

The Brain

- Learns because that is its job.
- It has an inexhaustible capacity to learn.

BRAIN QUIZ

??? True or False???

- "Use it or lose it" is a phrase that can be applied to the brain?
- Forgetfulness is a sign that there is something wrong with the brain?
- There is a recognizable limit to how much the brain can learn?

Nature vs. Nurture

- Genes and environment interact at every step of brain development, but they play very different roles. Generally speaking, genes are responsible for the basic wiring plan—for forming all of the cells (neurons) and general connections between different brain regions--while experience is responsible for fine-tuning those connections, helping each child adapt to the particular environment (geographical, cultural, family, school, peer-group) to which he belongs

Nature vs. Nurture

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- Genes and hormones set the ball rolling, but they do not fully account for sex differences in children's brains. Experience also plays a fundamental role.

Experience changes the structure of the brain

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- Yes. Brain development is "activity-dependent," meaning that the electrical activity in every circuit—sensory, motor, emotional, cognitive--shapes the way that circuit gets put together.
- Every experience--whether it is seeing one's first rainbow, riding a bicycle, reading a book, sharing a joke--excites certain neural circuits and leaves others inactive. Those that are consistently turned on over time will be strengthened, while those that are rarely excited may be dropped away. "Cells that fire together, wire together."

Critical Periods

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- . One theory is that they correspond to a period of synaptic excess in the brain: between infancy and the early grade school years, the brain actually over-produces connections--some 50 percent more than will be preserved in adulthood.
- During the critical period, a child's experience--sensory, motor, emotional, and intellectual--determines which of these synapses will be preserved, through pruning of the least useful connections. In this way, each child's brain becomes better tuned to meet the challenges of his or her particular environment.

Brain Development

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- Our brains are continually re-shaping themselves to meet the demands of everyday life, even throughout adulthood. However, there are certain aspects of brain structure and function that do level off during development. For example, the number of neurons peaks even before birth; some 100 billion are formed during just the first five months of gestation. (Recent evidence suggests that new neurons are produced throughout life, though far less rapidly, and probably in numbers sufficient only to replace those that gradually die off.)

Brain Development

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- In spite of the great number of neurons present at birth, brain size itself increases more gradually: a newborn's brain is only about one-quarter the size of an adult's. It grows to about 80 percent of adult size by three years of age and 90 percent by age five.
- Another way of measuring brain development is to look at the speed of neural processing. A newborn's brain works considerably more slowly than an adult's, transmitting information some sixteen times less efficiently. The speed of neural processing increases dramatically during infancy and childhood, reaching its maximum at about age fifteen.

Critical Periods

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- A related theory holds that learning itself creates critical periods in a child's brain. That is, the longer a child has been exposed to one type of experience or environment, the less likely he or she will be able to reverse the synaptic learning that has already taken place.

Nutrition

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- Children who are malnourished--not just fussy eaters but truly deprived of adequate calories and protein in their diet--throughout this period do not adequately grow, either physically or mentally. Their brains are smaller than normal, because of reduced dendritic growth, reduced myelination, and the production of fewer glia (supporting cells in the brain which continue to form after birth and are responsible for producing myelin).

Nutrition

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- Inadequate brain growth explains why children who were malnourished as fetuses and infants suffer often lasting behavioral and cognitive deficits, including slower language and fine motor development, lower IQ, and poorer school performance.
- After birth, brain growth depends critically on the quality of a child's nutrition.

Nutrition

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- A baby's birth weight--and brain size--do depend on the quality of his or her mother's nutrition during pregnancy.
- Because of the rapid pace of myelination in early life, children need a high level of fat in their diets--some 50 percent of their total calories--until about two years of age.

Parents and Brain Development

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- Parents are another important part of the developmental equation. Infants prefer human stimuli--your face, voice, touch, and even smell--over everything else. They innately orient to people's faces and would rather listen to a speech or singing than any other kind of sound.

Parents

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- Because brain development is so heavily dependent on early experience, most babies will receive the right kind of nurturing from their earliest days, through our loving urges and parenting instincts.
- In spite of all the recent hype about "making your baby smarter," scientists have not discovered any special tricks for enhancing the natural wiring phase in children's brain development. Normal, loving, responsive caregiving seems to provide babies with the ideal environment for encouraging their own exploration, which is always the best route to learning

Parents

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- The one form of stimulation that has been proven to make a difference is language: infants and children who are conversed with, read to, and otherwise engaged in lots of verbal interaction show somewhat more advanced linguistic skills than children who are not as verbally engaged by their caregivers.

