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LOVE IN THE 21ST CENTURY: MONEY TALKS—P. 78

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SCENTIMENTAL J

The mystery had haunted him for years. Shortly after birth, salmon abandoned their snug river spawning ground and headed for the sea. No matter how many leagues they traveled, no matter how many years they wandered, they always returned to their birthplace to spawn offspring of their own. But how did mere *fish*, zoologist Arthur Hasler wondered, traverse such vastness of time and space to find their way home?

The question had plagued him in his lab at the University of Wisconsin, had pursued him throughout his years of service in the Second World War. Finally back home, in Utah, he took a hike in the hills one day and was hit by a rush of fragrant mountain air. Slowly, imperceptibly, the odor released

JOURNEYS

BY PAMELA WEINTRAUB

Smells have the power to arouse our deepest memories, our most primitive drives

PAINTING BY WOLFGANG HUTTER

his deepest memories, and for a moment he was a boy again. He saw his friends traipsing up the slopes, heard their shouts ring out high and clear. In the course of seconds the fragrance had carried him back 25 years. Then came a second rush of fragrance, releasing not a memory but an idea. Hasler realized that salmon remembered the *odor* of their origins. They *smelled* their way home.

Today considered one of the grand old men of biology, Hasler spent much of his life proving his inspiration in the field. He showed that individual streams have individual odors, or bouquets. By plugging the salmons' noses, he showed that without the sense of smell, they just can't navigate home. As late as 1980 Hasler and his students

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showed that salmon could navigate in response to odors created in the laboratory.

Fittingly, the memories and intuition that led Hasler to his discovery are intrinsic features of his passionate interest—the sense of smell. In the last few years, scientists in fields as diverse as brain physiology and evolution have shown that scent ignites our deepest memories and drives. (To test your response to scent, please fill out our questionnaire, page 50, before continuing.)

Back in the days of the hunter–gatherers, new research suggests, our ancestors used olfaction not only to detect poisons but also to choose their mates. And this selection by smell was genetically preordained. Scientists have found that we all produce odorprints as distinctive as fingerprints, and they believe they have traced these auras to a particular set of genes. They have also mapped nerve pathways from the nose to the limbic brain, the roiling center of memory, lust, and rage. And most startling of all, they have shown that humans produce odorous messengers called pheromones, just as animals do, to prime each other for sex.

Spurred by these findings, scientists have begun to manipulate behavior through the sense of smell. At Yale and Duke, researchers are studying the impact of specific odors on physiological measures from brain waves and blood pressure to pulse. The result: the science of aroma therapy, which promises to revolutionize the workplace and home. In the not-too-distant future, office-ventilation systems might emit aromas that stimulate workers yet help them to relax. Scent machines as elaborate as stereo systems might churn vapors through the home, acting as aphrodisiacs and alarm clocks. And for those on the road, a scratch card like the one presented in this issue might provide an array of odors to fit conditions from anxiety and claustrophobia to migraine.

As scientists unravel the mysteries of the olfactory code, moreover, they'll engineer scents that act like drugs. One day, they say, such drugs will travel through olfactory neurons to the source of neurosis, psychosis, and disease in the brain. Among the ills such drugs might cure are schizophrenia, Alzheimer's disease, and depression.

According to psychologist William Cain of Yale, the twenty-first century will be the era of scent. "We'll gain tremendous understanding of the basic, neurophysiological ways in which odors regulate the body and influence the mind," he explains. "And after we've mapped the hidden pathways of olfactory nerves, we'll be able to influence behavior, modulate mood, and alleviate pain."

Before Cain's vision can be realized, scientists must understand how the sense of smell works. We have been studying smell for centuries, but only recently have the pieces started falling into place.

Back in the first century B.C., the Roman poet–philosopher Lucretius suggested that molecules of different substances entered tiny holes deep within the nose. Each hole had a different shape, so depending on the shape of the molecule, we might smell garlic, musk, or rose. In the centuries following Lucretius, scientists determined that nerves traveled from the olfactory epithelium—a small patch in each nasal cavity—to the olfactory bulbs in the brain. And in 1956 famed neurophysiologist David Ottoson attached an electrode to the epithelium, delivered a puff of odor, and measured an electrical response in thousands of cells. Sensory stimulation, he knew, had occurred.

Still, the sense of smell remained largely inscrutable. Scientists understood *other* senses. Vision, for instance, occurred when receptors known as rods and cones detected primary colors, each corresponding to a different wavelength of light. But as late as the Sixties, the sense of smell was as mysterious as it had been to Lucretius.

