, but it would still take a really long time for the hundredth person to be reached. Moreover, if someone in the sequence was not home when called, everyone later in the list would be left in the dark.

An alternative pattern of connections is a telephone tree. The first person calls two people, who each call two people, and so on until everyone is contacted. Unlike the bucket brigade, the telephone tree is designed to spread information to many people simultaneously, creating a cascade. The workload is distributed evenly among all group members, and the problem caused by one person not being home is limited. Moreover, with a single call, one person can set off a chain of events that could influence hundreds or thousands of other people—just as the person who donated the heart that was transplanted into John Lavis prompted another donation that

saved eight more lives. The telephone tree also vastly reduces the number of steps it takes for information to flow among people in the group, minimizing the chance that the message will be degraded. This particular network structure thus helps to both amplify and preserve the message. In fact, within a few decades of the widespread deployment of home-based phones in the United States, telephone trees were used for all sorts of purposes. An article in the *Los Angeles Times* from 1957, for example, describes the use of a phone tree to mobilize amateur astronomers, as part of the "Moonwatch System" of the Smithsonian Astrophysical Observatory, to track American and Russian satellites. [8]

Alas, this same network structure also allows a single swindler to cheat thousands of people. In Ponzi schemes, money flows "up" a structure like a telephone tree. As new people are added to the network, they send money to the people "above" them and then new members are recruited "below" them to provide more money. As time passes, money is collected from more and more people. In what might be the biggest Ponzi scheme of all time, federal investigators discovered in 2008 that during the previous thirty years Bernie Madoff had swindled $50 billion from thousands of investors. Like the Corsican vendetta network we described earlier, Madoff's investment network is the kind most of us would like to avoid.

The four different types of networks we have considered so far are shown in the illustration. First is a group of one hundred people (each represented by a circle, or *node*) among whom there are no ties. Next is a bucket brigade. Here, in addition to the one hundred people, there are a total of ninety-nine ties between the members of the group; every person (except the first and last) is connected to two other people by a *mutual tie* (meaning that full and empty buckets pass in both directions). In the telephone tree, there are one hundred people and again ninety-nine ties. But here, everyone, with the exception of the first and last people in the tree, is connected to three other people, with one

inbound tie (the person they get the call from) and two outbound ties (the people they make calls to). There are no mutual ties; the flow of information is directional and so are the ties between people. In a company of one hundred soldiers, each member of each squad knows every other member of the squad very well; and each person has exactly nine ties. Here, there are one hundred people and 450 ties connecting them. (The reason there are not nine hundred ties is that each tie counts once for the two people it connects.) In the drawing, we imagine that there are no ties between squads or, at least, that the ties within squads are much tighter than the ties between squads. This is clearly an oversimplification, but it illustrates still another point about communities in social networks. A *network community* can be defined as a group of people who are much more connected to one another than they are to other groups of connected people found in other parts of the network. The communities are defined by structural connections, not necessarily by any particular shared traits.

Unconnected group

Bucket brigade

Telephone tree

Military
squads

Four different ways to connect one hundred people. Each circle ("node") represents a person, and each line ("tie") a relationship between two people. Lines with arrows indicate a directed relationship; in the telephone tree, one person calls another. Otherwise, ties are mutual: in the bucket brigade, full and empty buckets travel in both directions; in military squads, the connections between the soldiers are all two-way.

In a very basic sense, then, a social network is an organized set of people that consists of two kinds of elements: human beings and the connections between them. Unlike the bucket brigade, telephone tree, and military company, however, the organization of natural social networks is typically not imposed from the top. Real, everyday social networks evolve organically from the natural tendency of each person to seek out and make many or few friends, to have large or small families, to work in personable or anonymous workplaces.

For example, in the next illustration, we show a network of 105 students in a single dormitory at an American university and the friendship ties between them. On average, each student is connected to six other close friends, but some students have only one friend, and others have many. Moreover, some students are more embedded than others, meaning they have more connections to other people in the network via friends or friends of friends. In fact, network visualization software is designed to place those who are more interconnected in the center and those who are less interconnected at the periphery, helping us to see each person's location in the network. When your friends and

continuously evolving social networks that surround us. Organic networks have a structure, complexity, function, spontaneity, and sheer beauty not found in organized networks, and their existence provokes questions about how they arise, what rules they obey, and what purpose they serve.

