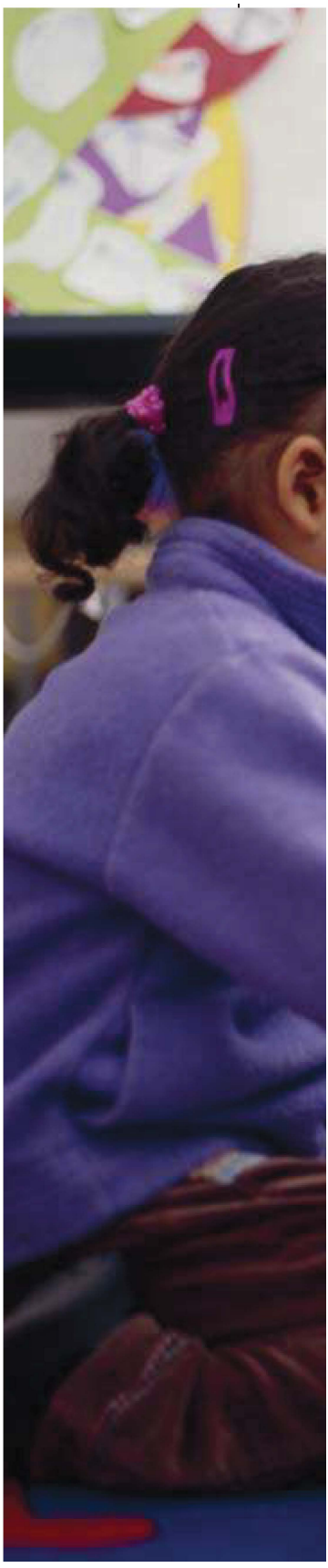


With special training early in life, children born with Down syndrome have a higher chance of developing into independent individuals

Just a Bit Different

By Ingelore Moeller

In the mid-1800s English doctor John Langdon Down was appointed director of a home outside London for mentally handicapped children, where he studied their symptoms. In 1862 he described the case of one of his wards who was short and had stubby fingers and unusual eyelids. The boy's condition was later labeled with his surname. But the genetic cause of Down syndrome was not uncovered for another century. In 1959 French pediatrician Jérome Lejeune discovered that these children have three copies of chromosome 21, instead of the standard two.

Chris Burke, an actor with Down syndrome, played a similarly affected character on *Life Goes On,* a series that stressed the need to accept such individuals into society.

For too long, people with Down syndrome, or trisomy 21, have been dismissed as "retarded" and thus incapable of having rich lives. But that view has begun to change. Psychologists, doctors and special-education teachers now realize that a diagnosis at infancy does not necessarily mean a child will have few options in life—as long as he or she receives special training early. And socially, Down syndrome children are finally being accepted as unspectacular, everyday kids, in part thanks to the 1990s hit ABC television series *Life Goes On,* starring an actor with Down syndrome, Chris Burke, who today is 41.

Physical limitations continue to challenge these individuals. Poor muscle tone (which often causes the tongue to protrude from the mouth); joint trouble; pale, sensitive skin; and vision, hearing and thyroid problems are prevalent. About half suffer from congenital heart defects. But medical progress in the past two decades has doubled the average life expectancy from 25 to 50 years. For those without heart defects, life expectancy is even higher. Yet for most, a rewarding mental and social life is their greatest desire—and their greatest challenge.

Third Copy Interference

Trisomy 21 is the most common chromosomal abnormality in humans. It affects one in every 800 to 1,000 live births. Today more than 350,000 Americans have Down syndrome. But why does having three copies of chromosome 21 cause the condition? With a completed map of the human genome, researchers are in hot pursuit of an answer.

Soon after scientists in the Human Genome Project finished describing chromosome 21 in 2000, they confirmed that within this chromosome are the genes that cause both Down syndrome and Alzheimer's disease. Neurologists had previously discussed a connection between the two disorders, because both involve an inadequate production of the neurotransmitter acetylcholine, one of the brain's messenger molecules. In a 2003 research review, Nancy Roizen of the Cleveland Clinic and David Patterson of the University of Denver focused on a particular gene that is crucial to energy production and oxygen utilization inside cells. They speculated that a defect in this system leads to the production of aggressive oxygen free radicals—molecules that damage cells—which may play a role in both Down syndrome and Alzheimer's.

