# BARBARA FREDRICKSON

AT THE END of the 1938 film, *The Wizard of Oz*, Dorothy Gale receives some sage advice about the importance of love. "A heart is not measured," the wizard says, "by how much you love but how much you are loved by others." These words echo notions expressed by countless writers long before the MGM studio was born. "Love is not love," William Shakespeare wrote, which "alters when it alteration finds ... O no! It is an ever-fixed mark." But what exactly is this *love*? Is it an experience or is it an emotion? Does it change constantly or should it remain "ever-fixed," as Shakespeare says? Advice about love is so prevalent that we can easily overlook its vagueness, sentimentality, and inherent contradictions.

Psychologist Barbara Lee Fredrickson, author of the book *Love 2.0: How Our Supreme Emotion Affects Everything We Feel, Think, Do, and Become*, has no doubt that love is real, but she has tried to bring scientific rigor to the tangled discourse on the topic. Her recent writing about love might be seen as an extension of her earlier research in the field of positive psychology, a branch of psychology focused on positive emotions, as opposed to the disorders studied by previous researchers. Fredrickson's work on positive emotions culminated in what she describes as the "broaden-and-build theory," which suggests that positive emotions lead people to become more curious, outgoing, and creative. As she argues in an article from *American Psychologist* (2005), positive emotions probably evolved to improve our ancestors' odds for "survival and reproduction."

After completing her first book, *Positivity*, Fredrickson was quick to recognize one limitation of her argument: even if we know that positivity helps, how can those trapped by negative thinking ever change their habits of mind? How, in other words, can we apply the findings of positivity research? Toward an answer to these questions, Fredrickson's more recent studies focus on forms of human interaction that actively encourage positivity. Among these forms of interaction, Fredrickson sees love as the most important because it takes place in the "micro-moments" of our "resonance" with others: "Just as your body was designed to extract oxygen from the Earth's atmosphere, and nutrients from the foods you ingest, your body was designed to love." For the first time, research demonstrates that love can change our biochemistry and even the

From *LOVE 2.0* by Barbara Fredrickson, copyright © 2013 by Barbara Fredrickson. Used by permission of Hudson Street Press, an imprint of Penguin Group (USA) LLC.

"Survival and reproduction" from Barbara L. Fredrickson and Marcial F. Losada, "Positive Affect and the Complex Dynamics of Human Flourishing," *American Psychologist* 60(7), Oct 2005: 678–686.

expression of our DNA. But perhaps the most important implications are to be found in our social lives rather than in our biology. If love, for example, plays an essential role in our neural processing, why does society often seem to reflect our worst tendencies, not our best? If we are naturally hardwired to love, why does love sometimes seem hard to find?

# *Selections from* Love 2.0: How Our Supreme Emotion Affects Everything We Feel, Think, Do, and Become

## LOVE, OUR SUPREME EMOTION

> The Eskimos had fifty-two names for snow because it was important to them: There ought to be as many for love.
>
> —MARGARET ATWOOD

*Longing.* You know the feeling. It's that ache of sensing that something vital is missing from your life; a deep thirst for more. More meaning, more connection, more energy—more *something*. Longing is that feeling that courses through your body just before you decide that you're restless, lonely, or unhappy.

Longing like this is not just another mental state. It's deeply physical. Your body craves some essential nutrient that it's not getting, yet you can't quite put your finger on what it is. Sometimes you can numb this ache with a deep dive into work, gossip, television, or gaming. More often than not, though, these and other attempts to fill the aching void are merely temporary distractions. The longing doesn't let up. It trails you like a shadow, insistently, making distractions all the more appealing. And distractions abound—that second or third glass of wine, that stream of texts and tweets, that couch and remote control.

Odds are, food is abundant in your life. And clean drinking water is as close as the nearest faucet and virtually limitless. You have access to reasonably clean air and adequate shelter. Those basic needs have long been met. What you long for now is far more intangible.

What you long for is love. Whether you're single or not, whether you spend your days largely in isolation or steadily surrounded by the buzz of



conversation, love is the essential nutrient that your cells crave: true positivity-charged connection with other living beings.

Love, as it turns out, nourishes your body the way the right balance of sunlight, nutrient-rich soil, and water nourishes plants and allows them to flourish. The more you experience it, the more you open up and grow, becoming wiser and more attuned, more resilient and effective, happier and healthier. You grow spiritually as well, better able to see, feel, and appreciate the deep interconnections that inexplicably tie you to others, that embed you within the grand fabric of life.

Just as your body was designed to extract oxygen from the earth's atmosphere and nutrients from the foods you ingest, your body was designed to love. Love—like taking a deep breath or eating an orange when you're depleted and thirsty—not only feels great but is also life-giving, an indispensable source of energy, sustenance, and health.

When I compare love to oxygen and food, I'm not just taking poetic license. I'm drawing on science: new science that illuminates for the first time how love, and its absence, fundamentally alters the biochemicals in which your body is steeped. They, in turn, can alter the very ways your DNA gets expressed within your cells. The love you do or do not experience today may quite literally change key aspects of your cellular architecture next season and next year—cells that affect your physical health, your vitality, and your overall well-being. In these ways and more, just as your supplies of clean air and nutritious food forecast how long you'll walk this earth—and whether you'll thrive or just get by—so does your supply of love.

### It's Not What You Think

To absorb what the new science of love has to offer, you'll need to step back from "love" as you may now know it. Forget about the love that you typically hear on the radio, the one that's centered on desire and yearns for touch from a new squeeze. Set aside the take on love your family might have offered you, one that requires that you love your relatives unconditionally, regardless of whether their actions disturb you or their aloofness leaves you cold. I'm even asking you to set aside your view of love as a special bond or relationship, be it with your spouse, partner, or soul mate. And if you've come to view love as a commitment, promise, or pledge, through marriage or any other loyalty ritual, prepare for an about-face. I need you to step back from all of your preconceptions and consider an upgrade. *Love 2.0* offers a different perspective—your body's perspective.

If you were asked today, by a roving reporter or an inquisitive dinner party guest, to provide your own definition of love, your answer would likely reflect a mishmash of shared cultural messages and your own deeply personal experiences with intimacy. However compelling your answer, I'd wager that your body has its own—quite different—definition of love. That's what this book is about. Love is not sexual desire or the blood-ties of kinship. Nor is it a special bond

or commitment. Sure enough, love is closely related to each of these important concepts. Yet none, I will argue, capture the true meaning of love as your body experiences it.

The vision of love that I offer here will require a radical shift, a departure from what you've come to believe. It's time to upgrade your view of love. Love is not a category of relationships. Nor is it something "out there" that you can fall into, or—years later—out of. Seeing love as a special bond is extraordinarily common, albeit misleading. A bond like this can endure for years—even a lifetime with proper commitment and effort. And having at least one close relationship like this is vital to your health and happiness, to be sure. Even so, that special bond and the commitments people often build around it are better taken as the *products* of love—the results of the many smaller moments in which love infuses you—rather than as love per se. When you equate love with intimate relationships, love can seem confusing. At times it feels great, while at other times it hurts like hell. At times it lifts you up with grand dreams for your future and at other times oppresses you with shame about your inadequacies, or guilt about your past actions. When you limit your view of love to relationships or commitment, love becomes a complex and bewildering thicket of emotions, expectations, and insecurities. Yet when you redirect your eyes toward your body's definition of love, a clear path emerges that cuts through that thicket and leads you to a better life.

There's still more ground to clear. I need to ask you to disengage from some of your most cherished beliefs about love as well: the notions that love is exclusive, lasting, and unconditional. These deeply held beliefs are often more wish than reality in people's lives. They capture people's daydreams about the love-of-their-life whom they've yet to meet. Love, as your body defines it, is not exclusive, not something to be reserved for your soul mate, your inner circle, your kin, or your so-called *loved ones*. Love's reach turns out to be far wider than we're typically coaxed to imagine. Even so, love's timescale is far shorter than we typically think. Love, as you'll see, is not lasting. It's actually far more fleeting than most of us would care to acknowledge. On the upside, though, love is forever renewable. And perhaps most challenging of all, love is not unconditional. It doesn't emerge no matter what, regardless of conditions. To the contrary, you'll see that the love your body craves is exquisitely sensitive to contextual cues. It obeys preconditions. Yet once you understand those preconditions, you can find love countless times each day.