Into this welter of confusion jumped a young researcher named Robert Gesteland. A former engineer interested in the neural basis of thought, Gesteland had recently joined MIT's experimental epistemology lab. There he got his hands on potent new tools—tiny electrodes that could measure the current produced not by thousands of cells but by just one. Now it might be possible, he told himself, to determine how specific odors affected individual cells.

> *"Smell could be the wellspring of social behavior. Both altruism and mate selection can be traced to individual odorprints generated by a sequence of genes."*

But Gesteland's first findings were disturbing. "We exposed frog olfactory tissue to various odors but found no two cells alike. We certainly couldn't find classes of cells that were, say, specialists in flowers or citrus fruits. Our experiments kept getting more elaborate, but we couldn't find categories. Without categories, we couldn't build a theory."

Then, in 1971, a Florida State University biologist named Pasquale Graziadei and some colleagues began to examine olfactory cells. "Some nerve cells were undergoing a phenomenal regeneration," Graziadei now says, "and they all seemed to vary in age—some were young, some middle-aged, and some very old."

This fact gave Gesteland and other neurophysiologists the clue they needed to begin to build an olfactory code. Gesteland had been measuring the current across just any random nerve cell. But by 1982 he had learned that young cells responded to myriad random odors, while old cells didn't work at all. Only *mature* cells were actually responding to specific odors and delivering meaningful messages to the brain.

By the early Eighties, patterns had begun to emerge. "We're finding a *statistical* orderliness in the system," Gesteland explains. "If a cell responds to banana, say, we can predict that it is likely to respond to perhaps five other odors seventy percent of the time. Each olfactory receptor cell responds to a number of different odors. But computer analysis can sort the odors and cells into groups." Each odor seems to stimulate the nerve cells in a unique pattern within the nose.

These patterns, evidence indicates, have had a pivotal role in the evolution of man. According to Graziadei's latest experiments, the development of the nose preceded that of the brain. Graziadei removed one eye from a group of frog embryos and inserted a third nasal cavity in its place. The adult frogs ended up having not just two brain hemispheres but also a third hemispherelike bulge. At another point Graziadei *removed* one of the two nasal cavities from frog embryos. The resulting adults had one normal brain hemisphere and one that was severely reduced.

"It looks as if the forebrain literally develops under the influence of the nose," Graziadei says. "For instance, human babies born with anencephaly—a disorder in which the brain is missing—also lack a nose. Without the nose, the brain might suffer severely in its development."

Our emotions might be truncated as well. In the simplest organisms, explains Howard Ehrlichman of the City University of New York, smell often provides a primary motivation for the basic behaviors of approach and avoidance. And the suggestion is that olfaction might also trigger powerful approach/avoidance responses—the foundation of emotion—in the human realm.

To test the hypothesis that emotions and smell are fundamentally related, Ehrlichman set out to see whether odor could induce positive or negative memories in the lab. He isolated subjects in a bare, darkish room with just an Edward Hopper print hanging on the wall; then he wafted mildly pleasant and unpleasant odors into the air. In preliminary tests he found that people exposed to the pleasant scent of almond tend to remember pleasant events such as making new friends or a day out on the town. Those smelling unpleasant odors, including pyridine (like a urinal) and butyric acid (reminiscent of vomit) tended to recall such unhappy situations as a job at a fast-food joint or periods of pain.

"The suggestion," Ehrlichman says, "is that the experience of odor and the experience of emotion are in some basic, physiological way the same. Molecules of odor seem to be stimulating the same brain centers that signal the drives toward or away, which underlie almost all human emotion."

But the drives leading to approach and avoidance may be just the tip of the olfactory iceberg. Some biologists say that the sense of smell is the wellspring of social behavior, too. These researchers contend that two

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types of social behavior—altruism and mate selection, both based on recognizing kin—can be traced to individual odorprints generated by a sequence of genes.

An authority no less august than physician/writer Lewis Thomas has produced the rationale for this radical notion. In 1974 Thomas suggested that a cluster of animal genes known as the major histocompatibility complex, or MHC, might be the key to the olfactory code. In many mammals, Thomas pointed out, the MHC generates thousands of antibodies to selectively fend off foreign particles invading the bloodstream. Perhaps, Thomas suggested, this same set of genes was generating thousands of different smell-receptor molecules in response to odors that invade the nose.