Rules of Life in the Network

There are two fundamental aspects of social networks, whether they are as simple as a bucket brigade or as complex as a large multigenerational family, a college dormitory, an entire community, or the worldwide network that links us all. First, there is *connection,* which has to do with who is connected to whom. When a group is constituted as a network, there is a particular pattern of ties that connects the people involved, the topology. Moreover, ties are complicated. They can be ephemeral or lifelong; they can be casual or intense; they can be personal or anonymous. How we construct or visualize a network depends on how we define the ties of interest. Most analyses emphasize ties to family, friends, coworkers, and neighbors. But there are all sorts of social ties and, thus, all sorts of social networks. In fact, when things such as sexually transmitted diseases or dollar bills flow through a network, this flow itself can define the ties and hence the structure of a particular set of network connections.

Second, there is *contagion,* which pertains to what, if anything, flows across the ties. It could be buckets of water, of course, but it also could be germs, money, violence, fashions, kidneys, happiness, or obesity. Each of these flows might behave according to its own rules. For example, fire cannot be transported in buckets toward the river; germs cannot affect someone who is immune; and obesity, which we will discuss

in chapter 4, tends to spread faster between people of the same sex.

Understanding why social networks exist and how they work requires that we understand certain rules regarding connection and contagion—the structure and function—of social networks. These principles explain how ties can cause the whole to be greater than the sum of the parts.

RULE 1: WE SHAPE OUR NETWORK

Humans deliberately make and remake their social networks all the time. The primary example of this is *homophily,* the conscious or unconscious tendency to associate with people who resemble us (the word literally means "love of being alike"). Whether it's Hells Angels or Jehovah's Witnesses, drug addicts or coffee drinkers, Democrats or Republicans, stamp collectors or bungee jumpers, the truth is that we seek out those people who share our interests, histories, and dreams. Birds of a feather flock together.

But we also choose the *structure* of our networks in three important ways. First, we decide how many people we are connected to. Do you want one partner for a game of checkers or many partners for a game of hide-and-seek? Do you want to stay in touch with your crazy uncle? Do you want to get married, or would you rather play the field? Second, we influence how densely interconnected our friends and family are. Should you seat the groom's college roommate next to your bridesmaid at the wedding? Should you throw a party so all your friends can meet each other? Should you introduce your business partners? And third, we control how central we are to the social network. Are you the life of the party, mingling with everyone at the center of the room, or do you stay on the sidelines?

Diversity in these choices yields an astonishing variety of structures for the whole network in which we come to be embedded. And it is diversity in these choices—a diversity that has both social and genetic origins as we will see in

chapter 7—that places each of us in a unique location in our own social network. Of course, sometimes these structural features are not a matter of choice; we may live in places that are more or less conducive to friendship, or we may be born into large or small families. But even when these social-network structures are thrust upon us, they still rule our lives.

We actually know quite a bit about how people vary in terms of how many friends and social contacts they have and in how interconnected they are. Yet, identifying who a person's social contacts are can be a tricky business since people have many interactions of varying intensities with all sorts of people. While a person may know a few hundred people by sight and name, he will typically be truly close to only a few. One way social scientists identify such close individuals is to ask questions like, who do you discuss important matters with? Or, who do you spend your free time with? When answering such questions, people will identify a heterogeneous mix of friends, relatives, coworkers, schoolmates, neighbors, and others.