It's difficult to speak of love in scientific terms, I've found, because listeners have so many preexisting and strong beliefs about it. Many of these beliefs reflect our shared cultural heritage, like all those proliferating songs and movies that equate love with infatuation or sexual desire, or with stories that end happily ever after, or even the realistic marriage ceremonies that celebrate love as an exclusive bond and commitment. Other beliefs about love are deeply personal. They reflect your own unique life history, with its interpersonal triumphs and scars, lessons about intimacy learned and not yet learned. Left unaddressed, these preconceptions can derail any serious intellectual discussion of love. They may even keep you from soaking up the full implications of the new findings on it....



## LOVE'S BIOLOGY

> The soul must always stand ajar, ready to welcome the ecstatic experience.
>
> —EMILY DICKINSON

It's all too tempting, especially in Western culture, to take your body to be a noun, a thing. Sure, it's a living thing, but still, like other concrete things that you can see and touch, you typically describe your body with reference to its stable physical properties, like your height, your weight, your skin tone, your apparent age, and the like. A photo works well to convey these attributes. You recognize, of course, that five years from now, today's photo will seem a bit outdated. By then, your body's physical properties might shift a bit—you might, for instance, become a little shorter, a little heavier, a little paler, or look a little older. Still, you're comfortable with the idea that your body remains pretty much the same from day to day. It has constancy.

Yet constancy, ancient Eastern philosophies warn, is an illusion, a trick of the mind. Impermanence is the rule—constant change, the only constancy. True for all things, this is especially true for living things, which, by definition, change or adapt as needed in response to changes in context. Just as plants turn toward the sun and track its arc from dawn to dusk, your own heart alters its activity with each postural shift, each new emotion, even each breath you take. Seen in this light, your body is more verb than noun: It shifts, cascades, and pulsates; it connects and builds; it erodes and flushes. Mere photographs fail to capture these nonstop and mostly unseen churning dynamics. Instead, you need movies. Increasingly, scientists work to capture these and other dynamic changes as they unfurl within living, breathing, and interacting bodies. True, scientists need to understand form as well as function, anatomy as well as physiology, nouns as well as verbs. Yet when it comes to love, verbs rule. Positivity resonance lies in the action, the doing, the connecting. It wells up, like a wave forming in the ocean, and then dissipates, like that same wave, after its crash. To fully appreciate love's biology, you'll need to train your eye to see this ever-shifting ebb and flow.

Taking cues from what leading neuroscientist Stephen Porges calls the *social engagement system*, I describe love's biology as a system, a whole comprised of several interacting parts. You can think of love, or positivity resonance, as one of the more complex and recurrent *scenes* nested within the *act* of your day, which is in turn nested within the *play* of your life. As with any scene in a play, the drama of love has its own cast of characters. Here I turn the spotlight on three main biological characters: your brain; one particular hormone, oxytocin, which circulates throughout your brain and body; and your vagus nerve, the tenth cranial nerve that runs from deep within your brain stem down to your heart, lungs, and other internal organs. Other characters step onto the biological stage to deliver their own lines, to be sure, but these three are primary players in love's biology.

Although always on stage, these main characters deliver their lines quietly, most often fully outside of your conscious awareness. As you move through

your day, these biological characters—your brain, your oxytocin, and your vagus nerve—are ever responsive to set changes. As you interact with one person after another, they gently nudge you to attend to these others more closely and forge connections when possible. They shape your motives and behaviors in subtle ways, yet ultimately, their actions serve to strengthen your relationships and knit you in closer to the social fabric of life. In the sections that follow, I'll shine the spotlight on each of these three main characters in turn, to help you see how each forges and supports those life-giving moments of positivity resonance for which your body thirsts.

## Love on the Brain

When you and another truly connect, love reverberates between you. In the very moment that you experience positivity resonance, your brain syncs up with the other person's brain. Within each moment of love, you and the other [person] are on the same wavelength. As your respective brain waves mirror one another, each of you—moment by moment—changes the other's mind.

... How do you know it really happens? You can't see this brain synchrony surface in real time after all. What you'd need is some way to peer inside two people's heads while they chatted so that you could tell whether their respective brain activity really does march along in time together. This would tell you whether they really "click." Only with this sort of X-ray vision could you decide whether love is better described as a solo act—an emotion contained within the boundaries of the person feeling it—or a duet or ensemble, performed by a duo or group. That sort of X-ray vision sounds like science fiction.

Yet turning science fiction into science fact is what scientists and engineers love most. Breakthrough work by neuroscientist Uri Hasson, of Princeton University, has done just that. He and his team have found ways to measure multiple brains connecting through conversation. The obstacles they faced to do this were large. First, brain scanners are loud machines—no place to carry on actual conversations. Second, they're also extraordinarily expensive, both to buy and to use. Almost all brain imaging studies thus scan just one person's brain at a time. Yet with clever engineering and clever experimental logistics, Hasson's team cleared both obstacles. They created a custom optic microphone that canceled out the noise of the scanner without distorting the delicate brain signals his team sought to capture. The logistics feat was to mimic a natural conversation by pulling it apart in time.

Suppose, for a moment, you were stranded at the airport last week. Your plane to Miami was delayed for hours. Bored with your reading and web-browsing, you got to talking to another stranded passenger, a lively young college student on her way home for break. You'd been chatting back and forth for a while, every so often, meeting eyes and sharing smiles. The conversation was very natural, like you were friends already. Somehow or another, she got to telling you about her crazy high school prom experience. In great detail, she launched into how she happened to have two dates to the same prom; how she ended up having only five minutes to get dressed and ready for the prom after a full day of scuba diving; how, on her way to after-prom festivities, she crashed her boyfriend's car in the wee hours of the morning; and then how she completely lucked out of getting ticketed (or arrested!) by the officer who witnessed her accident. She's a good storyteller: You hung on her every word. Fifteen minutes melted away as she shared all the twists and turns of her hapless prom night. It's clear, too, that you both enjoyed the chance to connect, rather than read, while you waited for your plane together.



Okay, now it's time for a set change: Instead of in an airport terminal, this conversation actually unfolded in a brain imaging lab at Princeton University. And instead of you sitting side by side with your impromptu friend, Hasson's team actually invited her to visit the lab weeks ago, and they audio-recorded her entire prom story while scanning her brain's activity with functional magnetic resonance imaging (fMRI). You're here lying in the scanner today, listening to her story over fancy headphones, while Hasson's team records your own brain activity. After you get out of the scanner, they ask you to report on what you heard in as much detail as possible. This takes a while; hers was a long, circuitous story after all.

Hasson's team later looked at the extent to which your brain activity mirrored hers. They painstakingly matched up each specific brain area across the two of you, time-locked your respective scans, and looked for "coupling," or the degree to which your brains lit up in synchrony with each other, matched in both space and time.

It turns out that the brain coupling evident between you two is surprisingly widespread. In other words, speaking with and listening to the human voice appear to activate much of the exact same brain activity at pretty much the same time. Keep in mind that—despite your new friend's gift for storytelling—this was still a pretty artificial conversation. Isolated inside the brain scanner across different days, you never actually got to see each other's gestures, meet each other's eyes, or even take turns speaking. You only listened to her voice over headphones. The brain coupling that would emerge in real time with the full and animated dialogue that could well spring up between the two of you if you were in fact seated side by side in the airplane terminal is likely to be far more extensive. Yet hearing someone's voice offers an important channel of sensory and temporal connection, because voice can convey so much emotion. By contrast, consider how little brain coupling would emerge if the connection between the two of you were to be further reduced, for instance, if you only read her story, at your own pacing and presumed intonations, or only heard *about* her story, as in my thumbnail depiction of it a few paragraphs back.