Thomas also speculated that the MHC genes might *produce* individual odors, each one as unique as a fingerprint. He even hypothesized that a dog might smell an individual who needed a kidney transplant and then sniff out a suitable donor from a crowd of people. Those with similar odorprints, Thomas explained, would have similar immunological systems and would thus be less likely to reject one another's organs.

The Thomas hypothesis captured the imagination of a Sloan-Kettering researcher named Ted Boyse. An immunologist, Boyse did much of his work with strains of inbred mice, and one day he noticed something odd. He had housed three mice from a single strain in a cage. The three were genetically identical, except in two ways. First, one was male and two were female. More important, the first female differed from the male and the second female in one crucial spot in the MHC gene cluster. Boyse was surprised that the male spent much more time with the female that was different from himself. And the only way such a difference could have been detected was—how else?—through the sense of smell. Boyse and his colleague Kunio Yamazaki went on to test thousands of mice, and the finding held firm: Mice could almost always sniff out mice genetically different from themselves.

To psychobiologist Gary Beauchamp of the Monell Chemical Senses Center, in Philadelphia, the implications were profound. "If God were going to devise a genetic system to distinguish kin from nonkin," Beauchamp says, "the MHC genes are the set he would use. It's the most variable set of genes in nature. And evidence suggests that the high variability in the MHC is essential for resistance to disease. Cheetahs, who have little variability in the MHC, can't be raised in captivity because they're unable to handle unusual pathogens. An individual who inherits a highly diverse MHC, on the other hand, would be more likely to survive. How can an animal pass on that characteristic? By mating with someone whose MHC is as different as possible from his own."

But do humans operate like mice? That's a question being asked at Monell today. Beauchamp, working with Monell animal behaviorist and evolutionary biologist Avery Gilbert, has found that in some instances people can distinguish among mouse odors almost as well as a mouse can. "At first," Beauchamp says, "we had people with blindfolds sniff a boxful of mice. Most were able to differentiate the strains. Then we had them sniff just the urine; about half could tell the difference." To see whether humans can smell the differences among *one another,* Beauchamp wants to conduct a study with a fairly homogeneous group of individuals—such as the Pennsylvania Dutch.

Until Beauchamp and others complete their research, we won't know to what extent MHC auras help us choose our mates. But according to a recent study, another type of odor—that of human pheromones—is literally priming us for reproduction.

Scientists became aware of pheromones in 1959, when they discovered that insects react to secretions from their mates and kin.

> *"If you take most any developing animal and expose it to odors from the opposite sex, you can advance the onset of puberty."*

That work revealed a distinction between releaser pheromones, which provoke immediate behavior, and primer pheromones, responsible for inhibiting or enhancing the way organisms develop.

It didn't take scientists long to realize that similar substances were operating in mammals as well. According to Chuck Wysocki, an animal behaviorist and geneticist at Monell, "If you take most any developing animal and expose it to odors from the opposite sex, you can advance the onset of puberty. Female animals living together in a cage menstruate together—the effect of odors. If you expose female rats to the odor of males, you shorten and regulate their cycles. And in male rats exposed to female odor, testosterone will surge."

Wysocki's favorite pheromone story concerns androstenone, the boar steroid that induces the female boar to assume the arched-back mating stance known as lordosis. Sitting in his cluttered office, Wysocki pulls a bottle of Boarmate from his desk. "It's canned androstenone," he says. "The sow needs two things before she'll mate—she must be in heat, and she must be with a boar who has androstenone in his saliva. Pig farmers go down a line of sows and spray androstenone in each animal's nose. One guy stands behind, pushing down on the sow's back. When she assumes the mating stance, he artificially inseminates her."

For more than a decade, some scientists have suggested that pheromones stimulate humans as well. In 1971 psychologist Martha McClintock of Harvard reported that women living together in a dormitory would begin to menstruate together. Some people proposed that the mediator was the same sort of pheromone that induced menstrual synchrony in monkeys. In another study, scientists sprayed androstenone on a seat in a dentist's waiting room. They found that many women chose the odorized seat.

But while such studies suggest pheromone activity, experts weren't convinced. As Richard Doty, director of the University of Pennsylvania Clinical Smell and Taste Research Center, says, "We needed more refined studies with better controls." And Wysocki points out another problem. Animals respond to pheromones not through the olfactory epithelium but through a more obscure nasal structure—the vomeronasal organ. (The vomeronasal organ connects with the hypothalamus, the part of the brain responsible for releasing sex hormones.) In humans, however, the vomeronasal organ is just a shell.

