

Fearfully and Wonderfully Made

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Fetal Psychology

Behaviorally speaking, there's little difference between a newborn baby and a 32-week-old fetus. A new wave of research suggests that the fetus can feel, dream, even enjoy "The Cat in the Hat." The abortion debate will never be the same.

By Janet L. Hopson

The scene never fails to give goose bumps: the baby, just seconds old and still dewy from the womb, is lifted into the arms of its exhausted but blissful parents. They gaze adoringly as their new child stretches and squirms, scrunches its mouth and opens its eyes. To anyone watching this tender vignette, the message is unmistakable. Birth is the beginning of all, ground zero, the moment from which the clock starts ticking.

Not so, declares Janet DiPietro. Birth may be a grand occasion, says the Johns Hopkins University psychologist, but "it is a trivial event in development. Nothing neurologically interesting happens."

Armed with highly sensitive and sophisticated monitoring gear, DiPietro and other researchers today are discovering that the real action starts weeks earlier. At 32 weeks of gestation -- two months before a baby is considered fully prepared for the world, or "at term" -- a fetus is behaving almost exactly as a newborn. And it continues to do so for the next 12 weeks.

As if overturning the common conception of infancy weren't enough, scientists are creating a startling new picture of intelligent life in the womb. Among the revelations:

- - By nine weeks, a developing fetus can hiccup and react to loud noises. By the end of the second trimester, it can hear.
- - Just as adults do, the fetus experiences the rapid eye movement (REM) sleep of dreams.
- - The fetus savors its mother's meals, first picking up the food tastes of a culture in the womb.

- - Among other mental feats, the fetus can distinguish between the voice of Mom and that of a stranger, and respond to a familiar story read to it.
- - Even a premature baby is aware, feels, responds, and adapts to its environment.
- - Just because the fetus is responsive to certain stimuli doesn't mean that it should be the target of efforts to enhance development. Sensory stimulation of the fetus can in fact lead to bizarre patterns of adaptation later on.

The roots of human behavior, researchers now know, begin to develop early -- just weeks after conception, in fact. Well before a woman typically knows she is pregnant, her embryo's brain has already begun to bulge. By five weeks, the organ that looks like a lumpy inchworm has already embarked on the most spectacular feat of human development: the creation of the deeply creased and convoluted cerebral cortex, the part of the brain that will eventually allow the growing person to move, think, speak, plan, and create in a human way.

At nine weeks, the embryo's ballooning brain allows it to bend its body, hiccup, and react to loud sounds. At week ten, it moves its arms, "breathes" amniotic fluid in and out, opens its jaw, and stretches. Before the first trimester is over, it yawns, sucks, and swallows as well as feels and smells. By the end of the second trimester, it can hear; toward the end of the pregnancy, it can see.

FETAL ALERTNESS

Scientists who follow the fetus' daily life find that it spends most of its time not exercising these new abilities, but sleeping. At 32 weeks, it drowns 90 to 95% of the day. Some of these hours are spent in deep sleep, some in REM sleep, and some in an indeterminate state, a product of the fetus' immature brain that is different from sleep in a baby, child, or adult. During REM sleep, the fetus' eyes move back and forth just as an adult's eyes do, and many researchers believe that it is dreaming. DiPietro speculates that fetuses dream about what they know -- the sensations they feel in the womb.

Closer to birth, the fetus sleeps 85 or 90% of the time, the same as a newborn. Between its frequent naps, the fetus seems to have "something like an awake alert period," according to developmental psychologist William Fifer, Ph.D., who with his Columbia University colleagues is monitoring these sleep and wakefulness cycles in order to identify patterns of normal and abnormal brain development, including potential predictors of sudden infant death syndrome. Says Fifer, "We are, in effect, asking the fetus: 'Are you paying attention? Is your nervous system behaving in the appropriate way?'"

FETAL MOVEMENT

Awake or asleep, the human fetus moves 50 times or more each hour, flexing and extending its body, moving its head, face, and limbs and exploring its warm wet compartment by touch. Heidelise Als, Ph.D., a developmental psychologist at

Harvard Medical School, is fascinated by the amount of tactile stimulation a fetus gives itself. "It touches a hand to the face, one hand to the other hand, clasps its feet, touches its foot to its leg, its hand to its umbilical cord," she reports.

Als believes there is a mismatch between the environment given to preemies in hospitals and the environment they have in the womb. She has been working for years to change the care given to preemies so that they can curl up, bring their knees together, and touch things with their hands as they would have for weeks in the womb.