Forget the idea of a few isolated mirror neurons. So-called mirror neurons refer to a microscopic brain area that Italian neurophysiologists found to "light up" both when a monkey reaches for a banana and when that same monkey sees a person reach for a banana. The discovery of mirror neurons was a huge breakthrough because it told us that taking some action and seeing someone else take that same action are far more alike than previously thought. This means that when you know something—like why that person who just walked into your

office is smiling—you know it because your brain and body simulate being in that person's shoes, in their skin. Your knowing is not just abstract and conceptual; it's embodied and physical. Yet it seems now that the concept of isolated mirror neurons was just the tip of the unseen and enormous iceberg. What Hasson and his team uncovered was far more extensive neuronal coupling than previously imagined. Far from being isolated to one or two brain areas, really "clicking" with someone else appears to be a whole brain dance in a fully mirrored room. The reflections between the two of you are that penetrating and widespread.

It turns out that you weren't the only one listening to your new friend's prom story. Hasson's team invited ten other people to have their brains scanned while listening to the very same audio-recording of her story that you heard. Whereas you listened attentively to everything she said, others didn't so much. Those differences showed up clearly when you were each asked to recount her story afterward. By tallying up the matches between her original, impromptu prom story and each listener's retelling of it, Hasson's team rank-ordered the whole set of listeners by how well they understood the story. Those differences in comprehension reflect the success or failure of communication—how thoroughly information from her brain was transferred to your brain, and to the brains of the other listeners. Strikingly, Hasson's team discovered that the degree of success in communication predicted the degree of brain coupling between speaker and listener, and did so in surprising ways.

Most of the time, across most brain areas, listeners' brains mirrored the speaker's brain after a short time lag, around one to three seconds later. It only makes sense, after all, that the speaker leads this dance, since the story is hers and she chooses her words before you and the others hear them. In other cases, though, this neural pas de deux between speaker and listener showed hardly any lag at all—the respective changes in brain activity were virtually synchronized. Your particular case was different, however. Recall that you were the one who grasped your new friend's story better than anybody. You hung on every word and picked up every detail of it, even the seemingly inconsequential ones. Your more complete grasp of her story went hand in hand with something truly remarkable: Your brain activity actually *anticipated* her brain activity by a few seconds in several cortical areas. Excellent communication, it thus seems, doesn't simply involve following along very closely. It also involves forecasting. Once you were in sync and on the same page with your new friend, enjoying her and her story, you could even anticipate what she'd say next, or how she'd say it. Your brain could anticipate her brain's next move.

Brain coupling, Hasson argues, is the means by which we understand each other. He goes even further to claim that communication—a true meeting of the minds—is a single act, performed by two brains. Considering the positivity resonance of love, what I find most fascinating about these findings is that a key brain area that showed coupling in Hasson's speaker-listener study was the insula, an area linked with conscious feeling states. Evidence for synchrony in two people's insulae suggests that in good communication, two individuals come to feel a single, shared emotion as well, one that is distributed across their two brains.



Indeed, in other work, Hasson and colleagues have shown that people's brains come particularly into sync during emotional moments. Neural coupling, then—really understanding someone else—becomes all the more likely when you share the same emotion. Even more so than ordinary communication, a micro-moment of love is a single act, performed by two brains. Shared emotions, brain synchrony, and mutual understanding emerge together. And mutual understanding is just steps away from mutual care. Once two people understand each other—really "get" each other in any given moment—the benevolent concerns and actions of mutual care can flow forth unimpeded.

As you move through your day, quite naturally you move in and out of different scenes. Each scene, of course, has its own script. For perhaps most of your day, you're pretty much caught up in your own thoughts and plans, oblivious to the presence or feelings of anyone nearby. Your brain, in such moments, is doing its own thing. But in those rarer moments when you truly connect with someone else over positivity—by sharing a smile, a laugh, a common passion, or an engaging story—you become attuned, with genuine care and concern for the other. You empathize with what they're going through, as your two brains sync up and act as one, as a unified team.

Neural coupling like this is a biological manifestation of oneness. Laboratory studies have already shown that when positive emotions course through you, your awareness expands from your habitual focus on "me" to a more generous focus on "we." When you're feeling bad—afraid, anxious, or angry—even your best friend can seem pretty remote or separate from you. The same goes for when you're feeling nothing in particular. Not so, when you're feeling good. Under the influence of positive emotions, your sense of self actually expands to include others to greater degrees. Your best friend, in these lighthearted moments, simply seems like a bigger part of you.

Hasson's work suggests that when you share your positive emotions with others, when you experience positivity resonance together with this sense of expansion, it's also deeply physical, evident in your brain. The emotional understanding of true empathy recruits coinciding brain activity in both you and the person of your focus. Another telling brain imaging study, this one conducted by scientists in Taipei, Taiwan, illustrates self-other overlap at the neuronal level. Imagine for a moment being a participant in this study. While you are in the fMRI brain scanner, the researchers show you a number of short, animated scenes and ask you to picture yourself in these scenes. Some of these scenes depict painful events, like dropping something heavy on your toe or getting your fingers pinched in a closing door. What the brain images show is that, compared to imagining neutral, nonpainful situations, imagining yourself in these painful situations lights up the well-known network of brain areas associated with pain processing, including the insula, that area linked with conscious feeling states. When you are later asked to imagine these same painful events happening to a loved one—your spouse, your best friend, or your child, for instance—these same brain areas light up. By and large, then, your loved one's pain *is* your pain. By contrast, when you imagine these painful events happening to complete strangers, a different pattern of activation emerges altogether, one that shows little activation in the insula and

more activation in areas linked with distinguishing and distancing yourself from others, and actively inhibiting or regulating emotions, as if to prevent their pain from becoming your pain. At the level of brain activity during imagined pain, you and your beloved are virtually indistinguishable.

Whereas the Taipei research team defined love to be a lasting loving relationship (what, for clarity's sake, I call a bond), the work from Hasson's team at Princeton tells me that neural synchrony and overlap can also unfold between you and a complete stranger—if you let it. Positivity resonance between brains, as it turns out, requires only connection, not the intimacy or shared history that comes with a special bond. Even so, the distinctions revealed in the Taipei study, between imagining your loved one's pain and imagining a stranger's pain, underscore that stifled emotions and guarded personal boundaries, while at times necessary and fully appropriate, can also function as obstacles to positivity resonance. As we'll see in the next section, your attunement to various opportunities for positive connection with others is supported not just by neural synchrony, but by the hormone oxytocin as well.

## Biochemistries in Love

Oxytocin, which is nicknamed by some the "cuddle hormone" or the "love hormone," is actually more properly identified as a neuropeptide because it acts not just within your body but also within your brain. Oxytocin has long been known to play a key role in social bonding and attachment. Clear evidence of this first emerged from experiments with a monogamous breed of prairie voles: Oxytocin, when dripped into one animal's brain in the presence of the opposite sex, creates in that animal a long-lasting preference to remain together with the other, cuddled up side by side, behavior taken as evidence that oxytocin sparked the formation of a powerful social bond between them. In humans, oxytocin surges during sexual intercourse for both men and women, and, for women, during childbirth and lactation, pivotal interpersonal moments that stand to forge new social bonds or cement existing ones. The natural blasts of oxytocin during such moments are so large and powerful that for many years they all but blinded scientists to the more subtle ebb and flow of oxytocin during more typical day-to-day activities, like playing with your kids, getting to know your new neighbor, or striking a deal with a new business partner. Technical obstacles also needed to be cleared. Decades after oxytocin's role in monogamous prairie voles had been amply charted, scientists studying human biochemistry still struggled to find ways to reliably and noninvasively measure and manipulate oxytocin during natural behavior. Scientific understanding of oxytocin's role in your everyday social life could not advance without more practical research tools at hand.