But new studies have begun to wash objections away. In two ground-breaking experiments, George Preti and Winnifred B. Cutler have proved that pheromones enhance human fertility and perhaps even ready us for reproduction.

Preti, an organic chemist at Monell, had spent years analyzing the volatiles emitted by the mouth, skin, underarms, and genitalia, the main odor-producing areas of man. Then, in 1980, he found himself deluged with questions about a controversial new perfume by Jovan. Called Andron because it was supposedly made with minute quantities of androstenone, the scent was marketed as a sexual attractant. Preti doubted that a boar pheromone could have power over people. He considered looking for a link between *human* volatiles and sexual attraction but realized that it would be hard to measure sex appeal in the lab. So he decided to test menstrual synchrony instead.

He was about to start his grant application, he recalls, when he met Cutler, a University of Pennsylvania biologist specializing in the menstrual cycle. Cutler had come up with a controversial theory. Her data showed that women who had intimate heterosexual contact at least once every week were more likely to have regular cycles; they menstruated about once every 29.5 days. But women who had sporadic sex or no sex were irregular—their cycles tended to be shorter than 26 days or longer than 33 days. Cutler suspected chemical communication might be involved and suggested that Preti test that possibility too.

In 1982 Preti and Cutler began to gather underarm secretions for two experiments. In the first, they recruited two groups of women who had regular menstrual cycles. In essence they collected daily underarm secretions from women in the first group and rubbed the extract under the noses of women in the second group. After three and a half months, the two groups achieved menstrual synchrony.

In the second experiment, the researchers collected underarm secretions from male donors three times a week for three months. Each week they pooled the secretions and then froze and stored the collective sample. When the sample was big enough, they recruited a group of women who had irregular menstrual cycles. Three times a week, half the women rubbed the extract under their noses; the other half were given a placebo. At the end of three and a half months, Preti says, the women receiving the male odor had an average cycle length of 28.3 days. Those not exposed to the male extract had an average cycle length of 41.2 days.

"There appears to be something in the underarm region that affects the menstrual cycle, probably regulating hormones to enhance fertility," Preti says. "That something seems to act like a primer pheromone."

If Wysocki's new studies pan out, moreover, the channel of communication to the hormone control center in the brain might be the vomeronasal organ itself. "Throughout evolution," Wysocki explains, "the vomeronasal organ has been associated with yet another element in the nose—the terminal nerve, present in all vertebrate groups from fish through humans. Our studies are aimed at seeing whether the terminal nerve senses the pheromones in any way."

If smell propels us in our basic animal drives, it's a prime mover of higher functions as well. According to recent studies, nerves from the olfactory bulb reach out, octopus style, to the farthest regions of the brain.

Much of the evidence comes from maps generated by neurophysiologist Michael Shipley, Gesteland's colleague at Cincinnati. To make his maps, Shipley inserted capsules of dye in the olfactory epithelium of rats. "We let the animals go about their business for a week," Shipley says, "then we sliced up their brains. Not only had the markers traveled from the nose to the olfactory bulb, they had also jumped out of the nerve ending and been picked up by the next neurons in line. They had been transported deeper into the brain."

Not surprisingly, Shipley traced some olfactory neurons to the piriform cortex, involved in analyzing olfactory information. He traced others to the hippocampus, the limbic seat of long-term memory, and to the amygdala, which controls the release of hormones involved in puberty, reproduction, and sex. But that wasn't all. He also found that some tracer had been transferred to the cholinergic cells, limbic-brain neurons implicated in Alzheimer's disease. Still more dye was transported to the raphe and the locus ceruleus, brain regions supposedly involved in schizophrenia and other mental disorders. "Cells from the raphe and ceruleus travel throughout the cortex," Shipley adds. "People have tied them to arousal, attention, sleep."

These dramatic findings lend credence to some of the most potentially useful experiments to date. In a few labs around the country, scientists have begun to work with aromas for relaxation, alertness, and the cessation of pain.

Psychobiologist Gary Schwartz, head of the aroma therapy effort at Yale, for instance, began his research after reading anecdotal literature on the power of smell. Lavender (scent number 3), he found, was said to reduce headaches; eucalyptus supposedly kept people awake. Mint (4) has been cited as a stimulant as well. But he was most intrigued by the mythology of apples, including "the mystique of the apple a day."