Gender Differences

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- Neuroscientists have known for many years that the brains of men and women are not identical. Men's brains tend to be more lateralized—that is, the two hemispheres operate more independently during specific mental tasks like speaking or navigating around one's environment. For the same kinds of tasks, females tend to use both their cerebral hemispheres more equally. Another difference is size: males of all ages tend to have slightly larger brains, on average, than females, even after correcting for differences in body size.

Gender Differences

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- Sex differences in the brain are reflected in the somewhat different developmental timetables of girls and boys. By most measures of sensory and cognitive development, girls are slightly more advanced: vision, hearing, memory, smell, and touch are all more acute in female than male infants

Gender Differences

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- Boys eventually catch up in many of these areas. By age three, they tend to out-perform girls in one cognitive area: visual-spatial integration, which is involved in navigation, assembling jigsaw puzzles, and certain types of hand-eye coordination.

Gender

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- Girl babies also tend to be somewhat more socially-attuned—responding more readily to human voices or faces, or crying more vigorously in response to another infant's cry—and they generally lead boys in the emergence of fine motor and language skills.

Gender

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- This remarkable plasticity also provides parents and other caregivers with a wonderful opportunity to compensate for the different tendencies of boys and girls.
- It is known that greater verbal interaction can improve young children's language skills. So the "typical boy" may especially benefit from a caregiver who engages him in lots of conversation and word play.

Gender

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- The "typical girl" may benefit more from a caregiver who engages her in a jigsaw puzzle or building a block tower—activities that encourage her visual-spatial integration. The point is not to discourage children from sex-typical play (since pushing trucks or playing with dolls are great activities for any young child), but to supplement those activities with experiences that encourage the development of many competences.

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- **The organization of a child's brain is affected by early experiences.**
- Repeated use strengthens a synapse. Synapses that are rarely used remain weak and are more likely to be eliminated in the pruning process. Synapse strength contributes to the connectivity and efficiency of the networks that support learning, memory, and other cognitive abilities.^{16,17} Therefore, a child's experiences not only determine what information enters her brain, but also influence how her brain processes information

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- **Genes provide a blueprint for the brain, but a child's environment and experiences carry out the construction.**
- The excess of synapses produced by a child's brain in the first three years makes the brain especially responsive to external input. During this period, the brain can "capture" experience more efficiently than it will be able to later, when the pruning of synapses is underway.¹¹ The brain's ability to shape itself – called plasticity – lets humans adapt more readily and more quickly than we could if genes alone determined our wiring

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- **The earliest messages that the brain receives have an enormous impact.**
- Early brain development is the foundation of human adaptability and resilience, but these qualities come at a price. Because experiences have such a great potential to affect brain development, children are especially vulnerable to persistent negative influences during this period. On the other hand, these early years are a window of opportunity for parents, caregivers, and communities: positive early experiences have a huge effect on children's chances for achievement, success, and happiness.

○ ASSIST CHILDREN IN EXPRESSING FEELINGS & EMOTIONS

○ TEACH EMPATHY

○ PROVIDE CHOICES

○ PROVIDE A POSITIVE MODEL OF APPROPRIATE SOCIAL SKILLS

WHAT WE CAN DO

○ ENSURE HEALTH, SAFETY, AND GOOD NUTRITION

○ PROVIDE HIGH QUALITY, ACTIVE LEARNING PRESCHOOLS

○ DEVELOP A WARM, CARING RELATIONSHIP WITH CHILDREN

○ RESPOND TO CHILDREN'S CUES AND CLUES

○ RECOGNIZE THAT EACH CHILD IS UNIQUE

○ TALK, READ, AND SING TO CHILDREN

○ ENCOURAGE SAFE EXPLORATION AND PLAY

○ USE DISCIPLINE TO TEACH

○ ESTABLISH ROUTINES

○ LIMIT TV

○ REINFORCE POSITIVE BEHAVIOR

○ MAKE TRANSITIONS EASIER

○ MAKE ACCOMMODATIONS FOR INDIVIDUAL CHILDREN

IMPLICATIONS FOR EDUCATORS

1. Cognitive growth and brain growth both show remarkable resilience and plasticity when children live and learn in adequate environments. The cyclical nature of cortical growth and optimal cognitive development seems to foster these characteristics of resilience and plasticity.
2. Brain development involves a recurring growth cycle of neural networks and learning, in which a child not only learns skills and concepts once, but also relearns and reworks them anew at each successive optimal level.

3. Children (and adults) function at multiple levels of skill and understanding, even for a single topic or domain. Their concepts and skills vary across a wide range of levels, and normal functioning is usually not at optimal level.

4. An individual's level of skill and understanding depends pervasively on contextual support for high-level function. Effective teaching and, at later ages, effective textual presentation powerfully support high-level functioning. Removing the support leads to a natural, rapid drop in the level of understanding.