We recently put these questions to a sample of more than three thousand randomly chosen Americans. And we found that the average American has just four close social contacts, with most having between two and six. Sadly, 12 percent of Americans listed no one with whom they could discuss important matters or spend free time. At the other extreme, 5 percent of Americans had eight such people. About half of the people listed as members of Americans' intimate groups were said to be friends, but the other half included a wide variety of different kinds of relationships, including spouses, partners, parents, siblings, children, coworkers, fellow members of clubs, neighbors, and professional advisers and consultants. Sociologist Peter Marsden has called this group of people that we all have a "core discussion network." In a national sample of 1,531 Americans studied in the 1980s, he found that core-discussion-network size decreases as we age, that there is no overall difference between men and women

in core-network size, and that those with a college degree have core networks that are nearly twice as large as those who did not finish high school. [9]

Next, in our own work, we asked the respondents to tell us how interconnected their social contacts were to each other. So if a person said that Tom, Dick, Harry, and Sue were his friends, we asked him if Tom knew Dick, if Tom knew Harry, if Tom knew Sue, if Dick knew Harry, and so on. We then used these answers to calculate the probability that any two of a person's friends were also friends with each other. This probability is an important property that we use to measure how tightly interwoven a network is.

If you know Alexi, and Alexi knows Lucas, and Lucas knows you, we say this relationship is *transitive*—the three people involved form a triangle. Some people live in the thick of many transitive relationships (like person A in the illustration on page 14), while others have friends who do not know each other (like person B). Those with high transitivity are usually deeply embedded within a single group, while those with low transitivity tend to make contact with people from several different groups who do not know one another, making them more likely to act as a bridge between different groups. Overall, we found that if you are a typical American, the probability that any two of your social contacts know each other is about 52 percent.

Although these measures characterize the networks we can see, they also tell us something about the networks we cannot see. In the vast fabric of humanity, each person is connected to his friends, family, coworkers, and neighbors, but these people are in turn connected to their friends, family, coworkers, and neighbors, and so on endlessly into the distance, until everyone on earth is connected (pretty much) to everyone else, one way or another. So whereas we think of our own network as having a more limited social and geographic reach, the networks that surround each of us are actually very widely interconnected.

It is this structural feature of networks that underlies the

common expression "it's a small world." It is often possible, through a few connections from person to person, for an individual to discover a connection to someone else. A famous example (at least among social scientists) was described in a paper first drafted in the 1950s by two early figures in the study of social networks, Ithiel de Sola Pool and Manfred Kochen. One of the authors overheard a patient in a hospital in a small town in Illinois say to a Chinese patient in the adjoining bed: "You know, I've only known one Chinese before in my life. He was——from Shanghai." Whereupon the response came back, "Why, that's my uncle." [10] In fact, the authors did not tell us his name, perhaps because they were worried that the reader, in a further illustration of the small-world effect, would know him.

RULE 2: OUR NETWORK SHAPES US

Our place in the network affects us in turn. A person who has no friends has a very different life than one who has many. For example, we will see in chapter 4 that having an extra friend may create all kinds of benefits for your health, even if this other person doesn't actually do anything in particular for you.

One study of hundreds of thousands of Norwegian military conscripts provides a simple example of how the mere number of social contacts (here, siblings) can affect you. [11] It has been known for some time that first-born children score a few points higher in terms of intelligence than second-born children, who in turn score a bit higher than third-born children. One of the outstanding questions in this area of investigation, however, has been whether these differences are due to biological factors fixed at birth or to social factors that come later. The study of Norwegian soldiers showed that simple features of social networks, such as family size and structure, are responsible for the differences. If you are a second-born son whose older sibling died while you were a child, your IQ increases and resembles

contains germs from numerous people whose hands it has passed through, and not just from the most recent pair of hands. Analogously, our friends and family can influence us to do things, like gain weight or show up at the polls. But their friends and family can influence us too. This is an illustration of *hyperdyadic spread,* or the tendency of effects to spread from person to person to person, beyond an individual's direct social ties. Corto's brother lost his life because of such spread.