Dramatic new evidence of oxytocin's power to shape your social life first surfaced in Europe, where laws permitted the use of a synthetic form of oxytocin, available as a nasal spray, for investigational purposes. Among the first of these studies was one in which 128 men from Zurich played the so-called trust game with real monetary outcomes on the line. At random, these men were



assigned to either the role of "investor" or the role of "trustee," and each was given an equivalent pot of starting funds. Investors made the first move in the game. They could give some, all, or none of their allocated funds to the trustee. During the transfer of funds, the experimenter tripled their investment while letting the trustee know how much the investors had originally transferred. Trustees made the next move. They could give some, all, or none of their new allotment of funds (the investors' tripled investment plus their own original allocation) back to investors. The structure of the game puts investors, but not trustees, at risk. If an investor chose to entrust the other guy with his investment, he risked receiving nothing in return if the trustee chose to selfishly keep the entire monetary gain for himself. But if the trustee was fair, they could each double their money.

Prior to playing this trust game, using a double-blind research design, participants received either oxytocin or an inert placebo by nasal spray. The effect of this single intranasal blast of oxytocin on the outcome of the trust game was dramatic: The number of investors who trusted their entire allotment to their trustee more than doubled. Interestingly, related research using this same trust game showed that the mere act of being entrusted with another person's money raises the trustee's naturally occurring levels of oxytocin, and that the greater the trustee's oxytocin rise, the more of his recent windfall he sacrificed back to the investor. The neuropeptide oxytocin, then, steers the actions of both the investor and the trustee, shaping both trust and reciprocity. These findings suggest that through synchronous oxytocin surges, trust and cooperation can quickly become mutual.

Since the original study on oxytocin and the trust game was published in *Nature* in 2005, variations on it have abounded. We now know, for instance, that oxytocin doesn't simply make people more trusting with money, it also makes them far more trusting—a whopping 44 percent more trusting—with confidential information about themselves. Interestingly, the simple act of sharing an important secret from your life with someone you just met increases your naturally circulating levels of oxytocin, which in turn raises your confidence that you can trust that person to guard your privacy. Thankfully, we also know that oxytocin does not induce trust indiscriminately, making people gullible and therefore open to exploitation. The effects of oxytocin on trust turn out to be quite sensitive to interpersonal cues, like those subtle signs that tip you off that another may be the gambling type or irresponsible in other ways. Rest assured, then, if oxytocin spray were to be aerated through your workplace ventilation system, you'd still maintain your shrewd attunement to subtle signs that suggest whether someone is worthy of your trust or not.

Researchers have since moved on to examine the effects of oxytocin on people's sensitivities to the subtle social cues that signal whether or not trust is warranted. From this work, I can tell you that, under the influence of oxytocin, you attend more to people's eyes and become specifically more attuned to their smiles, especially subtle ones. Perhaps because of the closer attention you pay to peoples' smiles and eyes, you become a better judge of their feelings and view people on the whole as more attractive and trustworthy. You also become particularly

sensitized to environmental cues linked to positive social connections—for instance, to words like *love* and *kissing*. Researchers who have combined the use of oxytocin nasal spray (versus placebo) with brain imaging have also learned that oxytocin modulates the activity of your amygdala, the subcortical structure deep within your brain linked to emotional processing. Specifically, under the influence of a single blast of oxytocin nasal spray, the parts of your amygdala that tune in to threats are muted, whereas the parts that tune in to positive social opportunities are amplified. Reflecting these negativity-dampening effects, a single shot of oxytocin can also help you glide through stressful social situations, like giving an impromptu speech or discussing a conflict-ridden topic with your spouse. If you were to face these difficulties under the influence of oxytocin, studies suggest, you'd have less cortisol, the so-called stress hormone, coursing through you, and you'd behave more positively, both verbally, by disclosing your feelings, and nonverbally, by making more eye contact and friendly gestures. Related research shows that behaving kindly in these ways also raises your naturally occurring levels of oxytocin, which in turn curbs stress-induced rises in heart rate and blood pressure, reduces feelings of depression, and increases your pain thresholds.

More generally, oxytocin has been cast as a lead character in the mammalian *calm-and-connect* response, a distinct cascade of brain and body responses best contrasted to the far more familiar *fight-or-flight* response. Let's face it, meeting new people can be a little scary at times. Think back to what it was like for you on your first day at a new school or in a new job. You're suddenly thrown in with people you'd never heard of before. Even if a new person seems friendly, it's hard to know his true motives. Will he help you? Or will he instead take advantage of you in one way or another? Human greed, after all, runs rampant and can yield all manner of exploitation. Oxytocin appears both to *calm* fears that might steer you away from interacting with strangers and also to sharpen your skills for *connection*. As I've mentioned, though, oxytocin is far from blind. It indeed heightens your attunement to cues that signal whether others are sincere or not. Through eye contact and close attention to all manner of smiles—and the embodied simulations such visual intake triggers—your gut instincts about whom to trust and whom not to trust become more reliable. Rather than avoid all new people out of fear and suspicion, oxytocin helps you pick up on cues that signal another person's goodwill and guides you to approach them with your own. Because all people need social connections, not just to reproduce, but to survive and thrive in this world, oxytocin has been dubbed "the great facilitator of life."

It, too, can jump the gap between people such that someone else's oxytocin flow can trigger your own. A biochemical synchrony can then emerge that supports mutual engagement, care, and responsiveness.

The clearest evidence that oxytocin rises and falls in synchrony between people comes from studies of infants and their parents. When an infant and a parent—either mom or dad—interact, sometimes they are truly captivated by each other, and other times not. When an infant and parent do click, their coordinated motions and emotions show lots of mutual positive engagement. Picture



moms or dads showering their baby with kisses, tickling their baby's tiny fingers and toes, smiling at their baby, and speaking to him or her in that high-pitched, singsong tone that scientists call *motherese*. These parents are superattentive. As they tickle and coo they're also closely tracking their baby's face for signs that their delight is mutual. In step with their parent's affectionate antics, these attentive babies babble, coo, smile, and giggle. Positivity resonates back and forth between them. Micro-moments of love blossom.

Of course, not every infant-parent interaction is so rosy. Some pairs show little mutual engagement. Some moms and dads rarely make eye contact with their infants and emit precious little positivity, either verbally or nonverbally. These pairs are simply less attuned to each other, less connected. And in those rare moments when they are engaged, the vibe that joins them is distinctly more negative. They connect over mutual distress or indifference, rather than over mutual affection.

It turns out that positive behavioral synchrony—the degree to which an infant and a parent (through eye contact and affectionate touch) laugh, smile, and coo together—goes hand in hand with oxytocin synchrony. Researchers have measured oxytocin levels in the saliva of dads, moms, and infants both before and after a videotaped, face-to-face parent-infant interaction. For infant-parent pairs who show mutual positive engagement, oxytocin levels also come into sync. Without such engagement, however, no oxytocin synchrony emerges.

Positivity resonance, then, can be viewed as the doorway through which the exquisitely attuned biochemical tendencies of one generation influence those of the next generation to form lasting, often lifelong bonds. Knowing, too, that oxytocin can ebb and flow in unison among non-kin—even among brand-new acquaintances just learning to trust each other—micro-moments of love, of positivity resonance, can also be viewed as the doorways through which caring and compassionate communities are forged. Love, we know, builds lasting resources. Oxytocin, studies show, swings the hammer.

This core tenet of my broaden-and-build theory—that love builds lasting resources—finds support in a fascinating program of research on ... rodents. It turns out that rat moms and their newborn pups show a form of positive engagement and synchrony analogous to that of human parents with their infants. Sensitive parenting in a rat mom, however, is conveyed by her attentively licking and grooming her newborn pups. When a rat mom licks and grooms her pup, it increases the pup's sensitivity to oxytocin, as indicated, for instance, by the number of oxytocin receptors deep within the pup's amygdala, as well as within other subcortical brain regions. Sure enough, these well-groomed—or I dare say well-*loved*—rat pups grow up to have calmer demeanors; they're less skittish, more curious. The researchers can be certain that it's the experiences of loving connection that determine the brain and behavioral profiles of the next generation (that is, their oxytocin receptors and calm demeanors)—and not simply shared genes—because cross-fostering studies show the same patterns of results. That is, even when a rat mom raises a newborn pup that is not her own, her maternal attention still forecasts that pup's brain sensitivity to oxytocin and whether it grows up to be anxious or calm.

