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When a White House conference on early child development convenes today, one of the findings Hillary Rodham Clinton will hear from scientists is that the neurological foundations for rational thinking, problem solving and general reasoning appear to be largely established by age 1 — long before babies show any signs of knowing an abstraction from a pacifier.

Furthermore, new studies are showing that spoken language has an astonishing impact on an infant's brain development. In fact, some researchers say the number of words an infant hears each day is the single most important predictor of later intelligence, school success and social competence. There is one catch — the words have to come from an attentive, engaged human being. As far as anyone has been able to determine, radio and television do not work.

"We now know that neural connections are formed very early in life and that the infant's brain is literally waiting for experiences to determine how connections are made," said Dr. Patricia Kuhl, a neuroscientist at the University of Washington in Seattle and a key speaker at today's conference. "We didn't realize until very recently how early this process begins," she said in a telephone interview. "For example, infants have learned the sounds of their native language by the age of six months."

This relatively new view of infant brain development, supported by many scientists, has obvious political and social implications. It suggests that infants and babies develop most rapidly with caretakers who are not only loving, but also talkative and articulate, and that a more verbal family will increase an infant's chances for success. It challenges some deeply held beliefs — that infants will thrive intellectually if they are simply given lots of love and that purposeful efforts to influence babies' cognitive development are harmful.

If the period from birth to 3 is crucial, parents may assume a more crucial role in a child's intellectual development than teachers, an idea sure to provoke new debates about parental responsibility, said Dr. Irving Lazar, a professor of special education and resident scholar at the Center for Research in Human Development at Vanderbilt University in Nashville. And it offers yet another reason to provide stimulating, high quality day care for infants whose primary caretakers work, which is unavoidably expensive.

The idea that early experience shapes human potential is not new, said Dr. Harry Chugani, a pediatric

neurologist at Wayne State University in Detroit and one of the scientists whose research has shed light on critical periods in child brain development. What is new is the extent of the research in the field known as cognitive neuroscience and the resulting synthesis of findings on the influence of both nature and nurture. Before birth, it appears that genes predominantly direct how the brain establishes basic wiring patterns. Neurons grow and travel into distinct neighborhoods, awaiting further instructions.

After birth, it seems that environmental factors predominate. A recent study found that mice exposed to an enriched environment have more brain cells than mice raised in less intellectually stimulating conditions. In humans, the inflowing stream of sights, sounds, noises, smells, touches — and most impor-

Environmental factors seem to take over for genetic influence.

tantly, language and eye contact — literally makes the brain take shape. It is a radical and shocking concept.

Experience in the first year of life lays the basis for networks of neurons that enable us to be smart, creative and adaptable in all the years that follow, said Dr. Esther Thelen, a neurobiologist at Indiana University in Bloomington.

The brain is a self-organizing system, Dr. Thelen said, whose many parts co-operate to produce coherent behavior. There is no master program pulling it together but rather the parts self-organize. "What we know about these systems is that they are very sensitive to initial conditions," Dr. Thelen said. "Where you are now depends on where you've been."

The implication for infant development is clear. Given the explosive growth and self-organizing capacity of the brain in the first year of life, the experiences an infant has during this period are the conditions that set the stage for everything that follows.

In later life, what make us smart and creative and adaptable are networks of neurons which support our ability to use abstractions from one memory to help form new ideas and solve problems, said Dr. Charles Stevens, a neurobiologist at the Salk Institute in San Diego. Smarter people may have a greater number of

neural networks that are more intricately woven together, a process that starts in the first year.

The complexity of the synaptic web laid down early may very well be the physical basis of what we call general intelligence, said Dr. Lazar at Vanderbilt. The more complex that set of interconnections, the brighter the child is likely to be since there are more ways to sort, file and access experiences.

Of course, brain development "happens" in stimulating and dull environments. Virtually all babies learn to sit up, crawl, walk, talk, eat independently and make transactions with others, said Dr. Steve Petersen, a neurologist at Washington University School of Medicine in St. Louis. Such skills are not at risk except in rare circumstances of sensory and social deprivation, like being locked in a closet for the first few years of life. Subject to tremendous variability within the normal range of environments are the abilities to perceive, conceptualize, understand, reason, associate and judge. The ability to function in a technologically complex society like ours does not simply "happen."

One implication of the new knowledge about infant brain development is that intervention programs like Head Start may be too little, too late, Dr. Lazar said. If educators hope to make a big difference, he said, they will need to develop programs for children from birth to 3.

Dr. Bettye Caldwell, a professor of pediatrics and an expert in child development at the University of Arkansas in Little Rock, who supports the importance of early stimulation, said that in early childhood education there is a strong bias against planned intellectual stimulation. Teachers of very young children are taught to follow "developmentally appropriate practices," she said, which means that the child chooses what he or she wants to do. The teacher is a responder and not a stimulator.