It is easy to think about hyperdyadic effects when the network is a straight line—("that guy three people down the line better pass the bucket, or we're all going to be in big trouble"). But how on earth can they be understood in a natural social network such as the college students in the illustration on page 14, or complex networks of thousands of people with all kinds of crosscutting paths stretching far beyond the social horizon (as we will consider later)? To decipher what is going on, we need two kinds of information. First, we must look beyond simple, sequential dyads: we need to know about individuals and their friends, their friends' friends, their friends' friends' friends, and so on. And we can only get this information by observing the whole network at once. It has just recently become possible to do this on a large scale. Second, if we want to observe how things flow from person to person to person, then we need information about the ties and the people they connect at more than one point in time, otherwise we have no hope of understanding the dynamic properties of the network. It would be like trying to learn the rules of an unfamiliar sport by looking at a single snapshot of a game.

We will consider many examples and varieties of hyperdyadic spread, but we can set the stage with a simple one. The usual way we think about contagion is that if one person has something and comes into contact with another person, that contact is enough for the second person to get it. You can become infected with a germ (the most straightforward example) or with a piece of gossip or

information (a less obvious example). Once you get infected by a single person, additional contact with others is generally redundant. For example, if you have been told accurately that stock XYZ closed at $50, another person telling you the same thing does not add much. And you can pass this information on to someone else all by yourself.

But some things—like norms and behaviors—might not spread this way. They might require a more complex process that involves reinforcement by multiple social contacts. If so, then a network arranged as a simple line, like a bucket brigade, might not support transmission of more complicated phenomena. If we wanted to get people to quit smoking, we would not arrange them in a line and get the first one to quit and tell him to pass it on. Rather, we would surround a smoker with multiple nonsmokers, perhaps in a squad.

Psychologist Stanley Milgram's famous sidewalk experiment illustrates the importance of reinforcement from multiple people. [12] On two cold winter afternoons in New York City in 1968, Milgram observed the behavior of 1,424 pedestrians as they walked along a fifty-foot length of street. He positioned "stimulus crowds," ranging in size from one to fifteen research assistants, on the sidewalk. On cue, these artificial crowds would stop and look up at a window on the sixth floor of a nearby building for precisely one minute. There was nothing interesting in the window, just another guy working for Milgram. The results were filmed, and assistants later counted the number of people who stopped or looked where the stimulus crowd was looking. While 4 percent of the pedestrians stopped alongside a "crowd" composed of a single individual looking up, 40 percent stopped when there were fifteen people in the stimulus crowd. Evidently, the decisions of passersby to copy a behavior were influenced by the size of the crowd exhibiting it.

An even larger percentage of pedestrians copied the behavior incompletely: they looked up in the direction of the stimulus crowd's gaze but did not stop. While one person

influenced 42 percent of passersby to look up, 86 percent of the passersby looked up if fifteen people were looking up. More interesting than this difference, however, was that a stimulus crowd of five people was able to induce almost as many passersby to look up as fifteen people did. That is, in this setting, crowds larger than five did not have much more of an effect on the actions of passing individuals.

RULE 5: THE NETWORK HAS A LIFE OF ITS OWN

Social networks can have properties and functions that are neither controlled nor even perceived by the people within them. These properties can be understood only by studying the whole group and its structure, not by studying isolated individuals. Simple examples include traffic jams and stampedes. You cannot understand a traffic jam by interrogating one person fuming at the wheel of his car, even though his immobile automobile contributes to the problem. Complex examples include the notion of culture, or, as we shall see, the fact that groups of interconnected people can exhibit complicated, shared behaviors without explicit coordination or awareness.

Many of the simple examples can be understood best if we completely ignore the will and cognition of the individuals involved and treat people as if they were "zero-intelligence agents." Consider the human waves at sporting events that first gained worldwide notice during the 1986 World Cup in Mexico. In this phenomenon, originally called *La Ola* ("the wave"), sequential groups of spectators leap to their feet and raise their arms, then quickly drop back to a seated position. The effect is quite dramatic. A group of physicists who usually study waves on the surface of liquids were sufficiently intrigued that they decided to study a collection of filmed examples of *La Ola* in enormous soccer stadiums; they noticed that these waves usually rolled in a clockwise direction and consistently moved at a speed of twenty "seats per second." [13]

To understand how such human waves start and

propagate, the scientists employed mathematical models of excitable media that are ordinarily used to understand inanimate phenomena such as the spread of a fire through a forest or the spread of an electrical signal through cardiac muscle. An *excitable medium* is one that flips from one state to another (like a tree that is either on fire or not) depending on what others around it are doing (are nearby trees on fire?). And these models yielded accurate predictions of the social phenomenon, suggesting that *La Ola* could be understood even if we knew nothing about the biology or psychology of humans. Indeed, the wave cannot be understood by studying the actions of a single individual standing up and sitting down. It is not orchestrated by someone with a megaphone atop a cooler. It has a life of its own.