## Touring Vagus

Who you are today is also shaped by the third biological character that I want you to meet: your tenth cranial nerve. This key conduit connects your brain to your body and is also called your vagus nerve (sounds like Vegas, as in Las Vegas). It emerges from your brain stem deep within your skull and, although it makes multiple stops at your various internal organs, perhaps most significantly it connects your brain to your heart. You already know that your heart rate shoots up when you feel insulted or threatened—registering the ancestral fight-or-flight response—but you may not know that it's your vagus nerve that eventually soothes your racing heart, by orchestrating (together with oxytocin) the equally ancestral calm-and-connect response.

Keeping in mind that love *is* connection, you should know that your vagus nerve is a biological asset that supports and coordinates your experiences of love. Completely outside of your awareness, your vagus nerve stimulates tiny facial muscles that better enable you to make eye contact and synchronize your facial expressions with another person. It even adjusts the minuscule muscles of your middle ear so you can better track the other person's voice against any background noise. In these exquisitely subtle yet consequential ways, your vagus nerve increases the odds that the two of you will connect, upping your chances for positivity resonance.

Scientists can measure the strength of your vagus nerve—your biological aptitude for love—simply by tracking your heart rate in conjunction with your breathing rate. Specifically, I can look at the degree to which your heart rate, as tracked by sensors placed on your lowest ribs, is patterned by your breathing rate, as revealed by an expandable bellows that encircles your rib cage. This pattern is called *vagal tone*. Like muscle tone, the higher your vagal tone, the better.

In addition to putting the brakes on the big jumps in your heart rate that may be caused by stress, fear, or exertion, your vagus nerve also increases the routine efficiency of your heart, beat by beat, or more precisely, breath by breath. The human heart rate tends to run fairly high, as if we're always on guard for the next danger that might be hidden around the corner. When you're breathing in, a fast heart rate is an efficient heart rate. After all, each successive heartbeat during an in-breath circulates more freshly oxygenated blood throughout your brain and body. Yet when you're breathing out, a fast heart rate is not all that helpful because your supply of freshly oxygenated blood is waning. Here again, your vagus nerve steps in to help out. It can very gently apply the brake on your heart while you exhale, slowing your heart rate down a small degree. In turn your vagus nerve can gently let up on the brake while you inhale, letting your naturally high heart rate resume to grab all the oxygenated blood that it can get. This creates a subtle yet healthy pattern of cardiac arrhythmia: Your heart rate speeds up a bit when you inhale and slows down a bit when you exhale. This is the pattern that reflects your vagal tone, the strength or condition of your vagus nerve. It characterizes the nimbleness with which your primitive, nonconscious brain holds the reins on your galloping heart.



I give you this quick tour of vagus because this conduit within you, between your brain and your heart, has a story to tell about how attuned you are to sources of love in your midst. It even makes a quiet prediction about what illnesses may beset you and how long you're likely to live. Your biological propensities for love and health are intimately intertwined. Measured at rest, vagal tone also tends to be extraordinarily stable over time. For most people, it remains roughly the same year after year, rhythmically channeling them toward loneliness or social prosperity, sickness or health.

That's because people with higher vagal tone, science has shown, are more flexible across a whole host of domains—physical, mental, and social. They simply adapt better to their ever-shifting circumstances, albeit completely at nonconscious levels. Physically, they regulate their internal bodily processes more efficiently, like their glucose levels and inflammation. Mentally, they're better able to regulate their attention and emotions, even their behavior. Socially, they're especially skillful in navigating interpersonal interactions and in forging positive connections with others. By definition, then, they experience more micro-moments of love. It's as though the agility of the conduit between their brains and hearts—as reflected in their high vagal tone—allows them to be exquisitely agile, attuned, and flexible as they navigate the ups and downs of day-to-day life and social exchanges. High vagal tone, then, can be taken as high loving potential. Indeed, this is what doctoral student Bethany Kok and I have found: Compared to people with lower vagal tone, those with higher vagal tone experience more love in their daily lives, more moments of positivity resonance.

You might now be wondering whether you're one of the lucky ones blessed with high vagal tone. If you are, that's great. Yet even if you're not advantaged with high vagal tone today, the latest science gives plenty of reason for hope. Just as you can build muscle tone through regular physical exercises, you can build vagal tone.... The key, once again, is the power of love.

My students and I work together in what I call the PEP Lab, or the Positive Emotions and Psychophysiology Laboratory. Not long ago, we conducted an experiment on the effects of learning the ancient mind-training practice of loving-kindness meditation. Our study participants visited the PEP Lab at the University of North Carolina one by one, and we measured their vagal tone while they sat and relaxed for a few minutes. At the end of this initial laboratory testing session, we instructed participants how to log on to the study website each evening to record their emotions and social connections of the day. A few weeks later, by random assignment, we determined which participants would learn loving-kindness meditation and which would not. All would continue to monitor their day-to-day emotions and social connections using our study website. Months later, weeks after the meditation workshop ended, one by one we invited all participants back to the PEP Lab, where we again measured their vagal tone under the same resting conditions as before....

[It] was those study participants who had been assigned at random to learn loving-kindness meditation who changed the most. They devoted scarcely more than an hour of their time each week to the practice. Yet within a matter of

months, completely unbeknownst to them, their vagus nerves began to respond more readily to the rhythms of their breathing, emitting more of that healthy arrhythmia that is the fingerprint of high vagal tone. Breath by breath—loving moment by loving moment—their capacity for positivity resonance matured. Moreover, through painstaking statistical analyses, we pinpointed that those who experienced the most frequent positivity resonance in connection with others showed the biggest increases in vagal tone. Love literally made people healthier.

## Upward Spirals Unleashed

It's time now to step back from isolated scientific findings and take in the big picture. Recall that your body's positivity resonance operates within a much larger system. Along with love and all the other positive emotions, this system also includes your enduring resources—your physical health, your social bonds, your personality traits, and your resilience. Having assets like these certainly makes life easier, and more satisfying. In addition, though, such resources also serve as booster shots that increase the frequency and intensity of your micro-moments of positivity resonance. Love built those resources in you, and those resources in turn boost your experiences of love. This is not a simple case of cause and effect. The causal arrow instead runs in both directions at once, creating the dynamic and reciprocal causality that drives self-sustaining trajectories of growth. Through love, you become a better version of yourself. And as your better self, you experience love more readily. It is in this dance between your enduring resources and your micro-moments of love that life-giving upward spirals are born.

... By learning how to self-generate love, you can raise your vagal tone. And with higher vagal tone, your attention and actions become more agile, more attuned to the people in your midst. You become better able to forge the interpersonal connections that give rise to positivity resonance. Through vagal tone, then, love begets love.

Likewise, evidence suggests that positivity resonance raises your oxytocin levels. And under the influence of oxytocin, you grow calmer, more attuned to others, friendlier, and more open. Here, too, your skills for forging connections sharpen, which increases your ability to cultivate positivity resonance. Through oxytocin as well then, love begets love.

Recall, too, that positive connections with others create neural coupling, or synchronous brain activity between people. With repetition, positivity resonance also produces structural changes in the brain, for instance, rendering the threat-detecting amygdala more sensitive to the calming influence of oxytocin. While much of the work on neuroplasticity—the brain's capacity to change with experience—comes from research on nonhuman animals, tantalizing evidence has also recently emerged from studies of humans. Becoming a parent, for instance, not only opens the door for parent-infant positivity resonance but also appears to usher in structural changes in brain regions that facilitate positivity resonance. This research shows how love reroutes the neural wiring of your brain, making it more likely that you'll have healthy habits and healthy social bonds in the future. Through brain plasticity, too, then, love begets love.



