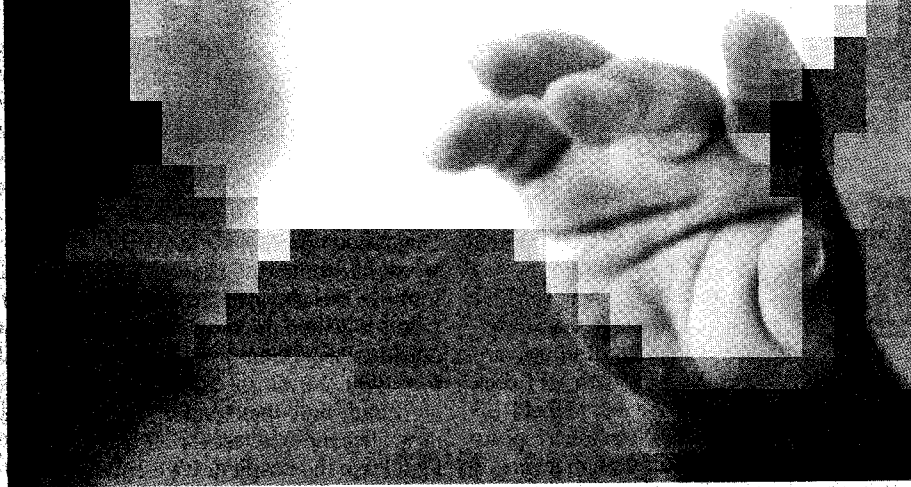


moment of birth, babies respond to their mothers' voices, distinguish  
 tastes and have definite taste and aroma preferences. **By Joan Raymond**

# The World Of the Senses



tile perceptions—is coming online; a gentle massage of Mom's belly will likely stimulate fetal movement. By about 28 weeks, the fetus will respond to loud noises. Taste buds make an appearance at a remarkably early seven weeks. And although the fetus doesn't smell in the conventional sense, it can absorb odors in the amniotic fluid by the 24th week of gestation.

Children fine-tune their sensory apparatus through the critical first years of life. "Infants and toddlers give their senses a tuneup every time they are exposed to new stimuli," says pediatric neurologist Dr. Max Wiznitzer of Cleveland's Rainbow Babies & Children's Hospital. Each new stimulus sets off a cascade of brain events; in fact, in the first three months of life the regions of the brain with the highest metabolic rate are those processing sights, sounds and touches, as if the nascent circuits within the gray matter were burning the midnight oil to take in everything they could about their new world.

Sensory information doesn't just stop with perception; it also interacts with oth-

**I**T'S TUESDAY AFTERNOON AT THE Epsteins' Philadelphia apartment. Seven-month-old Ana Natalia is sitting up, smiling, waiting for her favorite midafternoon activities: snack time, featuring a lovely sweet-potato purée, accompanied by a gentle back rub. When her mother, Lucia, puts some world music on the CD player, Ana Natalia arches her 15-pound body in delight. Life doesn't get any better than cool tunes, good food and a massage.

Even babies—especially babies—know that. They revel in their senses and almost intuitively know what looks, tastes, feels, sounds and smells good. They love skin-to-skin touching, which can inhibit the release of stress hormones and heighten immune responses. They respond to their mothers' voices and can distinguish them (thanks to hearing her voice through the walls of the womb) from all others. They are fascinated by shapes and moving objects. And they definitely know what they like to eat. All of these talents reflect the fact that at birth a baby's sensory system is

## REACH OUT



**At birth, the sense of touch is so developed that a baby will prefer soft flannel to coarse burlap**

well developed, even though the neural pathways that underlie perception still need years of fine-tuning. In the first years of life neurons in the brain—the master sense organ—form circuits that will enable a child to distinguish the smell of lilacs from gasoline, the sight of cerulean from mauve, the sounds of her native tongue from all others.

