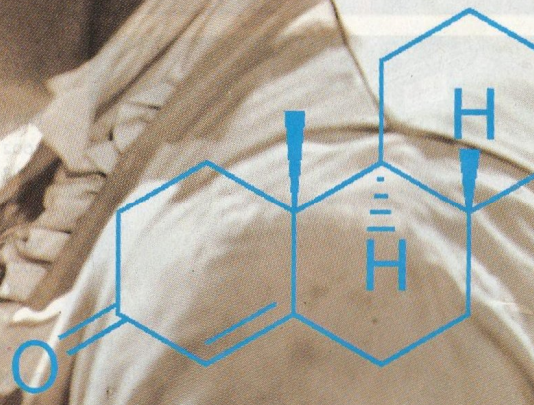
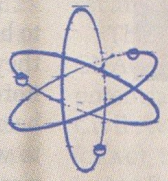




$$j = \sum_{i=1}^3 \frac{\partial L}{\partial \dot{x}_i} Q[x_i]$$



$$= \frac{m}{2} \sum_i \dot{x}_i^2 - V(\dots)$$

# The Science of Romance

How we fall in love may be the hardest human behavior to explain. Scientists are seeking answers—and finding them

BY JEFFREY KLUGER

**T**HE LAST TIME YOU HAD SEX, THERE WAS arguably not a thought in your head. O.K., if it was very familiar sex with a very familiar partner, the kind that—truth be told—you probably have most of the time, your mind may have wandered off to such decidedly nonerotic matters as balancing your checkbook or planning your week. If it was the kind of sex you shouldn't have been having in the first place—the kind you were regretting even as it was taking place—you might have already been flashing ahead to the likely consequences. But if it was that kind of sex that's the whole reason you took up having sex in the first place—the out-of-breath, out-of-body, can-you-believe-this-is-actually-happening kind of sex—your rational side had probably taken a powder.

Losing our faculties over a matter like sex ought

not to make much sense for a species like ours that relies on its wits. A savanna full of predators, after all, was not a place to get distracted. But the lure of losing our faculties is one of the things that makes sex thrilling—and one of the very things that keeps the species going. As far as your genes are concerned, your principal job while you're alive is to conceive offspring, bring them to adulthood and then obligingly die so you don't consume resources better spent on the young. Anything that encourages you to breed now and breed plenty gets that job done.

But mating and the rituals surrounding it make us come unhinged in other ways too, ones that are harder to explain by the mere baby-making imperative. There's the transcendent sense of tenderness you feel toward a person who sparks your interest. There's the sublime feeling of relief and reward

Nearly 30 years ago, psychologist Elaine Hatfield of the University of Hawaii and sociologist Susan Sprecher now of Illinois State University developed a 15-item questionnaire that ranks people along what the researchers call the Passionate Love Scale. Hatfield has administered it in places as varied as the U.S. Pacific Islands, Russia, Mexico, Pakistan and, most recently, India and has found that no matter where she looks, it's impossible to squash love. "It seemed only people in the West were goopy enough to marry for passionate love," she says. "But in all of the cultures I've studied, people love wildly."

What scientists not to mention the rest of us, want to know is: Why? What makes us go so joony over love? Why would we bother with this elaborate exercise in fan dances and tirades, winks and sighing, joy and sorrow? "We have only a very limited understanding of what romance is in a scientific sense," admits Helen Fisher, director of the Kinsey Institute in Bloomington, Ind., a place where they know a thing or two about the way human beings pair up, but that limited understanding is

when that interest is returned. There are the flowers you buy and the poetry you write and the impulsive trip you make to the other side of the world just so you can spend 48 hours in the presence of a lover who's far away. That's an awful lot of busy work just to get a sperm to meet an egg—let alone a sperm to meet an egg to really get that's about.

Human beings make a terrible fuss about a lot of things but none more than romance. Eating and drinking are just as important for keeping the species going—more so actually, since a celibate person can at least continue living but a starving person can't. Yet while we may build whole institutions around the simple ritual of eating, it never turns us flat-out nuts. Romance does.