An authority on the use of biofeedback to reduce stress, Schwartz devised some revealing tests. With the aid of colleagues, he wired his subjects for measurements of blood pressure, muscle tension, and skin temperature. Then he asked stressful questions, such as whom they wanted to fight. After eliciting an answer, he exposed each to a spiced apple (1), plain apple, and spice scent. According to Schwartz, all fragrances relaxed the subjects, but spiced apple did best, bringing systolic blood pressure down an average of three to five points and lowering diastolic pressure as well.

"When I smell a perfume called Emeraude, for instance, I get a rush of memories of the first girl that I ever grappled with."

"These results," Schwartz adds, "make common sense. Scents entering the nose might be absorbed by the bloodstream, exerting a chemical effect. At a more psychobiological level, when we savor a pleasant fragrance, we take deeper and slower breaths, relaxing our respiratory pattern much as we do in meditation. The olfactory input might also serve as a distracter, focusing our attention on the scent or inducing positive memories and emotions."

According to Schwartz, the most potent fragrances work at a multitude of levels. Many of the scents studied in his lab, he says, have profoundly distinct effects, from reducing hunger to easing pain.

Other researchers are also dabbling in aroma therapy. Psychiatrist Robert Turfboer of Joplin, Missouri, has found that burning scented matches can end bouts of insomnia. And psychologist Susan Schiffman, of Duke University, has developed scented sprays for patients to use as alternatives to high-calorie food. Chocolate lovers, for instance, spray chocolate (2) on the back of the tongue and up through the nasal area. That, says Schiffman, curbs desire for the actual thing. She has also found that a peach scent (5) alleviates pain. "Some olfactory receptors," Schiffman suggests, "may be similar to the brain receptors that bind Valium. My guess is that they evolved to bind odors that have a similar effect."

But Schiffman's notion—that *hardwired* receptors travel from the nose to specific sites in the brain—presages breakthroughs to come. Once we figure out which substances stimulate which receptors, says Gesteland, and how those receptors connect with parts of the brain, we'll be able to design bullets of odor that act like drugs.

Such technology, Gesteland adds, would be particularly valuable because of the blood–brain barrier—the hard-to-penetrate lipid membrane covering the capillaries that carry blood past the body's nerve cells and the brain itself. Although tiny nutrient and oxygen molecules can pass through these capillary walls, larger molecules, including blood and therapeutic drugs, cannot. Thus, up to now it's been impossible to target such brain maladies as Alzheimer's disease with drugs that reach directly to the source.

The ancient olfactory nerves, which evolved *before* the brain, are the only neurons *not* protected by the sheath. Thus, they offer the only natural means of delivering drugs to the brain. By passing molecules of odor through the nose, we'll be able to deliver drugs to brain sites implicated in disease, emotion, and thought.

"This seems to be the magic pathway," Gesteland asserts. "Ten years from now, odor pharmacologists will be designing two-part molecules. The first part will be targeted to specific receptors in the nose. The second part will have therapeutic or medicinal effects on targeted areas in the brain."

It's ironic that smell, the last sensory modality to yield its secrets to science, is also the most ancient. Hasler's former student Peter Johnsen recently returned from a trip to the Amazon, where he found that *he* could smell and taste the differences among a variety of river bouquets. "Our olfactory system has evolved from the fish," Johnsen says. "The architecture of the fish nose is almost exactly like that of our own. Human olfaction, it seems, has such deeply evocative overtones because it lies in a primitive part of the brain. When I smell a perfume called Emeraude, I get a rush of the first girl I grappled with. When I smell fresh dough, I hear my grandmother's voice."

Humans are more dependent on learning, on context, on personal history, than fish are. But as is often the case, we will enter the future by confronting our past. We, like our aquatic predecessors, are bound by olfactory tentacles embracing the core of the brain. Like the salmon, we may find that olfactory pathways can lead us home. ∞

TEST YOUR SCENTSABILITY

Scents, says Yale researcher Gary Schwartz, can put you in a "psychobiological state of happiness." They can also relax you, enhance your appetite, or turn your stomach. But scientists have only begun to chart the more subtle effects of fragrance. And that's where you come in: By filling out this questionnaire (and please do so before reading "Scentimental Journey"), you can help scent researchers *and* test your own olfactory powers. Here's how: Scratch each numbered section with your fingernail. A single scratch ruptures some 2,000 microcapsules containing the scents. Smell the spot, and then try to identify each scent—and its effect—in questions 1 through 10. Make sure you wait at least one minute before smelling the next patch. Move on to questions 11 through 15—they're future scenarios that incorporate each of the five scents. Then complete the rest of the questionnaire, which was prepared with the help of Richard Doty of the Clinical Smell and Taste Research Center at the University of Pennsylvania. Send the page to *Omni*-Smell, 1965 Broadway, New York, NY 10023-5965. We'll report the results in an upcoming issue.