Plasticity, or openness to change, characterizes your body's cells as well. New cells are born within you all the time. Even now, as you take time to read this book, new cells are coming online within you, taking their predetermined place within the massive orchestra of communication and mutual influence that you call your body. Yet not everything about the birth of your new cells is scripted in advance by your DNA. Some aspects are open to contextual influences signaled by the changing biochemicals that course through you. If you feel lonely and disconnected from others, for instance, your circulating levels of the stress hormone cortisol will rise. Your cortisol levels, in turn, signal your immune system to alter the way your genes are expressed in your next-generation white blood cells, specifically making them less sensitive to cortisol. When this happens, studies show, your inflammatory response becomes more chronic, less responsive to cues that a crisis situation has subsided. This is how, over time, chronic feelings of loneliness can weaken people's immune systems and open the door to inflammation-based chronic illnesses, like cardiovascular disease and arthritis. The data go further to suggest that *feeling* isolated or unconnected to others does more bodily damage than *actual* isolation, suggesting that painful emotions drive the bodily systems that in turn steer you toward dire health outcomes. By tracking how your emotions—and the biochemical changes they trigger—alter gene expression within your immune system, the tools of molecular biology now show how a lack of love compromises your immunity and your health.

Even so, there is ample reason for hope. In countless social exchanges each day, your potential to alleviate loneliness with love is enormous. Your biology, as we have seen in this chapter, enacts your experiences of love. Even so, you have more control over your biology than you realize. Once you grasp the pathways and common obstacles to love, you gain a measure of control over the biochemicals that bathe your cells. To a considerable extent, you orchestrate the messages that your cells hear, the messages that tell your cells whether to grow toward health or toward illness. My collaborators and I are just beginning to chart the ways that oxytocin and other ingredients that make up love's biochemistry trigger healthy changes in gene expression that may foster physical and mental well-being. Also through the plasticity of your cells, we hypothesize, love begets love..

All of love's unseen biological transformations—in your brain rhythms, your blood stream, your vagus nerve, and your cells—in turn ready you to become even more attuned to love, better equipped, biologically, to cultivate moments of positivity resonance with others. This latent biological upward spiral is a powerful force: Love can affect you so deeply that it reshapes you from the inside out and by doing so alters your destiny for further loving moments. With each micro-moment of love, then, you climb another rung on the spiraling ladder that lifts you up to your higher ground, to richer and more compassionate social relationships, to greater resilience and wisdom, and to better physical health.

## NOTES

118 **The Eskimos had fifty-two names for snow:** Margaret Atwood (1972). *Surfacing*. New York: Simon and Schuster.

120 **having at least one close relationship like this is vital to your health and happiness, to be sure:** James S. House, Karl R. Landis, and Debra Umberson (1988). "Social relationships and health." *Science* 241(4865): 540–45. See also Ed Diener and Martin E. P. Seligman (2002). "Very happy people." *Psychological Science* 13(1): 81–84.

121 **The soul must always stand ajar, ready to welcome the ecstatic experience:** Emily Dickinson (1960). *The Complete Poems of Emily Dickinson*. Edited by Thomas Johnson. Boston: Little Brown.

121 **the *social engagement system:*** Stephen W. Porges (2003). "Social engagement and attachment: A phylogenetic perspective." *Annals of the New York Academy of Sciences* 1008: 31–47.

123 **the degree to which your brains lit up in synchrony with each other, matched in both space and time:** Greg J. Stephens, Lauren J. Silbert, and Uri Hasson (2010). "Speaker-listener neural coupling underlies successful communication." *Proceedings of the National Academy of Sciences (USA)* 107(32): 14425–30. See also Uri Hasson (2010). "I can make your brain look like mine." *Harvard Business Review*, December.

123 **voice can convey so much emotion:** Klaus R. Scherer, Tom Johnstone, and Gudrun Klasmeyer (2009). "Vocal expression of emotion." In *Handbook of Affective Sciences*, edited by Richard J. Davidson, Klaus R. Scherer, and Hill H. Goldsmith, pp. 433–56. New York: Oxford University Press; and Jo-Anne Bachorowski and Michael J. Owren (2008). "Vocal expressions of emotion." In *The Handbook of Emotions*, 3rd ed., edited by Michael Lewis, Jeanette M. Haviland-Jones, and Lisa Feldman Barrett, pp. 196–210.

124 **Your knowing is not just abstract and conceptual; it's embodied and physical:** Paula N. Niedenthal, Martial Mermillod, Marcus Maringer, and Ursula Hess (2010). "The Simulation of Smiles (SIMS) model: Embodied stimulation and the meaning of facial expressions." *Behavioral and Brain Sciences* 33(6): 417–80.

124 **Brain coupling, Hasson argues, is the means by which we understand each other:** You might be wondering how Hasson and his team can be so sure they've captured communication, a true transfer of information from one brain to another, and not simply matched responses to listening to the same sounds, like hearing your own voice, or the incomprehensible dialogue from a foreign-language film. They ruled this out by having listeners also hear a story in Russian (which none of them understood). In that case, virtually no neural coupling emerged.

124 **a single act, performed by two brains:** Hasson (2010), p. 1.

124 **the insula, an area linked with conscious feeling states:** A. D. (Bud) Craig (2009). "How do you feel—now? The anterior insula and human awareness." *Nature Reviews Neuroscience* 10: 59–70.

125 **people's brains come particularly into sync during emotional moments:** Uri Hasson, Yuval Nir, Ifat Levy, Galit Fuhrmann, and Rafael Malach (2004). "Intersubject synchronization of cortical activity during natural vision." *Science* 303: 1634–40.



125 **your awareness expands from your habitual focus on "me" to a more generous focus on "we":** This is work I described in my first book, *Positivity* (2009). See especially chapter 4.

126 **as if to prevent their pain from becoming your pain:** Yawei Cheng, Chenyi Chen, Ching-Po Lin, Kun-Hsien Chou, and Jean Decety (2010). "Love hurts: An fMRI study." *Neuroimage* 51: 923–29. See also work by Mary Helen Immordino-Yang, Andrea McColl, Hanna Damasio, and Antonio Damasio (2009). "Neural correlates of admiration and compassion." *Proceedings of the National Academy of Sciences (USA)* 106(19): 8021–26.

126 **stifled emotions ... can also function as obstacles to positivity resonance:** For support for this idea, see work by Iris Mauss and colleagues. It suggests that stifled positivity erodes social connection and thereby limits well-being. Iris B. Mauss, Amanda J. Shallcross, Allison S. Troy, Oliver P. John, Emilio Ferrer, Frank H. Wilhelm, and James J. Gross (2011). "Don't hide your happiness! Positive emotion dissociation, social connectedness, and psychological functioning." *Journal of Personality and Social Psychology* 100(4): 738–48.

126 **oxytocin sparked the formation of a powerful social bond between them:** Jessie R. Williams, Thomas R. Insel, Carroll R. Harbaugh, and C. Sue Carter (1994). "Oxytocin administered centrally facilitates formation of partner preference in female prairie voles (microtus ochrogaster)." *Journal of Neuroendocrinology* 6: 247–50. See also work by Mary M. Cho, A. Courtney DeVries, Jessie R. Williams, and C. Sue Carter (1999). "The effects of oxytocin and vasopressin on partner preferences in male and female prairie voles (microtus ochrogaster)." *Behavioral Neuroscience* 113(5): 1071–79.

126 **oxytocin surges during sexual intercourse:** Marie S. Carmichael, Richard Humbert, Jean Dixon, Glenn Palmisano, Walter Greenleaf, and Julian M. Davidson (1987). "Plasma oxytocin increases in the human sexual response." *Journal of Clinical Endocrinology and Metabolism* 64(1): 27–31.

126 **a synthetic form of oxytocin, available as a nasal spray, for investigational purposes:** Synthetic oxytocin has now been approved for limited investigational use within the United States by the U.S. Federal Drug Administration.