Mathematical models of flocks of birds and schools of fish and swarms of insects that move in unison demonstrate the same point: there is no central control of the movement of the group, but the group manifests a kind of collective intelligence that helps all within it to flee or deter predators. This behavior does not reside within individual creatures but, rather, is a property of groups. Examination of flocks of birds "deciding" where to fly reveals that they move in a way that accounts for the intentions of all the birds, and, even more important, the direction of movement is usually the best choice for the flock. Each bird contributes a bit, and the flock's collective choice is better than an individual bird's would be. [14] Similar to *La Ola* and to flocking birds, social networks obey rules of their own, rules that are distinct from the people who form them. But now, people are not having fun in a stadium: they are donating organs or gaining weight or feeling happy.

In this regard, we say that social networks have emergent properties. *Emergent properties* are new attributes of a whole that arise from the interaction and interconnection of the parts. The idea of emergence can be understood with an analogy: A cake has a taste not found in any one of its ingredients. Nor is its taste simply the average of the

ingredients' flavors—something, say, halfway between flour and eggs. It is much more than that. The taste of a cake transcends the simple sum of its ingredients. Likewise, understanding social networks allows us to understand how indeed, in the case of humans, the whole comes to be greater than the sum of its parts.

Six Degrees of Separation and Three Degrees of Influence

Stanley Milgram masterminded another, much more famous experiment showing that people are all connected to one another by an average of "six degrees of separation" (your friend is one degree from you, your friend's friend is two degrees, and so on). Milgram's experiment, conducted in the 1960s, involved giving a few hundred people who lived in Nebraska a letter addressed to a businessman in Boston, more than a thousand miles away. [15] They were asked to send the letter to somebody they knew personally. The goal was to get it to someone they thought would be more likely than they to have a personal relationship with the Boston businessman. And the number of hops from person to person that the letter took to reach the target was tracked. On average, six hops were required. This amazing fact initiated a whole set of investigations into the small-world effect originally characterized by de Sola Pool and Kochen, and it entered popular culture too, with John Guare's play *Six Degrees of Separation* and even the trivia game Six Degrees of Kevin Bacon.

But some academics were skeptical. For instance, as far apart as Nebraska and Boston might be (both geographically and culturally), they were both inside the United States. So in 2002, physicist-turned-sociologist Duncan Watts and his colleagues Peter Dodds and Roby Muhamad decided to

influence beyond three degrees. Put another way, we may not be able to influence people four degrees removed from us because, in our hominid past, there was no one who was four degrees removed from us. We call this the *evolutionary-purpose explanation.*

It seems likely that all these factors play a role. But no matter the reasons, the Three Degrees Rule appears to be an important part of the way human social networks function, and it may continue to constrain our ability to connect, even though technology gives us access to so many more people.

While this inherent limit may seem, well, limiting (who doesn't want to rule the world?), we should remember how small the world is. If we are connected to everyone else by six degrees and we can influence them up to three degrees, then one way to think about ourselves is that each of us can reach about halfway to everyone else on the planet.

Moreover, even when restricted to three degrees, the extent of our effect on others is extraordinary. The way natural social networks are structured means that most of us are connected to thousands of people. For example, suppose you have twenty social contacts, including five friends, five coworkers, and ten family members, and each of them in turn has similar numbers of friends and family (to make things simple, let's assume they are not the same contacts as yours). That means you are indirectly connected to four hundred people at two degrees of separation. And your influence doesn't stop there; it goes one more step to the twenty friends and family of each of those people, yielding a total of $20 \times 20 \times 20$ people, or eight thousand people who are three degrees removed from you. That would include every single person in the small Oklahoma town where James grew up.