Asked about the bias Dr. Caldwell described, Matthew Melmed, executive director of Zero to Three, a research and training organization for early childhood development in Washington, D.C., said that knowing how much stimulation is too much or too little, especially for infants, is "a really tricky question. It's a dilemma parents and educators face every day," he said.

In a poll released today, Zero to Three found that 87 percent of parents think that the more stimulation a baby receives the better off the baby is, Mr. Melmed said. "Many parents have the concept that a baby is something you fill up with information and that's not good," he said.

TIMETABLE

The Growing Brain: What Might Help Your Infant

Dr. William Staso, an expert in neurological development, suggests that different kinds of stimulation should be emphasized at different ages. At all stages, parental interaction and a conversational dialogue with the child are important. Here are some examples:

FIRST MONTH A low level of stimulation reduces stress and increases the infant's wakefulness and alertness. The brain essentially shuts down the system when there is overstimulation from competing sources. When talking to an infant, for example, filter out distracting noises, like a radio.

MONTHS 1 TO 3 Light/dark contours, like high-contrast pictures or objects, foster development in neural networks that encode vision. The brain also starts to discriminate among acoustic patterns of language, like intonation, lilt and pitch. Speaking to the infant, especially in an animated voice, aids this process.

MONTHS 3 TO 5 The infant relies primarily on vision to acquire information about the world. Make available increasingly complex designs that correspond to real objects in the baby's environment; motion also attracts attention. A large-scale picture of a fork, moved across the field of vision, would offer more

stimulation than just an actual fork.

MONTHS 6 TO 7 The infant becomes alert to relationships like cause and effect, the location of objects and the functions of objects. Demonstrate and talk about situations like how the turning of a doorknob leads to the opening of a door.

MONTHS 7 TO 8 The brain is oriented to make associations between sounds and some meaningful activity or object. For example, parents can deliberately emphasize in conversation that the sound of water running in the bathroom signals an impending bath, or that a doorbell means a visitor.

MONTHS 9 TO 12 Learning adds up to a new level of awareness of the environment and increased interest in exploration; sensory and motor skills coordinate in a more mature fashion. This is the time to let the child turn on a faucet or a light switch, under supervision.

MONTHS 13 TO 18 The brain establishes accelerated and more complex associations, especially if the toddler experiments directly with objects. A rich environment will help the toddler make such associations, understand sequences, differentiate between objects and reason about them.

Challenging the deep belief that lots of love is enough.

"We are concerned that many parents are going to take this new information about brain research and rush to do more things with their babies, more activities, forgetting that it's not the activities that are important. The most important thing is connecting with the baby and creating an emotional bond," Mr. Melmed said.

There is some danger of overstimulating an infant, said Dr. William Staso, a school psychologist from Orcutt, Calif., who has written a book called "What Stimulation Your Baby Needs to Become Smart." Some people think that any interaction with very young children that involves their intelligence must also involve pushing them to excel, he said. But the "curriculum" that most benefits young babies is simply common sense, Dr. Staso said. It does not involve teaching several languages or numerical concepts but rather carrying out an ongoing dialogue with adult speech. Vocabulary words are a magnet for a child's thinking and reasoning skills.

This constant patter may be the single most important factor in early brain development, said Dr. Betty Hart, a professor emerita of human development at the University of Kansas in Lawrence. With her colleague, Dr. Todd Ridley of the University of Alaska, Dr. Hart recently

co-authored a book — "Meaningful Differences in the Everyday Experience of Young American Children."

The researchers studied 42 children born to professional, working class or welfare parents. During the first two and half years of the children's lives, the scientists spent an hour a month recording every spoken word and every parent-child interaction in every home. For all the families, the data include 1,300 hours of everyday interactions, Dr. Hart said, involving millions of ordinary utterances.

At age 3, the children were given standard tests. The children of professional parents scored highest. Spoken language was the key variable, Dr. Hart said.

A child with professional parents heard, on average, 2,100 words an hour. Children of working-class parents heard 1,200 words and those with parents on welfare heard only 600 words an hour. Professional parents talked three times as much to their infants, Dr. Hart said. More-

over, children with professional parents got positive feedback 30 times an hour — twice as often as working-class parents and five times as often as welfare parents.

The tone of voice made a difference, Dr. Hart said. Affirmative feedback is very important. A child who hears, "What did we do yesterday? What did we see?" will listen more to a parent than will a child who always hears "Stop that," or "Come here!"

By age 2, all parents started talking more to their children, Dr. Hart said. But by age two, the differences among children were so great that those left behind could never catch up. The differences in academic achievement remained in each group through primary school.

Every child learned to use language and could say complex sentences but the deprived children did not deal with words in a conceptual manner, she said.

A recent study of day care found the same thing. Children who were talked to at very young ages were better at problem solving later on.

For an infant, Dr. Hart said, all words are novel and worth learning. The key to brain development seems to be the rate of early learning — not so much what is wired but how much of the brain gets interconnected in those first months and years.