127 **a double-blind research design:** This is the gold standard in human science: Neither the researchers nor the participants are aware of who receives which nasal spray—the spray with the drug or the chemically inert spray that serves as the placebo control.

127 **trusted their entire allotment to their trustee more than doubled:** Michael Kosfeld, Markus Heinrichs, Paul J. Zak, Urs Fischbacher, and Ernst Fehr (2005). "Oxytocin increases trust in humans." *Nature* 435(2): 673–76.

127 **the mere act of being entrusted with another person's money raises the trustee's naturally occurring levels of oxytocin, and that the greater the trustee's oxytocin rise, the more of his recent windfall he sacrificed back to the investor:** Paul J. Zak, Robert Kurzban, and William T. Matzner (2005). "Oxytocin is associated with human trustworthiness." *Hormones and Behavior* 48: 522–27. Interestingly, the effect of being trusted on circulating oxytocin and monetary sacrifice is far higher if trustees have just had a shoulder massage. See Vera B. Morhenn, Jang Woo Park, Elisabeth Piper, and Paul J. Zak (2008). "Monetary sacrifice among strangers is mediated by endogenous oxytocin release after physical contact." *Evolution and Human Behavior* 29: 375–83.

127 **more trusting—a whopping 44 percent more trusting—with confidential information about themselves:** Moira Mikolajczak, Nicolas Pinon, Anthony Lane, Philippe de Timary, and Olivier Luminet (2010). "Oxytocin not only increases trust when money is at stake, but also when confidential information is in the balance." *Biological Psychology* 85: 182–84.

127 **sharing an important secret from your life with someone you just met increases your naturally circulating levels of oxytocin:** Szabolcs Keri and Imre Kiss (2011). "Oxytocin response in a trust game and habituation of arousal." *Physiology and Behavior* 102: 221–24. The effect of telling secrets on oxytocin holds unless you are diagnosed with schizophrenia; see Szabolcs Keri, Imre Kiss, and Oguz Keleman (2009). "Sharing secrets: Oxytocin and trust in schizophrenia." *Social Neuroscience* 4(4): 287–93.

127 **The effects of oxytocin on trust turn out to be quite sensitive to interpersonal cues:** Moiri Mikolajczak, James J. Gross, Anthony Lane, Olivier Corneille, Philippe de Timary, and Olivier Luminet (2010). "Oxytocin makes people trusting, not gullible." *Psychological Science* 21(8): 1072–74. Likewise, oxytocin seems to especially promote trust with in-group members; see Carsten K. W. De Dreu, Lidred L. Greer, Gerben A. Van Kleef, Shaul Shalvi, and Michel J. J. Handgraaf (2010). "Oxytocin promotes human ethnocentrism." *Proceedings of the National Academy of Sciences (USA)* 108(4): 1262–66.

127 **under the influence of oxytocin, you attend more to people's eyes:** Adam J. Guastella, Philip B. Mitchell, and Mark R. Dadds (2008). "Oxytocin increases gaze to the eye region of human faces." *Biological Psychiatry* 63: 3–5.

127 **more attuned to their smiles, especially subtle ones:** Abigail A. Marsh, Henry H. Yu, Daniel S. Pine, and R. J. R. Blair (2010). "Oxytocin improves specific recognition of positive facial expressions." *Psychopharmacology* 209: 225–32.

127 **a better judge of their feelings:** Gregor Domes, Markus Heinrichs, Andre Michel, Christoph Berger, and Sabine C. Herpertz (2007). "Oxytocin improves 'mind-reading' in humans." *Biological Psychiatry* 61: 731–33.

127 **view people on the whole as more attractive and trustworthy:** Angeliki Theodoridou, Angela C. Rowe, Ian S. Penton-Voak, and Peter J. Rogers (2009). "Oxytocin and social perception: Oxytocin increases perceived facial trustworthiness and attractiveness." *Hormones and Behavior* 56: 128–132.

127 **particularly sensitized to environmental cues linked to positive social connections—for instance, to words like *love and kissing:*** Christian Unkelback, Adam J. Guastella, and Joseph P. Forgas (2008). "Oxytocin selectively facilitates recognition of positive sex and relationship words." *Psychological Science* 19(11): 1092–94.

128 **the parts of your amygdala that tune in to threats are muted, whereas the parts that tune in to positive social opportunities are amplified:** Matthias Gamer, Bartosz Zurowski, and Christian Buchel (2010). "Different amygdala subregions mediate valence-related and attentional effects of oxytocin in humans." *Proceedings of the National Academy of Sciences (USA)* 107(20): 9400–9405. See also: Peter Kirsch, Christine Esslinger, Qiang Chen, et al. (2005). "Oxytocin modulates neural circuitry for social cognition and fear in humans." *Journal of Neuroscience* 25(49): 11489–93; and Predrag Petrovic, Raffael Kalisch, Tania Singer, and Raymond J. Dolan (2008). "Oxytocin attenuates affective evaluations of conditioned faces and amygdale activity." *Journal of Neuroscience* 28(26): 6607–15.



128 **If you were to face these difficulties under the influence of oxytocin, studies suggest:** Beate Ditzen, Marcel Schaer, Barbara Gabriel, et al. (2009). "Intranasal oxytocin increases positive communication and reduces cortisol levels during couple conflict." *Biological Psychiatry* 65: 728–731. See also work by Markus Heinrichs, Thomas Baumgartner, Clemens Kirschbaum, and Ulrike Ehlert (2003). "Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress." *Biological Psychiatry* 54: 1389–98.

128 **behaving kindly in these ways also raises your naturally occurring levels of oxytocin, which in turn curbs stress-induced rises in heart rate and blood pressure:** Julianne Holt-Lunstad, Wendy A. Birmingham, and Kathleen Light (2008). "Influence of a 'warm touch' support enhancement intervention among married couples on ambulatory blood pressure, oxytocin, alpha amylase, and cortisol." *Psychosomatic Medicine* 70: 976–85. See also forthcoming experimental work by Stephanie L. Brown, early versions of which she presented in a talk at the Society for Experimental Social Psychology meeting in October 2011 entitled "Prosocial behavior and health: Towards a biological model of a caregiving system."

128 **reduces feelings of depression, and increases your pain thresholds:** Kerstin Uvnäs-Moberg, E. Bjorkstrand, Viveka Hillegaart, and S. Ahlenius (1999). "Oxytocin as a possible mediator of SSRI-induced antidepressant effects." *Psychopharmacology* 142(1): 95–101. See also work by Maria Petersson, Pawel Alster, Thomas Lundeberg, and Kerstin Uvnäs-Moberg (1996). "Oxytocin increases nociceptive thresholds in a long-term perspective in female and male rats." *Neuroscience Letters* 212(2): 87–90.

128 **the mammalian *calm-and-connect* response:** Kerstin Uvnäs-Moberg, Ingemar Arn, and David Magnusson (2005). "The psychobiology of emotion: The role of the oxytocinergic system." *International Journal of Behavioral Medicine* 12(2): 59–65. See also Kerstin Uvnäs-Moberg's 2003 book written for a general audience, *The Oxytocin Factor: Tapping the Hormone of Calm, Love and Healing.* New York: Perseus.

128 **Human greed, after all, runs rampant and can yield all manner of exploitation:** Compelling new insights on the nature of greed can be drawn from new experimental research on social class. See work by Paul K. Piff, Daniel M. Stancato, Stephané Côté, Rodolfo Mendoza-Denton, and Dacher Keltner (2012). "Higher social class predicts increased unethical behavior." *Proceedings of the National Academy of Sciences (USA)* 109(11): 4086–91.

128 **Oxytocin appears both to calm fears that might steer you away from interacting with strangers and also to sharpen your skills for *connection:*** Anne Campbell (2009). "Oxytocin and human social behavior." *Personality and Social Psychological Review* 14(3): 281–95.

128 **your gut instincts about whom to trust and whom not to trust become more reliable:** Niedenthal et al. (2010).