So while the observation that there are six degrees of separation between any two people applies to how connected we are, the observation that there are three degrees of influence applies to how contagious we are. These properties, connection and contagion, are the structure and function of social networks. They are the anatomy and physiology of the

human superorganism.

Connected

Most of us are already aware of the direct effect we have on our friends and family; our actions can make them happy or sad, healthy or sick, even rich or poor. But we rarely consider that everything we think, feel, do, or say can spread far beyond the people we know. Conversely, our friends and family serve as conduits for us to be influenced by hundreds or even thousands of other people. In a kind of social chain reaction, we can be deeply affected by events we do not witness that happen to people we do not know. It is as if we can feel the pulse of the social world around us and respond to its persistent rhythms. As part of a social network, we transcend ourselves, for good or ill, and become a part of something much larger. We are connected.

Our connectedness carries with it radical implications for the way we understand the human condition. Social networks have value precisely because they can help us to achieve what we could not achieve on our own. In the next few chapters, we will show how networks influence the spread of joy, the search for sexual partners, the maintenance of health, the functioning of markets, and the struggle for democracy. Yet, social-network effects are not always positive. Depression, obesity, sexually transmitted diseases, financial panic, violence, and even suicide also spread. Social networks, it turns out, tend to magnify whatever they are seeded with.

Partly for this reason, social networks are creative. And what these networks create does not belong to any one individual—it is shared by all those in the network. In this way, a social network is like a commonly owned forest: we all stand to benefit from it, but we also must work together to ensure it remains healthy and productive. This means that

social networks require tending, by individuals, by groups, and by institutions. While social networks are fundamentally and distinctively human, and ubiquitous, they should not be taken for granted.

If you are happier or richer or healthier than others, it may have a lot to do with where you happen to be in the network, even if you cannot discern your own location. And it may have a lot to do with the overall structure of the network, even if you cannot control that structure at all. And in some cases, the process feeds back to the network itself. A person with many friends may become rich and then attract even more friends. This rich-get-richer dynamic means social networks can dramatically reinforce two different kinds of inequality in our society: *situational inequality* (some are better off socioeconomically) and *positional inequality* (some are better off in terms of where they are located in the network).

Lawmakers have not yet considered the consequences of positional inequality. Still, understanding the way we are connected is an essential step in creating a more just society and in implementing public policies affecting everything from public health to the economy. We might be better off vaccinating centrally located individuals rather than weak individuals. We might be better off persuading friends of smokers of the dangers of smoking rather than targeting smokers. We might be better off helping interconnected groups of people to avoid criminal behavior rather than preventing or punishing crimes one at a time.

The powerful effect of social networks on individual behaviors and outcomes suggests that people do not have complete control over their own choices. Interpersonal influence in social networks therefore raises moral questions. Our connections to others affect our capacity for free will. How much blame does Giacomo in Corsica deserve for his actions, and how much credit does Dan Lavis in Ontario deserve for his? If they acted merely as links in a chain, how can we understand their freedom to choose their actions at all?

Some scholars explain collective human behavior by studying the choices and actions of individuals. Others dispense with individuals and focus exclusively on groups formed by social class, race, or political party affiliation, each with collective identities that cause people in these groups to mysteriously and magically act in concert. The science of social networks provides a distinct way of seeing the world because it is about individuals *and* groups, and about how the former actually become the latter.

If we want to understand how society works, we need to fill in the missing links between individuals. We need to understand how interconnections and interactions between people give rise to wholly new aspects of human experience that are not present in the individuals themselves. If we do not understand social networks, we cannot hope to fully understand either ourselves or the world we inhabit.

CHAPTER 2

When You Smile, the World Smiles with You

A strange thing happened in Tanzania in 1962. At a mission boarding school for girls near Lake Victoria in the Bukoba District, there was an epidemic of laughter. And this was not just a few schoolgirls sharing a joke. An irresistible desire to laugh broke out and spread from person to person until more than one thousand people were affected.