"People compose poetry, novels, sitcoms for love," says Helen Fisher, an anthropologist at Rutgers University and something of the Queen Mum of romance research. "They live for love, die for love, kill for love. It can be stronger than the drive to stay alive." On its good days (and love has a lot of them), all this seems to make perfect sense

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expanding. The more scientists look, the more they're able to tease romance apart into its individual strands—the visual, auditory, olfactory, tactile, neurochemical processes that make it possible. None of those things may be necessary for simple procreation, but all of them appear essential for something larger. What that something is—and how we achieve it—is only now coming clear.

### The Love Hunt

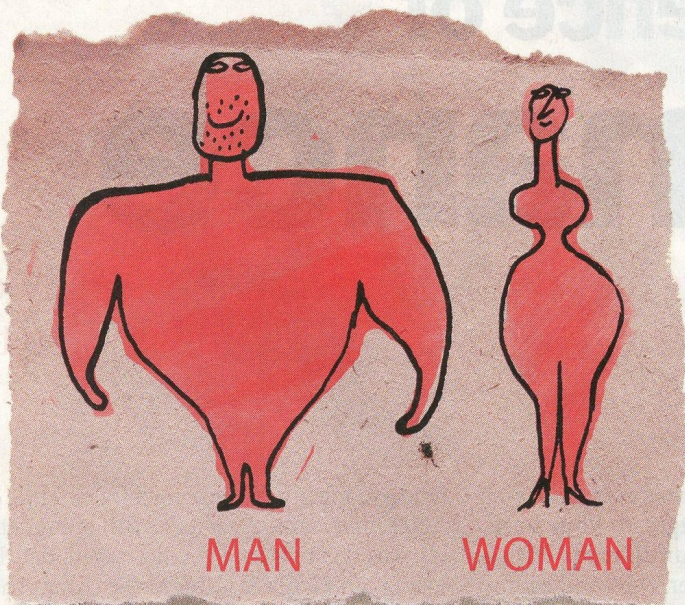
IF HUMAN REPRODUCTIVE BEHAVIOR IS A complicated thing, part of the reason is that it's designed to serve two clashing purposes. On the one hand, we're driven to mate a lot. On the other hand, we want to mate well so that our offspring survive. If you're a female, you get only a few rolls of the reproductive dice in a lifetime. If you're a male, your freedom to conceive is limited only by the availability of willing partners, but the demands of providing for too big a brood are a powerful incentive to limit your pairings to the female who will give you just a few strong young. For that reason, no sooner do we reach sexual maturity than we learn to look for signals of good genes and reproductive fitness in potential partners and, importantly, to display them ourselves.

"Every living human is a descendant of a long line of successful maters," says David Buss, an evolutionary psychologist at the University of Texas at Austin. "We've adapted to pick certain types of mates and to fulfill the desires of the opposite sex."

One of the most primal of those desires is that a possible partner smells right. Good smells and bad smells are fundamentally no different from each other; both are merely volatile molecules wafting off an object and providing some clue as to the thing that emitted them. Humans, like all animals, quickly learn to assign values to those scents, recognizing that, say, putrefying flesh can carry disease and thus recoiling from its smell and that warm cookies carry the promise of vanilla, sugar and butter and thus being drawn to them. Other humans carry telltale smells of their own, and those can affect us in equally powerful ways.

The best-known illustration of the invisible influence of scent is the way the menstrual cycles of women who live communally tend to synchronize. In a state of nature, this is a very good idea. It's not in a tribe's or community's interests for one ovulating female to monopolize the reproductive attention of too many males. Better to have all the females become fertile at once and allow the fittest potential mates to compete with one another for them.