128 **oxytocin has been dubbed "the great facilitator of life":** Heon-Jin Lee, Abbe H. Macbeth, Jerome H. Pagani, and W. Scott Young, III (2009). "Oxytocin: The great facilitator of life." *Progress in Neurobiology* 88(2): 127–51.

129 **Without such engagement, however, no oxytocin synchrony emerges:** Ruth Feldman, Ilanit Gordon, and Orna Zagoory-Sharon (2010). "The cross-generation transmission of oxytocin in humans." *Hormones and Behavior* 58: 669–76.

129 **When a rat mom licks and grooms her pup, it increases the pup's sensitivity to oxytocin:** Frances A. Champagne, Ian C. G. Weaver, Josie Diorio, Sergiy

Dymov, Moshe Szyf, and Michael J. Meaney (2006). "Maternal care associated with methylation of the estrogen receptor-α1b promoter and estrogen receptor-α1b expression in the medial preoptic area of female off-spring." *Endocrinology* 147(6): 2909–15.

130 **your vagus nerve increases the odds that the two of you will connect:** Porges (2003).

131 **regulate their internal bodily processes more efficiently, like their glucose levels and inflammation:** Julian F. Thayer and Esther Sternberg (2006). "Beyond heart rate variability: Vagal regulation of allostatic systems." *Annals of the New York Academy of Sciences* 1088: 361–72.

131 **better able to regulate their attention and emotions, even their behavior:** Stephen W. Porges, Jane A. Doussard-Roosevelt, and Ajit Maiti (1994), "Vagal tone and the physiological regulation of emotion." *Monographs of the Society for Research in Child Development* 59(2/3): 167–86.

131 **especially skillful in navigating interpersonal interactions and in forging positive connections with others:** Kok and Fredrickson (2010).

131 **those with higher vagal tone experience more love in their daily lives, more moments of positivity resonance:** Kok and Fredrickson (2010).

132 **their vagus nerves began to respond more readily to the rhythms of their breathing, emitting more of that healthy arrhythmia that is the fingerprint of high vagal tone:** Kok, et al. (in press).

132 **Having assets like these certainly makes life easier, and more satisfying:** Michael A. Cohn, Barbara L. Fredrickson, Stephanie L. Brown, et al. (2009). "Happiness unpacked: Positive emotions increase life satisfaction by building resilience." *Emotion* 9(3): 361–68.

132 **appears to usher in structural changes in brain regions that facilitate positivity resonance:** Pil Young Kim (2009). "The interplay of brain and experience in parental love." *Dissertation Abstracts International: Section B: The Sciences and Engineering* 70(6-B): 3810.

133 **your inflammatory response becomes more chronic, less responsive to cues that a crises situation has subsided:** Steve W. Cole (2009). "Social regulation of human gene expression." *Current Directions in Psychological Science* 18(3): 132–37.

133 ***feeling* isolated or unconnected to others does more bodily damage than *actual* isolation:** Steve W. Cole, Louise C. Hawkley, Jesusa M. Arevalo, et al. (2007). "Social regulation of gene expression in human leukocytes." *Genomic Biology* 8: R189.

133 **you orchestrate the messages that your cells hear, the messages that tell your cells whether to grow toward health or toward illness:** Of course, other forces are at work as well. You do not hold sole responsibility (or blame) for your health or illness via the emotions you experience. In other words, please do not use this science to blame those who suffer from illnesses for their own fate. For a sharp critique of how science can be misused in this manner, see Barbara Ehrenreich (2009). *Bright-Sided: How the Relentless Promotion of Positive Thinking Has Undermined America.* New York: Metropolitan Books.

133 **just beginning to chart the ways that oxytocin and other ingredients that make up love's biochemistry trigger healthy changes in gene expression:** In ongoing research funded by the U.S. National Institutes of Health (R01NR012899) I've teamed up with Steve W. Cole, director of UCLA's Social Genomics Core Laboratory, to examine how learning loving-kindness meditation may alter people's patterns of gene expression. We are especially interested in changes that may occur in the cells that regulate inflammatory processes in the immune system.



## QUESTIONS FOR MAKING CONNECTIONS WITHIN THE READING

1. Fredrickson, a psychologist, claims to reveal the "true meaning of love as your body experiences it." What does she imply by distinguishing between your body and you? Are you identical to your body, and how do you normally think about your body's relation to yourself? How does the body's experience differ from the experience of the mind? In Fredrickson's account of love, what role does the body play? When Fredrickson instructs you to "set aside the take on love your family might have offered you" and to suspend the "view of love as a special bond or relationship," does she mean that such views of love are incorrect, or does she simply want us to approach the subject from a different angle?
2. Since the time of Plato, Western thinkers have been fascinated—and frustrated—by the relations between the mind and the body. The body was described as material—made of matter—whereas the mind was immaterial, supposedly *pure thought.* Does Fredrickson see body and mind as separate? Does her account suggest that emotions like love would exist at all without the body? If thoughts and feelings are impossible without the existence of the body, then what is the mind? Does Fredrickson suggest that our mental lives are completely determined by our biology, or do we have some degree of freedom?
3. What is gained by thinking about "love's biology" as a "system"? How is the body involved in the operation of this system? In what ways are other people part of the system? How much of the experience of love involves consciousness and how much happens below the threshold of our conscious minds? Does the self exist only by virtue of its relations to others in a system of some kind? What other systems can you think of, and how might they be compared to the one that creates the experience of love?

## QUESTIONS FOR WRITING

1. A long tradition in many cultures represents suffering as redemptive. Suffering is believed to instill greater patience, endurance, and strength of will. To what degree does Fredrickson take issue with this view, at least implicitly? How can positive emotions, even if they are sometimes subtle and brief, help us become more flexible, attuned to others, and creative? If positive

emotions can have the powerful effects that Fredrickson describes, why has suffering enjoyed such prestige as a path to truth? Could it be the case that many of our traditional ideas about love as a form of self-sacrifice are bound up with a mistaken view of suffering as redemptive?

2. If love is, as Fredrickson affirms, the "supreme" emotion, why do people frequently behave in a manner that seems far removed from "positivity resonance"? Instead of speculating broadly, look back over the selection for clues: where does Fredrickson's account reveal potential vulnerabilities in the system? For example, Uri Hasson's work suggests that just as people can share positive emotions, they can transmit negative emotions, as well. Because positivity is not guaranteed by our biology, Fredrickson's essay might be seen as an argument for a special kind of mental hygiene. If we understand our emotions more fully, can we live more happily? Can we change the world beyond ourselves by trying to be happier?

## QUESTIONS FOR MAKING CONNECTIONS BETWEEN READINGS

1. In his essay "Wisdom," Robert Thurman argues that the existence of the self is only temporary and conditioned by its surroundings. "Realizing your selflessness," he writes, "does not mean that you become a nobody, it means that you become the type of somebody who is a viable, useful somebody, not a rigid, fixated, I'm-the-center-of-the-universe, isolated from others somebody. You become the type of somebody who is over the idea of a conceptually fixed and self-created 'self.'" Would Fredrickson agree that we are basically selfless? How does positivity resonance change our relations to others, and could it be said to take us beyond the limits of ourselves? Does love make us more "fixed" or more fluid? What can we learn about ourselves from the fact that love, according to Fredrickson, is not just one of the many positive emotions we experience from time to time but has a special status as "our supreme emotion"?
2. Fredrickson's description of love is unreservedly positive. As the "supreme emotion," love lifts us up, connects us to others and even restores our bodies to robust health. But could love—or "positivity resonance," as Fredrickson calls it—have a darker side as well? Consider the role that it might play in the social lives of the undergraduates described by Karen Ho in "Biographies of Hegemony?" Feted by Wall Street recruiters and surrounded by fellow students eager to embrace a career in finance, they seldom encounter anyone who challenges their sense of belonging. But in what ways could this resonance prevent them from exploring alternatives that would seem painful and lonely at first but might lead to greater satisfaction later on? When does resonance become "groupthink," and when do our differences enrich our personal and collective lives?