5. Educators need to focus on teaching children at lower, as well as at optimal, levels because independent learning and thinking usually occur at lower levels with optimal functioning limited to supportive situations.

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- Enriched environments have a pronounced effect on brain development during the early years.
- A child's brain at birth has all the brain cells, or neurons, that it will ever have.
- The brain changes physiologically as a result of experience. The environment in which a brain operates determines to a large degree the functioning ability of that brain.
- IQ is not fixed at birth.
- Some abilities are acquired more easily during certain sensitive periods, or "windows of opportunity."

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- Learning is strongly influenced by emotion.
- The brain is essentially curious, and it must be to survive.
- Human knowledge is stored in clusters and organized within the brain into systems that people use to interpret familiar situations and to reason about new ones.
- The more schools more closely match teaching to the way students' brains learn, the more likely they are to reach students and bring out their natural motivation to learn.

THE BRAIN

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- If we teach our children early enough, it will affect the organization, or "wiring" of their brains.
- Early education shapes the basic architecture of the brain.
- Research demonstrates that the brain does not reach into one specific area to retrieve a single piece of information or a command. Instead, it relies on a complex network of connections that respond in concert to messages received by the brain.

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- Research demonstrates that emotions develop in the brain's frontal cortex, which shows increased activity between 6 months and 2 years. This suggests the possibility of a critical window for emotional development.
- Meaningful learning - the kind that will equip our children and our society for the uncertain challenges of the future – occurs at the intersection of developmental readiness, curiosity, and significant subject matter.
- Early in life, neural connections (synapses) form rapidly in the brain.
- Critical periods occur in development.

RETHINKING THE BRAIN

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<ul style="list-style-type: none">• Old thinking...<ul style="list-style-type: none">○ How a brain develops depends on the genes you are born with.○ The experiences you have before age 3 have a limited impact on later development.○ A secure relationship with a primary caregiver creates a favorable context for early development and learning.	<ul style="list-style-type: none">• New Thinking...<ul style="list-style-type: none">○ How a brain develops hinges on a complex interplay between the genes you're born with and the experiences you have.○ Early experiences have a decisive impact on the architecture of the brain and on the nature and extent of adult capacities.○ Early interactions don't just create a context; they directly affect the way the brain is "wired."
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<ul style="list-style-type: none">• Old Thinking...<ul style="list-style-type: none">○ Brain development is linear: the brain's capacity to learn and change grows steadily as an infant progresses toward adulthood.○ A toddler's brain is much less active than the brain of a college student.	<ul style="list-style-type: none">• New Thinking...<ul style="list-style-type: none">○ Brain development is non-linear: there are prime times for acquiring different kinds of knowledge and skills.○ By the time children reach age 3, their brains are twice as active as those of adults. Activity levels drop during adolescence.
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MIND/BRAIN LEARNING PRINCIPLES

1. The brain is a complex adaptive system.
 - thoughts, emotions, imagination, predispositions, and physiology operate concurrently and interactively as the entire system interacts with and exchanges information from its environment.
2. The brain is a social brain.
 - our brain/minds change in response to their engagement with others.
3. The search for meaning is innate.
 - the search for meaning ranges from the need to eat and find safety, through the development of relationships and a sense of identity, to an exploration of our potential and the quest for transcendence.
4. The search for meaning occurs through "patterning."
 - effective education must give learners an opportunity to formulate their own patterns of understanding.
5. Emotions are critical to patterning.
 - what we learn is influenced and organized by emotions and mind-sets.

6. Every brain simultaneously perceives and creates parts and wholes.
 - in a healthy person both brain hemispheres interact in every activity.
7. Learning involves both focused attention and peripheral perception.
 - the brain absorbs information of which it is directly aware, but it also absorbs information that lies beyond the immediate focus of attention.
8. Learning always involves conscious and unconscious processes.
 - teaching is a matter of helping learners make visible what is invisible.

9. We have at least 2 ways of organizing memory.
 - taxon memory-system for recalling relatively unrelated information, (Taxonomies) **It requires practice and rehearsal.**
 - spatial/ autobiographical memory/**Locale memory**-does not need rehearsal and allows for "instant" recall. **It is motivated by novelty, curiosity, and expectations**
10. Learning is developmental.
 - there are predetermined sequences of development in childhood.
11. Complex learning is enhanced by challenge and inhibited by threat.
12. Every brain is uniquely organized

SOCIAL COMPETENCE AND THE BRAIN

- Early neurological development is shaped not only by physical conditions, but also by an individual's social environment.
- Children learn in the context of important relationships.
- Both quality of care and security of attachment affect children's later capacity for empathy, emotional regulation, and behavioral control.
- Among the protective factors that make children more resilient, a secure attachment with their caregivers is the most important.