But how does one female signal the rest? The answer is almost certainly



## Liking What We See—and Hear

We're suckers for a pretty face—and a lot more. Men prefer women with large breasts and a low waist-to-hip ratio, which are seen as signs of fertility. Women like men with muscular shoulders, a broad chest and a full beard. These are signs of strength and a healthy flow of virility-inducing testosterone. Men with deeper voices are perceived as having a high testosterone level and in one study were shown to have more children, suggesting that women respond to the way they sound.

smell. Pheromones—or scent-signaling chemicals—are known to exist among animals, and while scientists have had a hard time unraveling the pheromonal system in humans, they have isolated a few of the compounds. One type, known as driver pheromones, appears to affect the endocrine systems of others. Since the endocrine system plays a critical role in the timing of menstruation, there is at least a strong circumstantial case that the two are linked. “It’s thought that there is a driver female who gives off something that changes the onset of menstruation in the other women,” says chemist Charles Wysocki of the Monell Chemical Senses Center in Philadelphia.

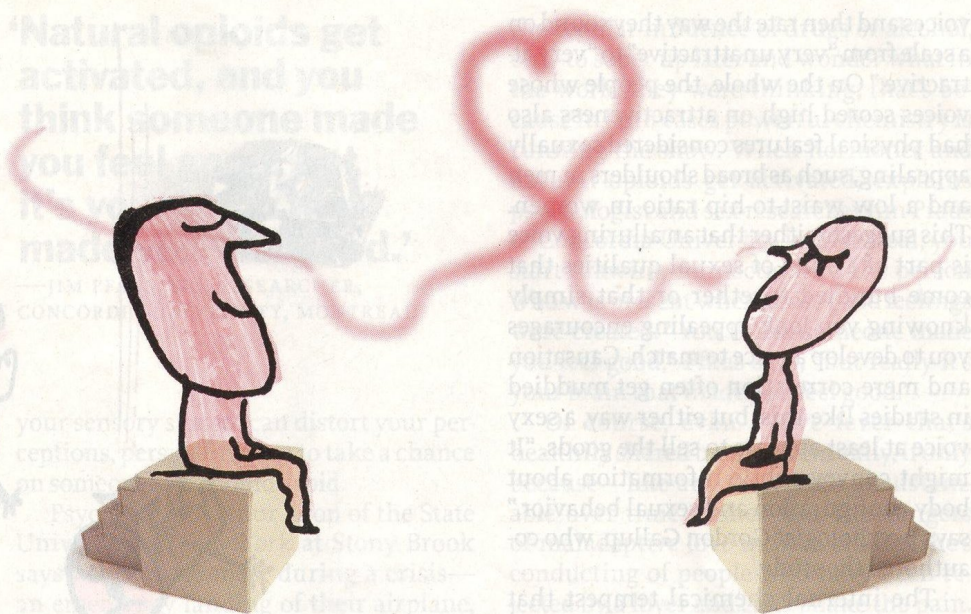
It’s not just women who respond to such olfactory cues. One surprising study published last October in the journal *Evolution and Human Behavior* showed that strippers who are ovulating average \$70 in tips per hour; those who are menstruating make \$35; those who are not ovulating or menstruating make \$50. Other studies suggest that men can react in more romantic ways to olfactory signals. In work conducted by Martie Haselton, an associate professor of psychology at UCLA, women report that when they’re ovulating, their partners are more loving and attentive and, significantly, more jealous of other men. “The men are picking up on something in their partner’s behavior that tells them to do more mate-guarding,” Haselton says.

Scent not only tells males which females are primed to conceive, but it also lets both sexes narrow their choices of potential partners. Among the constellation of genes that control the immune system are those known as the major histocompatibility complex (MHC), which influence tissue rejection. Conceive a child with a person whose MHC is too similar to your own, and the risk increases that the womb will expel the fetus. Find a partner with sufficiently different MHC, and you’re likelier to carry a baby to term.