In 2004 Guilherme Neves and Andrew Chess, now at the Center for Human Genetic Research at Massachusetts General Hospital, tracked the roles played by other genes on chromosome 21—in this case using a fruit fly as the model. They found a gene—dubbed *Dscam* (Down syndrome cell adhesion molecule)—that appears to give every nerve cell a unique identity during prebirth development, making sure that each cell ends up in the right location in the brain and body. Neves

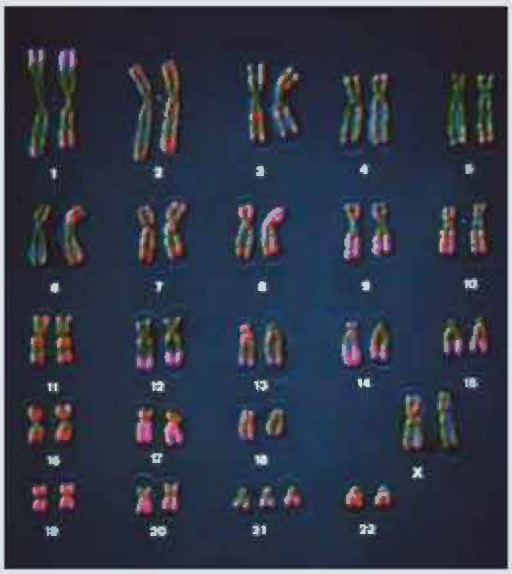
LAUREN SHEAR *Science Photo Library/Photo Researchers, Inc.* (*preceding pages*); COURTESY OF EVERETT COLLECTION (*this page*)

People with Down syndrome don't "suffer" from their disorder—only from bad treatment by others.

Chromosome 21: Three Instead of Two

Our genetic blueprint is stored in the chromosomes found in the nucleus of every cell in our bodies. There are 23 different bundles of DNA that normally exist in pairs, one copy each from the mother and father. They determine what people look like, how they develop and which diseases they may be vulnerable to.

A woman's egg and a man's sperm each contain a single set of the 23 chromosomes. The pairing occurs during fertilization, when the egg and sperm merge. On occasion, however, an egg or sperm may supply two copies of a particular chromosome, giving a fertilized egg—and thus every cell in the body of the future individual—three copies of that chromosome instead of two, and 47 chromosomes in total rather than 46. Most trisomies result in such devastating consequences that the embryo cannot survive and is rejected. But chromosome 21 is the smallest of the 23, and it seems that three copies of it may be less problematic; embryos with trisomy 21—the genetic cause of Down syndrome—do survive.



Caprice of nature: Individuals with Down syndrome have three copies of the smallest chromosome, number 21, instead of two and therefore have 47 total chromosomes rather than 46.

Geneticists have found that in 95 percent of babies born with trisomy 21, all body cells have 47 chromosomes. About 2 percent have mosaic trisomy, in which only some body cells have the third copy. The remaining 3 percent have translocational trisomy, the only inheritable form of Down syndrome; in this case, only parts of chromosome 21 are duplicated and attached to other chromosomes.

Babies with Down syndrome can be born into any family and to parents of any age or nationality. One well-documented risk factor, however, is maternal age. Ernest B. Hook of the University of California, Berkeley, estimates that the risk of having an infant with Down syndrome is one in 1,500 for a 20-year-old woman but rises to approximately one in 20 for a 45-year-old mother-to-be. *—I.M.*

and Chess hypothesize that a different version of the gene may affect humans similarly. Because people with trisomy 21 possess an additional copy of this gene, the oversupply may hinder the establishment of correct connections among brain cells during fetal development.

Shortly before birth, the brain starts checking over its entire network and sorting out the superfluous connections, which are then pared down. But in one explanation, with trisomy 21 many of the unproductive connections endure. They constitute "dead ends" that slow the physical growth, learning and thought processes of people with Down syndrome.

Delayed Development

After birth, trisomy 21 children go through essentially the same developmental steps as other children, but their rate of progress is slower and varies much more widely. The range has been well documented by researchers such as Hellgard Rauh, a psychologist at the University of Potsdam in Germany, who has observed the progress of more than 30 Down syndrome children over several years.

Rauh has found that their mental development during the first three years of life proceeds, on average, about half as fast as normal, meaning most two-year-olds with Down syndrome have reached the same milestones as average 12- to 14-month-old babies. In the following years, the rate of mental development slows to about one third of that for normal children. Grasping, crawling and walking prove to be especially difficult hurdles in the first two or three years. Physical development lags behind, although after the third year the rate of mental development may catch up to a degree. Speech is often a problem; most Down syndrome children at the age of five

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More than 350,000 Americans have trisomy 21. Helping them obtain jobs and build households will dissolve long-standing prejudices, enriching everyone's lives.

SUSAN VAN ETTEN *Photo Edit*

or six—just before starting elementary school—are only beginning to speak in two- or three-word sentences. For example, when they want their favorite toy they will just say, "Ball!" and they will express their fear of a neighbor's pet by crying, "Dog!" Delays in language continue to plague many young people with Down syndrome right into adulthood.