The affliction had an abrupt onset, and the initial bout of laughter lasted between a few minutes and a few hours in those affected. This was followed by a period of normal behavior, then typically a few relapses over the course of up to sixteen days. In what was to be a clue about the real nature of this epidemic, the victims often described feeling restless and fearful, despite their laughter.

The physicians who first investigated and reported on the outbreak—Dr. Rankin, a faculty member at Makerere University, and Dr. Philip, the medical officer of the Bukoba

states of the people they interact with. Why and how does this happen?

We might consider another question first: Why aren't emotions merely internal states? Why don't we just have our own private feelings? Having feelings is surely evolutionarily advantageous to us. For example, the ability to feel startled is probably good for us in situations where we need to react quickly to survive. But we do not just feel startled, we show that we are startled. We jump or shriek or curse or clench, and these actions do not go unnoticed. They are copied by others.

Given the organization of early hominids into social groups, the spread of emotions served an evolutionarily adaptive purpose. [6] Early humans had to rely on one another for survival. Their interactions with the physical environment (weather, landscape, predators) were modulated or affected by their interactions with their social environment. Humans bonded with others in order to face the world more effectively, and mechanisms evolved to support this bonding, most obviously verbal communication but also emotional mimicry. The development of emotions in humans, the display of emotions, and the ability to read the emotions of others helped coordinate group activity by three means: facilitating interpersonal bonds, synchronizing behavior, and communicating information.

Emotions and emotional contagion probably first arose to facilitate mother-infant pair bonding and then evolved to extend to kin members and ultimately to nonkin members. Emotional contagion fosters interaction synchrony. At the level of mother-child pairs, emotional contagion may have prompted mothers to be more attentive to and protective of their babies when their babies needed attention. Indeed, we are sadder when our family members are sad than when strangers are sad. There is an advantage in coordinating our moods with those to whom we are related.

Eventually this type of synchrony in mood or activity may have been beneficial for larger group activities, such as

warding off enemies or hunting prey. If you are trying to coordinate a hunting party, it helps if members of the group are all upbeat and fired up. Conversely, if you are part of a group and someone in it appears afraid, perhaps that person has seen a predator that you have not seen. Quickly adopting his emotional state can enhance your prospects for survival. Indeed, it is thought that positive emotions may work especially well to increase group cohesiveness ("I'm happy; stay with me") and that negative emotions may work well as communication devices ("I smell smoke; I'm scared").

Emotions may be a quicker way to convey information about the environment and its relative safety or danger than other forms of communication, and it seems certain that emotions preceded language. What emotions lack in specificity compared to oral language, they may make up for in speed. You can tell whether your spouse is mad at you very quickly, but having her explain it to you may take a good deal more time (especially if she insists that you guess why she is mad before she tells you). You can walk through the door at home at the end of the day and immediately know whether the environment is safe or dangerous, and that is quite a trick our ancestors bequeathed us.

Of course, rapidly coordinated emotions are not always a good thing. If you come home and are in a bad mood, your partner will often detect it long before you resort to the more laborious process of explaining why you are in a bad mood. And before you have a chance to explain, she might already have caught your bad mood, which may lead to an argument and a downward spiral.

Emotional Contagion

Emotions spread from person to person because of two features of human interaction: we are biologically hardwired

to mimic others outwardly, and in mimicking their outward displays, we come to adopt their inward states. If your friend feels happy, she smiles, you smile, and in the act of smiling you also come to feel happy. In bars and bedrooms, at work and on the street, everywhere people interact, we tend to synchronize our facial expressions, vocalizations, and postures unconsciously and rapidly, and as a result we also meld our emotional states.

