

emotions. When your child begins playing with peers, your ability to provide the time, space, and materials that are needed for complex pretense will enhance development of the higher brain centers. You may occasionally participate in the pretense to extend the ideas and actions. During this age period, the synapses in your child's higher brain centers are likely to be activated by following scripts and taking roles that require self-regulation and problem-solving. As your child's pretend play skills increase, provide reading, writing, and other symbolic materials for use during play.

- As your child becomes more able to use the frontal lobe of the brain, you can play games with rules that require higher order thinking processes, keeping in mind that your child's processing will be slower than yours. Playing symbolic games with your child is something you can do throughout childhood and adolescence; as you do, you will be able to observe how your child's brain becomes more and more capable of using the "control processes" of the frontal lobe. In early adolescence, children's choices of activities may become more narrow due to the pruning activity.

### In Summary

At all ages, an active brain is a developing brain. The choices of activity your child makes will not only enhance synaptic growth at an early age but also affect pruning at a later age. The most-practiced activities are likely to be the ones that become more stable when pruning is occurring. A family that pursues a wide range of recreational activities, enjoys word games and other types of play together, and values trying out new experiences will probably help their children's brains to develop richly and uniquely.

#### For further information, see:

Bergen, D., & Coscia, J. (2000). *Brain research and childhood education*. Olney, MD: Association for Childhood Education International.

# ACEI SPEAKS

## Play's Role in Brain Development

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## What Do We Now Know About Brain Development?

Because of recent advances in techniques to observe the electrical and chemical processes occurring in living brains, researchers can now tell us more about how the brain develops. However, because much of this research has focused on animal brains, human adult brains, and brains of children at developmental risk, we are only beginning to gain information about the typical course of child brain development over the years from birth to adolescence. Most researchers do agree on the following points:

- The "building blocks" for brain development are created before birth; 60% of human genes are dedicated to brain development and the brain is only about 25% completed at birth.
- While certain areas of the brain are more likely to be the major site of particular functions (for example, sight, hearing, language), the brain actually functions as a whole in an interactive and integrated manner; thus, the best metaphor to describe the brain is that it is like a "jungle" with rich, diffuse interconnections, rather than like a "computer" with machine-like qualities.
- The more basic human actions related to life sustenance and safety develop earlier than the "higher order" actions such as critical thinking and control processes, and it is likely that "stagelike" changes in behavior are related to brain development changes.
- Because 75% of brain development occurs after birth, the experiences children have during their early years profoundly affect the ways their individual brains are structured and the ways they perform. By adulthood, each individual's brain is uniquely constructed.
- The brain's "plasticity" and resilience provides some protection against early negative experiences. Only situations such as extreme neglect, abuse, starvation, illness, or environmental toxins are likely to cause major long-term damage.
- Because the brain continues to have some plasticity, experiences throughout life continue to affect its structures and functions.

## How Does Children's Brain Development Relate to Their Play Development?

### Age Birth to 1

- Almost all neurons (nerve cells) are present at birth but most are not connected in networks. The connecting process (synaptogenesis) is rapid during this year, with the sensorimotor areas most active during the 2-3 month period, and the frontal lobe becoming active by 6-8 months. By 12 months, the activity of the brain is more similar to the adult brain than to the newborn brain. The visual cortex develops rapidly during this period. Brain weight increases from about 1 pound at birth to 2 pounds by one year, partly due to the increase in synapses and partly due to the coating of nerve axons with fatty glial cells (myelination) that act to speed neural signals.
- Infants' play during this period follows a pattern that reflects the development of brain areas. Much early play involves practice of the sensorimotor system. For example, infants love to observe interesting patterns and colors, explore textures and sounds, grasp objects, and perform various actions on objects. Because of the repetitive nature of their play, Piaget has called it "practice play." When the frontal lobe begins to be activated, the social nature of play expands, with simple turn-taking games like "peek-a-boo" enjoyed, more elaborate practice play with objects occurs, and one-word naming of play objects is common ("baa" for ball).