For many trisomy 21 children, abstract thinking, such as dealing with numbers or geometric shapes, can be hard. They also have trouble with visual and linguistic symbolism, even with such simple concepts as same versus different and more versus less.

On the other hand, when Wolfgang Jantzen, a special-education expert who retired in 2005 from the University of Bremen in Germany, tested affected 11-year-olds—whose language skills were at about a four-year-old level—on spatial tasks, they performed almost age-appropriately. For example, he would give them a one-step problem such as "Place the yellow circle in front of the blue square," and they responded well. But if he added, "Before you pick up the yellow circle, touch the blue square," most of them would fail. The children had no trouble with the spatial placement, but the time-order sequence baffled them.

Also characteristic of children with Down syndrome is slower mental processing. Virtually all their reactions occur with a longer-than-usual time delay, which must be taken into account when working or living with them. Otherwise, misunderstandings will quickly mount. For example, a father may ask his seven-year-old son whether he would like a hamburger at supper time. The boy may not respond immediately. The father may interpret the silence as a "no" and ask, "Would you rather have cheese?" "Yes," the boy might answer—and when he gets a plate with cheese, he may burst into tears because he was expecting the hamburger.

One tricky aspect of Down syndrome is that the children often realize they cannot accomplish many things that other kids their age can. They therefore seek to protect themselves when faced with challenges and, as Rauh explains, may

Children whose mothers are relaxed seem at ease. Those with controlling mothers seem insecure.

choose from several different strategies. Some try, with a combination of charm and feigned helplessness, to get other people to rescue them from difficult situations. Others manipulate their environment by clowning or throwing tantrums. And some will become honestly sad and simply give up. This resignation can be deep enough to set off psychosomatic disorders, such as chronic stomachaches.

Lively and Imaginative

While psychologists learn more about the thoughts going through the minds of Down syndrome children, parents, friends and teachers must still grapple with how to help these boys and girls reach their highest mental and social potential. It is becoming clear that the best way to encourage such growth is to interact with the children in lively, imaginative ways.

This positive support starts with the parents. Rauh observed that some mothers responded to their children's initiatives in play in a relaxed manner; they were attentive and friendly without trying to control what was happening, which cultivated an especially close attachment between child and mother. Other mothers remained detached from their son's or daughter's play, which left the child detached as well. When mothers seemed to have a need to be constantly involved by controlling and limiting the child's activity, it made the child insecure. Children who felt confident of their mother's interest behaved in a more relaxed way and presumably would adapt better to their surroundings.

Special "games" can help infants as well. Jutta Hatzer, a special-education teacher in Bremen, emphasizes simple measures designed to reinforce self-awareness during a child's first year of life. She demonstrated one exercise during a session with a one-year-old boy, Tom. She stood Tom in a large bucket filled halfway with dry beans, which reached his waist. The beans acted like little massage balls for the baby, who sat quietly and happily in his snug lair. "The enclosure provides security," Hatzer explains. "He can feel his body, sense his limits and get a firsthand notion of himself."

After a while, Hatzer encouraged Tom to grasp the beans. Everything proceeded slowly, step by step—the boy needed plenty of time to deal with each new situation. Hatzer sang simple, made-up songs describing each step ("Tom is in the bucket"). She repeated each phrase several times and soothed Tom with both words and gestures. Through this continuous communication and play the child learned to understand links between his internal and external worlds. This kind of early support, which for Tom began shortly after he was born, is designed to bolster his mental development so that it will be easier for him to learn to walk and talk later.

Some therapists recommend that caregivers use hand and arm gestures in conjunction with words. The children seem to learn gestures very quickly, helping them grasp the meaning of spoken words. For example, the boy mentioned earlier who got cheese instead of a hamburger might have better understood an accompanying gesture for "hamburger"—such as pretending to hold and bite the burger—which could have prevented the misunderstanding.

To bring Down syndrome children along, adults must also be careful not to appear standoffish or afraid of them. People with Down syndrome do not "suffer" from their disorder—only from inappropriately high demands from their environment. They are just a little different. They think differently, handle emotions differently, view things differently, look a bit different and sometimes react in ways we do not expect. They are full of originality and creativity but often do need a lot of encouragement for it to show. If those around them can accept them and be positive, they will develop into full personalities who know what they want and don't want.

One-year-old Tom is still too young to express his wishes. For him, being close to his mother is most important. She takes him into her arms, and he presses his little face into her neck. "What I hope for is that he can remain as happy and content as he is now and that he will always be well treated," she says. "That would be the nicest thing." M

(Further Reading)

- Information about and for people with Down syndrome and their families can be found at the Trisomy 21 Online Community at **http://trisomy21online.com/**
- Research advancements are tracked by the National Down Syndrome Society at **www.ndss.org/**