Studies show that laboratory mice can smell too-similar MHC in the urine of other mice and will avoid mating with those individuals. In later work conducted at the

**When women are ovulating, they report that their mates are more loving and attentive and, significantly, more jealous of other men**

ILLUSTRATIONS BY SERGE BLOCH



## The Lure of Smell

**Like all other animals, we respond to olfactory cues. The menstrual cycles of women living together often synchronize, something that is probably governed by scent. In the same way, men seem able to detect when women are ovulating—and thus are most fertile—and will behave more solicitously toward them during those times. Men and women respond to the scent of each other’s MHC, part of the genetic makeup of the immune system and something that helps determine whether a fetus they might conceive will be carried to term.**

University of Bern in Switzerland, human females were asked to smell T-shirts worn by anonymous males and then pick which ones appealed to them. Time and again, they chose the ones worn by men with a safely different MHC. And if the smell of MHC isn’t a deal maker or breaker, the taste is. Saliva also contains the compound, a fact that Haselton believes may partly explain the custom of kissing, particularly those protracted sessions that stop short of intercourse. “Kissing,” she says simply, “might be a taste test.”

Precise as the MHC-detection system is, it can be confounded. One thing that throws us off the scent is the birth-control pill. Women who are on the Pill—which chemically simulates pregnancy—tend to choose wrong in the T-shirt test. When they discontinue the daily hormone dose, the protective smell mechanism kicks back in. “A colleague of mine wonders if the Pill may contribute to divorce,” says Wysocki. “Women pick a husband when they’re on birth control, then quit to have a baby and realize they’ve made a mistake.”

Less surprising than the importance of the way a partner smells is the way that

partner looks and sounds. Humans are suckers for an attractive face and a sexy shape. Men see ample breasts and broad hips as indicators of a woman’s ability to bear and nurse children—though most don’t think about such matters so lucidly. Women see a broad chest and shoulders as a sign of someone who can clobber a steady supply of meat and keep lions away from the cave. And while a hairy chest and a full beard have fallen out of favor in the waxed and buffed 21st century, they are historically—if unconsciously—seen as signs of healthy testosterone flow that gives rise to both fertility and strength.

A deep voice, also testosterone driven, can have similarly seductive power. Psychology professor David Feinberg of McMaster University in Ontario studied Tanzania’s Hadza tribesmen, one of the world’s last hunter-gatherer communities, and found that the richer and lower a man’s voice, the more children he had. Researchers at the University at Albany, State University of New York, recently conducted related research in which they had a sample group of 149 volunteers listen to recordings of men’s and women’s

voices and then rate the way they sound on a scale from “very unattractive” to “very attractive.” On the whole, the people whose voices scored high on attractiveness also had physical features considered sexually appealing, such as broad shoulders in men and a low waist-to-hip ratio in women. This suggests either that an alluring voice is part of a suite of sexual qualities that come bundled together or that simply knowing you look appealing encourages you to develop a voice to match. Causation and mere correlation often get muddled in studies like this, but either way, a sexy voice at least appears to sell the goods. “It might convey subtle information about body configuration and sexual behavior,” says psychologist Gordon Gallup, who co-authored the study.

The internal chemical tempest that draws us together hits Category 5 when sex gets involved. If it’s easy for a glance to become a kiss and a kiss to become much more, that’s because your system is tripped up to make it hard to turn back once you’re aroused. That the kiss is the first snare is no accident.

Not only does kissing serve the utilitarian purpose of providing a sample of MHC, but it also magnifies the other attraction signals—if only as a result of proximity. Scent is amplified up close, as are sounds and breaths and other cues. And none of that begins to touch the tactile experience that was entirely lacking until intimate contact was made. “At the moment of a kiss, there’s a rich and complicated exchange of postural, physical and chemical information,” says Gallup. “There are hardwired mechanisms that process all this.”

What’s more, every kiss may also carry a chemical Mickey, slipped in by the male. Though testosterone is found in higher concentrations in men than in women, it is present in both genders and is critical in maintaining arousal states. Traces of testosterone make it into men’s saliva, particularly among men who have high blood levels of the hormone to start with, and it’s possible that a lot of kissing over a long period may be a way to pass some of that natural aphrodisiac to the woman, increasing her arousal and making her more receptive to even greater intimacy.