- An individual's capacity to learn and thrive in a variety of settings depends on the interplay between nature (their genetic endowment) and nurture (the kind of care, stimulation, and teaching they receive).
- The human brain across all ethnic and racial groups - is uniquely constructed to benefit from experience and from good teaching, particularly during the first years of life.
- While the opportunities and risks are greatest during the first years of life, learning takes place throughout the human life cycle.

Brain Development

- **Windows of Development...**
 - "Periods of time during which the development of skills will be easier than at any other time"
 - if not learned during this time, skills may not develop to their full potential
 - vision, language, music, social development, and math/logic developmental stages are between the *first 5 years*
- **Gender differences in brain development:**
 - Females**
 - left hemisphere develops first
 - more dispersed than the male
 - levels of progesterone and estrogen impact the development of skills
 - Males**
 - right hemisphere develops earlier
 - activity more compartmentalized than female
 - testosterone aids in science, math, and sports development

**Brain Development
Facts**

- **A child's brain is wired differently than an adult's brain.**
 - nerve networks grow through experience
 - at birth the neocortex is 25% of the adult weight
 - at 6 months - 50% of adult weight
 - at 2.5 years - 75% of adult weight
 - at 5 years - 90% of adult weight

what we know...

- when child is born, they have 100 billion neurons
- children between 3-8 years old have twice as many neurons and twice as many connections between them as adults.
- peak activity of the brain occurs at 5 years old.

learning...

- movement - when kids are able to be mobile as they learn, their learning is more efficient
- social learning - interaction with other children and adults aids in efficient learning
- we learn
 - 10% of what we read
 - 15% of what we hear
 - 80% of what we experience

**Key Facts that Educators Should Know
About Our Brilliant Brain**

- **One**
 - It is not the size of the brain that is important in determining intelligence-
 - It's the number of connections

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- **Two**
 - The brain has two hemispheres –left and right.
 - Left- linear processing, logical thought, works with words and numbers, editing reality to agree with the patterns that already exist in our mental maps.
 - Traditional education methods serve left brain learners well.

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- **Three**
 - The brain can focus and learns best on **7 chunks** of information at any one time.
 - Smaller children learn in smaller chunks.

Multiple Intelligences

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- **Four**
 - musical
 - linguistic
 - logical-mathematical
 - visual-spatial
 - body-kinesthetic
 - inter-personal
 - intra-personal
 - naturalistic

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- **Five**
 - The brain has a 9 second attention span.
 - Learners tend to tune in and out of what the speaker is saying.

PIVOTAL DISCOVERIES
BY CARNEGIE CORPORATION

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- Brain development that takes place prenatally, and in the first years of life, is more rapid and extensive than previously realized.
- Brain development is much more vulnerable to environmental influence than ever before suspected.
- The influence of early environment on brain development is long-lasting.

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- The environment affects not only the number of brain cells and the number of connections among them, but also the way these connections are "wired." New scientific evidence exists concerning the negative impact of early stress on brain function. (Carnegie Corporation, 2008, p. Z)
- The findings of brain development research are astounding. In fact, "the discoveries are so profound that many researchers say we will surely look back on the 1990s as the Decade of the Brain" Simmons & Sheehan, (2006, p. 1). Moreover, the brain development research findings have serious implications for parents and policymakers (Nash, 2007).

- According to Carla Shatz of the University of California, Berkeley, "There are two broad stages of brain wiring; an early period [prenatal], when experience is not required, and a later one, when it is" (Begley, 2009).

She continues...

In the beginning, the brain-to-be consists of only a few advance scouts breaking trail: within a week of conception they march out of the embryo's "neural tube," a cylinder of cells extending from head to tail. Multiplying as they go (the brain adds an astonishing 250,000 neurons per minute during gestation), the neurons clump into the brain stem, which commands heartbeat and breathing, build the little cerebellum at the back of the head, which controls posture and movement, and form the grooved and rumped cortex wherein thought and perception originate. (p. 61)

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While all children grow and develop in similar patterns, each child develops at his or her own pace.[7]. The first five—and especially the first three years—of a child’s life are the most important. According to renowned child educator Maria Montessori, knowing how to arrange an interesting, beautiful environment for children is as much a part of their development as knowing how to select fine children’s books for their library.[3]. By kindergarten, a child’s brain has reached its full size but it won’t stop developing until the mid-20s. According to Sigmund Freud, psychological development in childhood takes place in five stages: 1) oral/0-1 years, 2) anal/1-3 years, 3) phallic/3-6 years, 4) latency/6 years to puberty; and 5) genital/puberty-adult.[6].