1. Scent 1 smells most like ____________
2. Scent 1 makes you feel
   a. relaxed c. giddy
   b. invigorated d. nostalgic
3. Scent 2 smells most like ____________
4. Scent 2 makes you feel
   a. hungry c. invigorated
   b. like singing d. sleepy
5. Scent 3 smells most like ____________
6. Scent 3 makes you feel
   a. relaxed c. like bathing
   b. alert d. giddy
7. Scent 4 smells most like ____________
8. Scent 4 makes you feel
   a. excited c. drowsy
   b. alert d. hungry
9. Scent 5 smells most like ____________
10. Scent 5 makes you feel
    a. as if you're in pain c. nauseated
    b. free from pain d. giddy
11. You have returned to Earth from your first space-station visit. You want to relax. Which scent do you smell?
    a. 1 c. 3 e. 5
    b. 2 d. 4
12. The robot that services your apartment has broken for the fifth time in a week. You have no idea what is wrong with it. Which scent do you smell to relieve your headache?
    a. 1 c. 3 e. 5
    b. 2 d. 4
13. You are a medical researcher with a chance to land a job at the Forever Young Institute, where you will be developing a drug to slow the aging process. Your interview is today. Which scent do you smell to get psyched?
    a. 1 c. 3 e. 5
    b. 2 d. 4
14. You have sprained your ankle stepping out of your flotation tank. Which scent do you smell to ease the pain?
    a. 1 c. 3 e. 5
    b. 2 d. 4
15. You're trying to watch your weight, but you crave a candy bar. Which scent do you smell to satisfy your craving?
    a. 1 c. 3 e. 5
    b. 2 d. 4
16. Do you currently have problems smelling or tasting?
    a. yes b. no
17. If you answered yes, briefly explain.
18. Do you deliberately smell your own body periodically?
    a. yes b. no
19. If you answered yes, how often?
    a. every hour
    b. several times a day
    c. only rarely
20. Do you use perfume or after-shave lotion?
    a. yes b. no
21. If you answered yes, do you use more than one kind?
    a. yes b. no
22. Do you smell your laundry before it is washed?
    a. yes b. no
23. Do you smell your laundry after it is washed?
    a. yes b. no
24. Compared with your friends or co-workers, you feel your sense of smell is
    a. less sensitive
    b. equally sensitive
    c. more sensitive
25. Do you have a favorite smell?
    a. yes b. no
26. If you answered yes, what is it?
27. You find most odors
    a. pleasant
    b. unpleasant
    c. neither pleasant nor unpleasant
28. Have you ever detected the smell of smoke or gas in a situation where your safety or that of others was involved?
    a. yes b. no
29. On average, you bathe ______times a week
30. Do you observe any personal, religious, or medical dietary restrictions?
    a. yes b. no
31. If yes, please explain.
32. Do you wear dentures?
    a. yes b. no
33. Have you ever taken hallucinogenic or addictive drugs?
    a. yes b. no
34. If you answered yes, which ones?
35. Did any of these drugs alter your ability to smell?
    a. yes b. no
36. If yes, please explain.
37. Do you have problems with airflow through your nose?
    a. yes b. no
38. If yes, please explain.
39. Do you smell things better in one nostril than the other?
    a. yes b. no
40. If yes, is it the right or left nostril?
    a. the right
    b. the left
41. Does this stay the same, or does it change periodically?
    a. stays the same
    b. changes
42. In your occupation, do you work around chemical vapors?
    a. yes b. no
43. If you answered yes, how long are you exposed to the vapors, and to which ones are you exposed?
44. Do you smoke currently?
    a. yes b. no
45. If yes, what do you smoke?
    a. cigarettes
    b. cigars
    c. other ____________
46. How much do you smoke?
    a. _____cigarettes a day
    b. _____cigars a day
    c. other ____________
47. Have you ever smoked?
    a. yes b. no
48. Did your ability to smell change after you stopped smoking?
    a. yes b. no
49. If yes, how?
50. What is the worst thing you have ever smelled?

Age ____________
Sex _____Female _____Male
If a woman, are you pregnant?
_____yes _____no
Height _____Weight _____
Occupation ____________
City of residence ____________
Ethnic or cultural background:
_____Black _____White _____Asian
_____Hispanic _____Other

1 2 3

4 5