A baby's journey through the realm of the senses begins in the womb. By the seventh month, nerves connecting the eye and the brain's visual cortex have begun to function in a rudimentary way, transmitting visual information in the form of electrical impulses (but not very efficiently). Nerves that relay touch perceptions appear on the skin of the fetus by about the 10th week. By the fourth month, the somatosensory cortex—the part of the brain that registers tac-



er functions and regions of the brain. In adults, the sense of smell can be a powerful trigger to memory (with the aroma of roses, perhaps, triggering memories of a long-ago romance), and such connections start to be forged in the first weeks of life. Right from birth a baby's ability to detect odors is well developed. That makes sense, since smell is processed in one of the most primitive and (evolutionarily) oldest parts of the brain. A newborn can distinguish her mother's fragrance from all others and, since it is generally associated with pleasant things like food and comfort, comes to prefer it. When a baby smells his mother's skin, the olfactory signal reaching the brain triggers the formation of neuronal links between it and the brain's memory and emotion centers. As a result, the baby remembers Mom's smell and associates it with pleasant events.

As early as the second month, babies learn to distinguish between more types and intensities of aromas. Their repertoire continues expanding, with the result that toddlers form even more sophisticated neuronal links between aromas and memories. Smelling a flower, for instance, sends signals to the brain's limbic system, a site of memory storage. Presto: emotion-laden memories—happy (if the toddler was having a lovely day with Mom when he picked the rose) or not (it was a prize-winning bloom, and plucking it led to a very, very long timeout).

Vision is the last sense to reach full capacity. At birth, the neurons of the visual cortex (which receive visual information from the eye) are still not "myelinated," or coated with the fatty substance that keeps nerve signals from leaking out like electricity from badly insulated transmission lines. As a result of the faulty lines, newborns see little more than light and shadow. They focus best on objects eight to 15 inches away—about the distance to the face of the person feeding them—and even



with their fuzzy vision can tell circles from squares and prefer the former. They love to look at faces.

By 3 months a baby can track objects that move toward him, and soon after that can follow moving objects smoothly. By 4 to 7 months a child develops full color vision; this is when brightly colored toys will capture his attention. By 6 months his depth and distance perception work reliably—convenient for a little being just starting to scoot around. By 2, most children have 20/60 vision, which will gradually improve over the next three years to 20/25. Vision will continue to sharpen until the age of 9 or so, when a child sees as clearly as a normal adult. But this progression is far from inevitable: visual stimulation is crucial to the developing child. When deprived of visual stimulation, the ocular columns in the brain's visual cortex fail to wire up correctly. That means those

mobiles over the bed do more than just look pretty. They help your child focus and improve his vision (though everyday interactions and a caring environ-

## FLAVOR CRAVER



**Taste buds appear at seven weeks' gestation. Babies have an acute sense of taste, and prefer sweet.**

ment are perfectly adequate to stimulate visual development).

Hearing depends on experience, too. Newborns have a well-developed auditory system, and can distinguish loud from quiet. But they can pick up higher-pitched sounds better than they can lower-frequency ones, which may be why they are entranced by the high-pitched coos and singsong of "parentese." Adults' practice of speaking to babies in a higher pitch therefore matches their auditory abilities. By 2 to 3 months a baby can distinguish the source of a sound, and follow it, which makes tracking the conversations around them possible.

Perhaps the most impressive aspect of newborns' auditory abilities is their enviable talent for hearing the phonemes of every language, from that odd (to an English speaker) French "eu" to the "r" and "l" that a Japanese adult can't distinguish. But

## LOOKIN' GOOD



**The world looks fuzzy to newborns, but within 3 months they can track moving objects**

by the age of 1, infants lose the ability to hear sounds not present in the language they hear every day, finds Patricia Kuhl, professor of speech and hearing at the University of Washington. A baby raised amid the sounds of English literally loses the ability to hear the sound of, say, a Swedish vowel; if auditory neurons that once had the ability to detect it are never exposed to it, they essentially give up and find a job detecting sounds that the baby is exposed to. The brain becomes deaf to other phonemes, which is why native Japanese speakers have trouble telling "l" from "r."

At birth, the sense of touch is developed enough that a baby will prefer a soft piece of flannel to coarse burlap. There is growing evidence that touch is crucial to an infant's cognitive and physical development. Tiffany Field, director of the Touch

**Even newborns revel in their senses; they seem to intuitively prefer sweet to bitter and high tones to low**

Research Institutes at the University of Miami, has shown that premature infants massaged three times a day for 15 minutes gained weight 47 percent faster than preemies who were not massaged. She also finds that infants showed fewer signs of stress, such as grimacing or fist clenching, and had lower levels of stress hormones following a massage with oil.