Nowhere do we show our emotions more than on our faces. It is not difficult to explain why our facial expressions change in response to environmental stimuli or how this may be evolutionarily adaptive. Recent research, for example, has provided insight into how two facial expressions, fear and disgust, moderate our reception of sensations coming from the outside world. [7] When we are terrified, our eyes widen and our nostrils flare to help us see and smell more of our surroundings, just as the ears of a dog perk up when it hears something interesting. Similarly, when we are disgusted, such as by an offensive odor, our noses wrinkle and our eyes narrow to reduce the impact. Air intake increases when we are afraid and decreases when we are disgusted.

Yet, facial expressions appear to have evolved not just to modify our experience of the world as individuals but as a way to communicate with others. Over time, this aspect of facial expressions probably eclipsed their original role. Such changes happen often in evolution. Feathers may have arisen merely to insulate the bodies of prehistoric reptiles, but they wound up contributing to a different and more important advantage, the ability to fly.

We developed an ability to read the facial expressions of others. Hence, we benefit when our own faces are contorted in disgust *and* by being able to notice whether others' faces are contorted in disgust. Humans have an extraordinary knack for detecting even small changes in facial expressions. This ability is localized in a particular area of the brain and can even be lost, a condition tongue-twistingly known as *prosopagnosia*. Reading the expressions of others was probably

a key step on the way toward synchronizing feelings and developing the emotional empathy that underlies the process of emotional contagion.

Even as early as 1759, it was apparent to founding economist and philosopher Adam Smith that conscious thought was one way we could feel for others and hence feel like others: "Though our brother is upon the rack... by the imagination we place ourselves in his situation, we conceive ourselves enduring all the same torments, we enter as it were into his body, and become in some measure the same person with him, and thence form some idea of his sensations, and even feel something which, though weaker in degree, is not altogether unlike them." [8]

However, emotions spread in ways beyond simply reading faces and thinking about the experiences of others. There is actually a more primitive, less deliberative process of emotional contagion, a kind of instinctive empathy. People imitate the facial expressions of others, then, as a direct result, they come to feel as others do. This is called *affective afference,* or the facial-feedback theory, since the path of the signals is from the muscles (of the face) to the brain, rather than the more usual, efferent pathway from the brain to the muscles. The beneficial effects of facial expressions on a person's mood are among the reasons, for example, that telephone operators are trained to smile when they work, even though the person at the other end of the line cannot see them. This theory also explains why it helps to smile when your heart is breaking.

One biological mechanism that makes emotions (and behaviors) contagious may be the so-called *mirror neuron system* in the human brain. [9] Our brains practice doing actions we merely observe in others, as if we were doing them ourselves. If you've ever watched an intense fan at a game, you know what we are talking about—he twitches at every mistake, aching to give his own motor actions to the players on the field. When we see players run, jump, or kick, it is not only our visual cortex or even the part of our brain that

thinks about what we are observing that is activated, but also the parts of our brain that would be activated if we ourselves were running, jumping, or kicking.

In one experiment related to emotional contagion, subjects listened to recordings of nonverbal vocal reactions communicating two positive emotions, such as amusement and triumph, and two negative emotions, such as fear and disgust. Investigators monitored the subjects' brains for a response by placing them in a magnetic resonance imaging (MRI) machine. [10] The subjects were told not to react to what they heard. While subjects did not visibly respond to the sounds, the MRI results showed that hearing the cues stimulated parts of the brain that command the corresponding facial expressions. It seems we are always poised to feel what others feel and to do what others do.

Emotional Stampedes

Everyone has experience with emotional contagion: we share a joke with a friend, we feel sad when a spouse cries, we rage against city hall with our neighbors, and we hug our kids tight when they've had a bad day. Yet one often overlooked aspect of all this sharing is that emotions spread not only to our friends but to our friends' friends and beyond—even when we are not present. We are like a herd of buffalo quietly grazing on the plain until one of our neighbors starts to run. Then we start to run, and others start to run, and suddenly, mysteriously, the whole herd is barreling forward.

Epidemics of emotional states have been reported for centuries. They just have not involved laughter like the Bukoba outbreak. When emotions spread from person to person and affect large numbers of people, it is now called *mass psychogenic illness* (MPI) rather than the old-fashioned and more poetic epidemic hysteria. MPI is a specifically social