### When Mating Becomes Love

IF WE’VE SUCCEEDED IN BECOMING SUCH efficient reproductive machines—equipped with both a generous appetite for mates and a cool ability to screen them for genetic qualities—why muddy things up with romance? For one thing, we may not be able to help it. Just being attracted to someone doesn’t mean that that person is attracted back, and few things drive us crazier than



## When Love Dies

Love is strong, but it’s not indestructible. People who meet under the influence of alcohol or drugs or in a state of high excitement may cool off when their bodies return to baseline. Rejection may activate regions of the brain that control addiction, which is why it can be hard to quit someone even after that person has quit you. The spurned lover who grows angry or needy can push the other person even further away, which accelerates the split and may actually help both parties.

wanting something we may not get. Cultural customs that warn against sex on the first date may have emerged for such practical reasons as avoiding pregnancy or sexually transmitted diseases, but they’re also there for tactical reasons. Males or females who volunteer their baby-making services too freely may not be offering up very valuable genes. Those who seem more discerning are likelier to be holding a winning genetic hand—and are in a better position to demand one in return.

The elaborate ritual of dating is how this screening takes place. It’s when that process pays off—when you finally feel

**‘At the moment of a kiss, there’s a rich exchange of postural, physical and chemical information.’**

—GORDON GALLUP, PSYCHOLOGIST,  
STATE UNIVERSITY OF NEW YORK

you’ve found the right person—that the true-love thrill hits, and studies of the brain with functional magnetic resonance imagers (fMRIs) show why it feels so good. The earliest fMRIs of brains in love were taken in 2000, and they revealed that the sensation of romance is processed in three areas. The first is the ventral tegmental, a clump of tissue in the brain’s lower regions, which is the body’s central refinery for dopamine. Dopamine does a lot of jobs, but the thing we notice most is that it regulates reward. When you win a hand of poker, it’s a dopamine jolt that’s responsible for the thrill that follows. When you look forward to a big meal or expect a big raise, it’s a steady flow of dopamine that makes the anticipation such a pleasure.

Fisher and her colleagues have conducted recent fMRI scans of people who are not just in love but newly in love and have found that their ventral tegmental areas are working particularly hard. “This little factory near the base of the brain is sending dopamine to higher regions,” she says. “It creates craving, motivation, goal-oriented behavior—and ecstasy.”

## When Love Becomes a Habit

EVEN WITH ITS INTOXICATING SUPPLY OF dopamine, the ventral tegmental couldn't do the love job on its own. Most people eventually do leave the poker game or the dinner table, after all. Something has to turn the exhilaration of a new partner into what can approach an obsession, and that something is the brain's nucleus accumbens, located slightly higher and farther forward than the ventral tegmental. Thrill signals that start in the lower brain are processed in the nucleus accumbens via not just dopamine but also serotonin and, importantly, oxytocin. If ever there was a substance designed to bind, it's oxytocin.

New mothers are flooded with the stuff during labor and nursing—one reason they connect so ferociously to their babies before they know them as anything more than a squirmy body and a hungry mouth. Live-in fathers whose partners are pregnant experience elevated oxytocin too, a good thing if they're going to stick around through months of gestation and years of child-rearing. So powerful is oxytocin that a stranger who merely walks into its line of fire can suddenly seem appealing.

"In one study, an aide who was not involved with the birth of a baby would stand in a hospital room while the mother was in labor," says Sue Carter, a professor of psychiatry at the University of Illinois. "The mothers later reported that they found the person very sympathetic, even though she was doing nothing at all."

The last major stops for love signals in the brain are the caudate nuclei, a pair of structures on either side of the head, each about the size of a shrimp. It's here that patterns and mundane habits, such as knowing how to type and drive a car, are stored. Motor skills like those can be hard to lose, thanks to the caudate nuclei's indelible memory. Apply the same permanence to love, and it's no wonder that early passion can gel so quickly into enduring commitment. The idea that even one primal part of the brain is involved in processing love would be enough to make the feeling powerful. The fact that three are at work makes that powerful feeling consuming.