Newborns' sense of taste is acute enough that some reject breast milk after Mom has eaten a heaping plate of broccoli. They can tell salty from sweet and bitter from acidic because amniotic fluid acts as a kind of "flavor bridge," says Julie Mennella, a biopsychologist at Philadelphia's Monell Chemical Senses Center. That bridge seems to lead babies to definite, and early, taste preferences. Earlier this year Mennella reported the findings

of an experiment designed to trace the origins of babies' likes and dislikes. The old wives' tale about breast milk's influence on a child's taste preferences holds true, she found. When she gave 6-month-olds cereal prepared with either water or carrot juice, the infants who were exposed to carrot juice either prenatally or in breast milk strongly preferred the carrot-juice porridge to the water version. The other infants showed no preference, suggesting that if women eat a varied diet during pregnancy and while nursing, their babies are more likely to accept new foods. Scientists have confirmed another bit of folk wisdom: babies are born with a sweet tooth, probably because breast milk is sweet. In our drive to survive, we have a natural preference for the taste of that first food. (Formula manufacturers try to mimic the sweet taste of human breast milk.) A baby's sensory development starting in the months before birth is nothing short of extraordinary, says Field. "Children are little hedonists," she says. "That's how they learn about their world."

**MAKING SENSE OF IT**

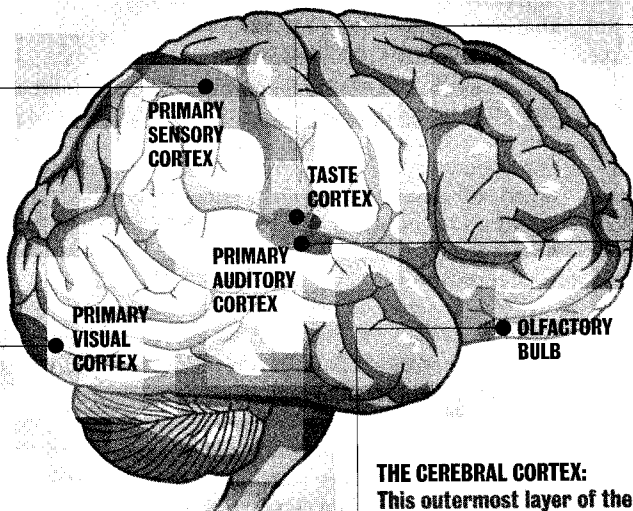
**Five Windows on the World**

Although babies come into the world wired for vision, hearing, touch, smell and taste, their experiences in infancy and throughout childhood complete the neuronal circuitry.

**Touch** It's such a crucial sense that the area of the brain responsible for touch perceptions—the primary sensory cortex—can process tactile sensations by the fourth month of gestation. Skin nerves appear at week 10.

**Vision** It's the slowest sense to develop. Although the rudimentary visual cortex can receive signals from the fetus's eye at seven months' gestation, neurons in the vision pathway remain immature for months after birth. Much of the world looks fuzzy to babies.

**Smell** Even while in utero, babies perceive the smell of the amniotic fluid; at birth they can distinguish their mother's smell from all others. Olfaction seems to be tightly linked to memories and emotions.



**THE CEREBRAL CORTEX:** This outermost layer of the brain processes signals from the peripheral nervous system

**Taste** Preferences are shaped so early that even newborns have definite likes and dislikes. The 10,000 or so taste buds on the tongue and soft palate begin to appear a mere seven weeks after conception. Each responds most strongly to salty, sour, sweet or bitter. In general, newborns prefer sweet. But the specific tastes that the fetus is exposed to before birth, through what Mom eats and through breast milk—whose taste also reflects Mom's previous meals—shape which ones he will prefer and which he will reject.

**Hearing** Just as prenatal exposure to tastes shapes a baby's preferences, so the sounds penetrating the womb leave a lasting effect. By 28 weeks' gestation, the brain's auditory cortex, which receives input from nerve cells in the inner ear, can perceive loud noises. At birth, a baby can usually distinguish her mother's voice, the one she has been hearing for the last 12 or so weeks of gestation, and prefers it to all others. Newborns can perceive every phoneme in the world's languages, an ability that's lost within the first year.

SOURCE: DR. MAKY WIZNITZER, RAINBOW BABIES & CHILDREN'S HOSPITAL. DRAWING BY STANFORD KAY—NEWSWEEK