Along with such common movements, DiPietro has also noted some odder fetal activities, including "licking the uterine wall and literally walking around the womb by pushing off with its feet." Laterborns may have more room in the womb for such maneuvers than first babies. After the initial pregnancy, a woman's uterus is bigger and the umbilical cord longer, allow more freedom of movement. "Second and subsequent children may develop more motor experience in utero and so may become more active infants," DiPietro speculates.

Fetuses react sharply to their mother's actions. "When we're watching the fetus on ultrasound and the mother starts to laugh, we can see the fetus, floating upside down in the womb, bounce up and down on its head, bum-bum-bum, like it's bouncing on a trampoline," says DiPietro. "When mothers watch this on the screen, they laugh harder, and the fetus goes up and down even faster. We've wondered whether this is why people grow up liking roller coasters."

FETAL TASTE

Why people grow up liking hot chilies or spicy curries may also have something to do with the fetal environment. By 13 to 15 weeks, a fetus' taste buds already look like a mature adult's, and doctors know that the amniotic fluid that surrounds it can smell strongly of curry, cumin, garlic, onion and other essences from a mother's diet. Whether fetuses can taste these flavors isn't yet known, but scientists have found that a 33-week-old preemie will suck harder on a sweetened nipple than on a plain rubber one.

"During the last trimester, the fetus is swallowing up to a liter a day" of amniotic fluid, notes Julie Mennella, Ph.D., a biopsychologist at the Monell Chemical Senses Center in Philadelphia. She thinks the fluid may act as a "flavor bridge" to breast milk, which also carries food flavors from the mother's diet.

FETAL HEARING

Whether or not a fetus can taste, there's little question that it can hear. A very premature baby entering the world at 24 or 25 weeks responds to the sounds already around it, observes Als, so its auditory apparatus must already have

been functioning in the womb. Many pregnant women report a fetal jerk or sudden kick just after a door slams or a car backfires.

Even without such intrusions, the womb is not a silent place. Researchers who have inserted a hydrophone into the uterus of a pregnant woman have picked up a noise level "akin to the background noise in an apartment," according to DiPietro. Sounds include the whooshing of blood in the mother's vessels, the gurgling and rumbling of her stomach and intestines, as well as the tones of her voice filtered through tissues, bones, and fluid, and the voices of the other people coming through the amniotic wall. Fifer has found that fetal heart rate slows when the mother is speaking, suggesting that the fetus not only hears and recognizes the sound, but is calmed by it.

FETAL VISION

Vision is the last sense to develop. A very premature infant can see light and shape; researchers presume that a fetus has the same ability. Just as the womb isn't completely quiet, it isn't utterly dark, either. Says Fifer: "There may be enough visual stimulation filtered through the mother's tissues that a fetus can respond when the mother is in bright light," such as when she is sunbathing.

Japanese scientists have even reported a distinct fetal reaction to flashes of light shined on the mother's belly. However, other researchers warn that exposing fetuses (or premature infants) to bright light before they are ready can be dangerous. In fact, Harvard's Als believes that retinal damage in premature infants, which has long been ascribed to high concentrations of oxygen, may actually be due to over-exposure to light at the wrong time of development.

A six-month fetus, born about 14 weeks too early, has a brain that is neither prepared for nor expecting signals from the eyes to be transmitted into the brain's visual cortex, and from there into the executive-branch frontal lobes, where information is integrated. When the fetus is forced to see too much too soon, says Als, the accelerated stimulation may lead to aberrations of brain development.

FETAL LEARNING

Along with the ability to feel, see, and hear, comes the capacity to learn and remember. These activities can be rudimentary, automatic, even biochemical. For example, a fetus, after an initial reaction of alarm, eventually stops responding to a repeated loud noise. The fetus displays the same kind of primitive learning, known as habituation, in response to its mother's voice, Fifer has found.

But the fetus has shown itself capable of far more. In the 1980s, psychology professor Anthony James DeCasper, Ph.D., and colleagues at the University of

North Caroline at Greensboro, devised a feeding contraption that allows a baby to suck faster to hear one set of sounds through headphones and to suck slower to hear a different set. With this technology, DeCasper discovered that within hours of birth, a baby already prefers its mother's voice to a stranger's, suggesting it must have learned and remembered the voice, albeit not necessarily consciously, from its last months in the womb. More recently, he's found that a newborn prefers a story read to it repeatedly in the womb -- in this case, "The Cat in the Hat" -- over a new story introduced soon after birth.