## Love Gone Wrong

THE PROBLEM WITH ROMANCE IS THAT it doesn't always deliver the goods. For all the joy it promises, it can also play us for fools, particularly when it convinces us that we've found the right person, only to upend our expectations later. Birth-control pills that mask a woman's ability to detect her mate's incompatible MHC are one way bad love can slip past our perimeters. Adrenaline is another. Any overwhelming emotional experience that ratchets up

## 'Natural opioids get activated, and you think someone made you feel good, but it's your brain that made you feel good.'

—JIM PFAUS, SEX RESEARCHER, CONCORDIA UNIVERSITY, MONTREAL

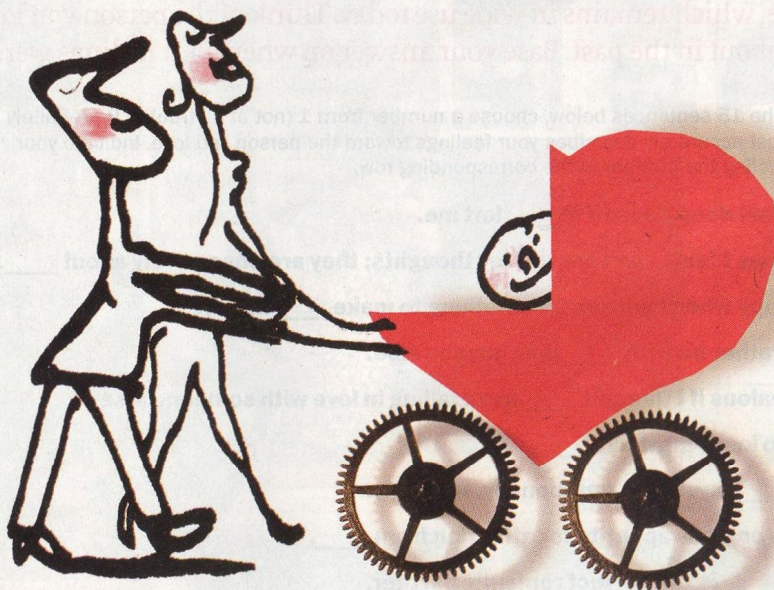
your sensory system can distort your perceptions, persuading you to take a chance on someone you should avoid.

Psychologist Arthur Aron of the State University of New York at Stony Brook says people who meet during a crisis—an emergency landing of their airplane, say—may be much more inclined to believe they've found the person meant for them. "It's not that we fall in love with such people because they're immensely attractive," he says. "It's that they seem immensely attractive because we've fallen in love with them."

If that sounds a lot like what happens when people meet and date under

the regular influence of drugs or alcohol, only to sober up later and wonder what in the world they were thinking, that's because in both cases powerful chemistry is running the show. When hormones and natural opioids get activated, explains psychologist and sex researcher Jim Pfaus of Concordia University in Montreal, you start drawing connections to the person who was present when those good feelings were created. "You think someone made you feel good," Pfaus says, "but really it's your brain that made you feel good."

Of course, even a love fever that's healthily shared breaks eventually, if only because—like any fever—it's unsustainable over time. Fisher sees the dangers of maladaptive love in fMRI studies she's conducting of people who have been rejected by a lover and can't shake the pain. In these subjects, as with all people in love, there is activity in the caudate nucleus, but it's specifically in a part that's adjacent to a brain region associated with addiction. If the two areas indeed overlap, as Fisher suspects, that helps explain why telling a jilted lover that it's time to move on can be fruitless—as fruitless as admonishing a drunk to put a cork in the bottle.



## Why We Do It

Nature doesn't really care if we experience the thrill of falling in love or not, but it deeply cares that we make a lot of babies and stick around to raise them. The problem is, human babies require an awful lot of care—18 years or more. When we first reach sexual maturity, we scan the world for people to mate with. When we find someone, romance focuses that scattershot attention. Companionate love then bonds us to our partner for our child-rearing years and beyond.