### Ages 2-3

- During this age period the synapses continue to expand and reach about 1,000 trillion—twice the density of the adult brain. The toddler brain is 2-1/2 times as active as the adult brain and as

the glial cells coat the axons, the weight of the brain continues to increase. The structures of the brain that are sensitive to language production (Broca) and comprehension (Weirnicke) become active and language typically develops during this period. Because the areas of the brain that generate social-emotional responses (amygdala/limbic system) begin to be connected with frontal lobe areas, initial understanding of emotions begins but self-control of emotions is still difficult.

- By age 2 the first examples of pretend play are evident, indicating that the brain is now capable of simple symbolic thought. Children begin to transform actions and objects in play, "feeding" dolls, "driving" trucks, and building "garages." Language is also played with in rhymes and songs and "silly" sounds and pretend characters can "talk," expressing emotions as well as actions. For example, children can make pretend characters show fear or anger and can interpret that behavior in words ("I'm mad").

### Ages 3-8

- This is the fastest growth period for the frontal lobe networks, and speed of processing, memory, and problem solving is increasing. The brain is at 90% of its adult weight by age 6, and the frontal lobe of the cortex is at its most dense around age 7. The synaptic connections in motor and sensory areas are firmly established and the process of eliminating synapses (pruning) in these areas has begun. Because of the activity in the higher brain "control" centers, children increase in levels of attention and ability to inhibit impulses. There is some evidence that spurts in cortical growth seem to parallel cognitive stage theories.
- Play during this period is at its most elaborate and extensive. The early pretense has

blossomed into sociodramatic play in which children engage in complex theme play, involving roles, scripts, and costumes (such as "doctor's office," "princesses," or "superman saving the world"). By age 6, games with rules become a pervasive play activity, and much negotiation of rules, discussion of "fairness," and both cooperation and competition occur in spontaneous and traditional games. Through their play, children demonstrate their extensive symbolic thought capacities and their ability to self-regulate and explain their behavior.

### Ages 8-14

- The maturation of the frontal lobe continues and pruning begins in this area. Myelination of these higher brain centers also continues and is completed in late adolescence. Speed and efficiency of thought increases, spatial working memory improves, emotional regulation becomes greater, planning and problem solving skills increase, and scientific reasoning and ability to understand one's own thinking (metacognition) develops. Children still use a larger area of the brain than an adult would use in carrying out discrimination tasks, however. By this age there begins to be stable individual differences in brain structures and functions.
- Play becomes sophisticated and increasingly symbolic, with pretend themes often carrying on for weeks or months (but usually in the privacy of the home). Symbolic games such as Monopoly and symbolic computer games are popular, and the more elaborate the rules, the better. Although some informal games with rules continue, many children are introduced to adult-controlled, highly organized games (sports), which require greater control of motor, social, and cognitive processes. Children introduced to sports that require more of these abilities than their brains are ready for often experience frustration and disinterest.

## What Play Experiences Are Most Likely To Produce Well-developed Brains?

Children's spontaneous play is a good indicator of the developmental level of their brains. As a parent or teacher you can help them extend that play in ways that may add to the richness of their positive experiences. At present, no research points to specific activities, such as listening to Mozart, or to particular curriculum, such as ones labeled "brain-based," as being especially useful to the brain. The most important role that play can have is to help children to be active, to make choices, and to practice actions to mastery. They should have experience with a wide variety of content (art, music, language, science, math, social relations) because each is important for the development of a complex and integrated brain. Play that links sensorimotor, cognitive, and social-emotional experiences provides an ideal setting for brain development. Here are some suggestions for extending play's role in enhancing children's brain development.

- For younger children, ensure that many safe and interesting objects are accessible to the child. Initiate play with your child, demonstrating various ways to use the objects and encourage your child to explore and expand on their uses during play. By keeping a variety of objects that activate sensorimotor and language areas of the brain available and by increasing the complexity level of toys as your child grows older, you will be giving opportunities for synaptic growth. Similarly, your language, social, and emotional interactions with your child in play will help activate those brain centers related to these capabilities.
- As pretend play begins, provide models of symbolic actions and pretend with your child while also labeling your actions and