DeCasper and others have uncovered more mental feats. Newborns can not only distinguish their mother from a stranger speaking, but would rather hear Mom's voice, especially the way it sounds filtered through amniotic fluid rather than through air. They're xenophobes, too: they prefer to hear Mom speaking in her native language that to hear her or someone else speaking in a foreign tongue.

By monitoring changes in fetal heart rate, psychologist Jean-Pierre Lecanuet, Ph.D., and his colleagues in Paris have found that fetuses can even tell strangers' voices apart. They also seem to like certain stories more than others. The fetal heartbeat will slow down when a familiar French fairy tale such as "La Poulette" ("The Chick") or "Le Petit Crapaud" ("The Little Toad"), is read near the mother's belly. When the same reader delivers another unfamiliar story, the fetal heartbeat stays steady.

The fetus is likely responding to the cadence of voices and stories, not their actual words, observes Fifer, but the conclusion is the same: the fetus can listen, learn, and remember at some level, and, as with most babies and children, it likes the comfort and reassurance of the familiar.

FETAL PERSONALITY

It's no secret that babies are born with distinct differences and patterns of activity that suggest individual temperament. Just when and how the behavioral traits originate in the womb is now the subject of intense scrutiny.

In the first formal study of fetal temperament in 1996, DiPietro and her colleagues recorded the heart rate and movements of 31 fetuses six times before birth and compared them to readings taken twice after birth. (They've since extended their study to include 100 more fetuses.) Their findings: fetuses that are very active in the womb tend to be more irritable infants. Those with irregular sleep/wake patterns in the womb sleep more poorly as young infants. And fetuses with high heart rates become unpredictable, inactive babies.

"Behavior doesn't begin at birth," declares DiPietro. "It begins before and develops in predictable ways." One of the most important influences on development is the fetal environment. As Harvard's Als observes, "The fetus gets an enormous amount of 'hormonal bathing' through its mother, so its

chronobiological rhythms are influenced by the mother's sleep/wake cycles, her eating patterns, her movements."

The hormones a mother puts out in response to stress also appear critical. DiPietro finds that highly pressured mothers-to-be tend to have more active fetuses -- and more irritable infants. "The most stressed are working pregnant women," says DiPietro. "These days, women tend to work up to the day they deliver, even though the implications for pregnancy aren't entirely clear yet. That's our cultural norm, but I think that's insane."

Als agrees that working can be an enormous stress, but emphasizes that pregnancy hormones help to buffer both mother and fetus. Individual reactions to stress also matter. "The pregnant woman who chooses to work is a different woman already from the one who chooses not to work," she explains.

She's also different from the woman who has no choice but to work. DiPietro's studies show that fetuses of poor women are distinct neurobehaviorially -- less active, with a less variable heart rate -- from fetuses of middle-class women. Yet "poor women rate themselves as less stressed than do working middle-class women," she notes. DiPietro suspects that inadequate nutrition and exposure to pollutants may significantly affect the fetuses of poor women.

Stress, diet, and toxins may combine to have a harmful effect on intelligence. A recent study by biostatistician Bernie Devlin, Ph.D., of the University of Pittsburgh, suggests that genes may have less impact on IQ than previously thought and that the environment of the womb may account for much more. "Our old notion of nature influencing the fetus before birth and nurture after birth needs an update," DiPietro insists. "There is an antenatal development, too, that is provided by the mother."

Parents-to-be who want to further their unborn child's mental development should start by assuring that the antenatal environment is well-nourished, low-stress, drug-free. Various authors and "experts" also have suggested poking the fetus at regular intervals, speaking to it through a paper tube or "pregaphone," piping in classical music, even flashing lights at the mother's abdomen.

Does such stimulation work? More importantly: Is it safe? Some who use these methods swear their children are smarter, more verbally and musically inclined, more physically coordinated and socially adept than average. Scientists, however, are skeptical.

"There has been no defended research anywhere that shows any enduring effect from these stimulations," asserts Fifer. "Since no one can even say for certain when a fetus is awake, poking them or sticking speakers on the mother's abdomen may be changing their natural sleep patterns. No one would consider

poking or prodding a newborn baby in her bassinet or putting a speaker next to her ear, so why would you do such a thing with a fetus?"

Als is more emphatic. "My bet is that poking, shaking, or otherwise deliberately stimulating the fetus might alter its developmental sequence, and anything that affects the development of the brain comes at a cost."

Gently talking to the fetus, however, seems to pose little risk. Fifer suggests that this kind of activity may help parents as much as the fetus. "Thinking about your fetus, talking to it, having your spouse talk to it, will all help prepare you for this new creature that's going to jump into your life and turn it upside down," he says -
- once it finally makes its anti-climactic entrance.