Happily, romance needn't come to ruin. Even irrational animals like ourselves would have quit trying if the bet didn't pay off sometimes. The eventual goal of any couple is to pass beyond serial dating—beyond even the thrill of early love—and into what's known as companionate love. That's the coffee-and-Sunday-paper phase, the board-games-when-it's-raining phase, and the fact is, there's not a lick of excitement about it. But that, for better or worse, is adaptive too. If partners are going to stay together for the years of care that children require, they need a love that bonds them to each other but without the passion that would be a distraction. As early humans relied more on their brainpower to survive—and the dependency period of babies lengthened to allow for the necessary learning—companionate bonding probably became more pronounced.

That's not to say that people can't stay in love or that those couples who say they still feel romantic after years of being together are imagining things. Aron has conducted fMRI studies of some of those

## The eventual goal of people who pair-bond is to move beyond the thrill of early love and into the comfort of the Sunday-paper-and-coffee phase

stubbornly loving pairs, and initial results show that their brains indeed look very much like those of people newly in love, with all the right regions lighting up in all the right ways. "We wondered if they were really feeling these things," Aron says. "But it looks like this is really happening."

These people, however, are the exceptions, and nearly all relationships must settle and cool. That's a hard truth, but it's a comforting one too. Long for the heat of early love if you want, but you'd have

to pay for it with the solidity you've built over the years. "You've got to make a transition to a stabler state," says Barry McCarthy, a psychologist and sex therapist based in Washington. If love can be mundane, that's because sometimes it's meant to be.

Calling something like love mundane, of course, is true only as far as it goes. Survival of a species is a ruthless and reductionist matter, but if staying alive were truly all it was about, might we not have arrived at ways to do it without joy—as we could have developed language without literature, rhythm without song, movement without dance? Romance may be nothing more than reproductive filigree, a bit of decoration that makes us want to perpetuate the species and ensures that we do it right. But nothing could convince a person in love that there isn't something more at work—and the fact is, none of us would want to be convinced. That's a nut science may never fully crack. —REPORTED BY EBEN HARRELL/LONDON, KRISTIN KLOBERDANZ/MODESTO, CALIF., AND KATE STINCHFIELD/NEW YORK ■

## The Thermometer of Love

You can't precisely measure love, but you can't deny that it comes in different temperatures: cool, hot and scalding. Three decades ago, psychologist Elaine Hatfield and sociologist Susan Sprecher devised the Passionate Love Scale, which remains in wide use today. Think of the person you love passionately now or someone you felt that way about in the past. Base your answer on when your feelings were most intense.

For each of the 15 sentences below, choose a number from 1 (not at all true) to 9 (definitely true) that most accurately describes your feelings toward the person you love. Indicate your answer by circling the number in the corresponding row.

1. I would feel deep despair if \_\_\_ left me.
2. Sometimes I feel I can't control my thoughts; they are obsessively about \_\_\_.
3. I feel happy when I am doing something to make \_\_\_ happy.
4. I would rather be with \_\_\_ than anyone else.
5. I'd get jealous if I thought \_\_\_ were falling in love with someone else.
6. I yearn to know all about \_\_\_.
7. I want \_\_\_ physically, emotionally, mentally.
8. I have an endless appetite for affection from \_\_\_.
9. For me, \_\_\_ is the perfect romantic partner.
10. I sense my body responding when \_\_\_ touches me.
11. \_\_\_ always seems to be on my mind.
12. I want \_\_\_ to know me—my thoughts, fears and hopes.
13. I eagerly look for signs indicating \_\_\_'s desire for me.
14. I possess a powerful attraction for \_\_\_.
15. I get extremely depressed when things don't go right in my relationship with \_\_\_.

	Not at all true				Moderately true				Definitely true
1	2	3	4	5	6	7	8	9	
1	2	3	4	5	6	7	8	9	
1	2	3	4	5	6	7	8	9	
1	2	3	4	5	6	7	8	9	
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1	2	3	4	5	6	7	8	9	
1	2	3	4	5	6	7	8	9	
1	2	3	4	5	6	7	8	9	

### ADD UP YOUR TOTAL

Your score can range from a minimum of 15 to a maximum of 135. The higher your score, the more your feelings reflect passionate love; the items for which you picked a particularly high number indicate the components of passionate love you experience most.