COGNITIVE DEVELOPMENT

Cognitive development is a field of study in neuroscience and psychology focusing on a child's development in terms of information processing, conceptual resources, perceptual skill, language learning, and other aspects of brain development and cognitive psychology compared to an adult's point of view. In other words, cognitive development is the emergence of the ability to think and understand. A large portion of research has gone into understanding how a child imagines the world. Jean Piaget was a major force in the establishment of this field, forming his "theory of cognitive development". In recent years, however, alternative models have been advanced, including information-processing theory, neo-Piagetian theories of cognitive development, which aim to integrate Piaget's ideas with more recent models and concepts in developmental and cognitive science, theoretical cognitive neuroscience, and social-constructivist approaches.

PIAGETIAN APPROACH TO COGNITIVE DEVELOPMENT:

Piaget was the first psychologist to make a systematic study of cognitive development. His contributions include a theory of cognitive child development, detailed observational studies of cognition in children, and a series of simple but ingenious tests to reveal different cognitive abilities. Before Piaget's work, the common assumption in psychology was that children are merely less competent thinkers than adults. Piaget showed that young children think in strikingly different ways compared to adults.

According to Piaget, children are born with a very basic mental structure (genetically inherited and evolved) on which all subsequent learning and knowledge is based.

There Are Three Basic Components To Piaget's Cognitive Theory:

Schemas

Piaget called the schema the basic building block of intelligent behavior – a way of organizing knowledge. Indeed, it is useful to think of schemas as “units” of knowledge, each relating to one aspect of the world, including objects, actions and abstract (i.e. theoretical) concepts. When a child's existing schemas are capable of explaining what it can perceive around it, it is said to be in a state of equilibrium, i.e. a state of cognitive (i.e. mental) balance. Piaget emphasized the importance of schemas in cognitive development, and described how they were developed or acquired.

A schema can be defined as a set of linked mental representations of the world, which we use both to understand and to respond to situations. The assumption is that we store these mental representations and apply them when needed.

For example, a person might have a schema about buying a meal in a restaurant. The schema is a stored form of the pattern of behavior which includes looking at a menu, ordering food, eating it and paying the bill. This is an example of a type of schema called a 'script'. Whenever they are in a restaurant, they retrieve this schema from memory and apply it to the situation. The schemas Piaget described tend to be simpler than this - especially those used by infants. He described how - as a child gets older - his or her schemas become more numerous and elaborate.

Piaget believed that newborn babies have some innate schemas - even before they have had much opportunity to experience the world. These neonatal schemas are the cognitive structures underlying innate reflexes. These reflexes are genetically programmed into us. For example babies have a sucking reflex, which is triggered by something touching the baby's lips. A baby will suck a nipple, a comforter (dummy), or a person's finger. Piaget therefore assumed that the baby has a 'sucking schema'. Similarly the grasping reflex which is elicited when something touches the palm of a baby's hand, or the rooting reflex, in which a baby will turn its head towards something which touches its cheek, were assumed to result operations: for example shaking a rattle would be the combination of two schemas, grasping and shaking.

Assimilation and Accommodation

Jean Piaget viewed intellectual growth as a process of adaptation (adjustment) to the world. This happens through:
• Assimilation

Which is using an existing schema to deal with a new object or situation.

• Accommodation

This happens when the existing schema (knowledge) does not work, and needs to be changed to deal with a new object or situation.

• Equilibration

This is the force, which moves development along. Piaget believed that cognitive development did not progress at a steady rate, but rather in leaps and bounds.

Equilibration is occurs when a child's schemas can deal with most new information through assimilation. However, an unpleasant state of disequilibrium occurs when new information cannot be fitted into existing schemas (assimilation).

Equilibration is the force which drives the learning process as we do not like to be frustrated and will seek to restore balance by mastering the new challenge (accommodation).

Once the new information is acquired the process of assimilation with the new schema will continue until the next time we need to make an adjustment to it.

Stages of Development

A child's cognitive development is about a child developing or constructing a mental model of the world. Imagine what it would be like if you did not have a mental model of your world. It would mean that you would not be able to make so much use of information from your past experience, or to plan future actions.

Jean Piaget was interested both in how children learnt and in how they thought. Piaget studied children from infancy to adolescence, and carried out many of his own investigations using his three children. He used the following research methods:

Naturalistic observation: Piaget made careful, detailed observations of children. These were mainly his own children and the children of friends. From these he wrote diary descriptions charting their development.

Clinical interviews and observations of older children who were able to understand questions and hold conversations.

Piaget believed that children think differently than adults and stated they go through 4 universal stages of cognitive development. Development is therefore biologically based and changes as the child matures. Cognition therefore develops in all children in the same sequence of stages.

Each child goes through the stages in the same order, and no stage can be missed out - although some individuals may never attain the later stages. There are individual differences in the rate at which children progress through stages.

Piaget did not claim that a particular stage was reached at a certain age - although descriptions of the stages often include an indication of the age at which the average child would reach each stage.

Piaget believed that these stages are universal - i.e. that the same sequence of development occurs in children all over the world, whatever their culture.

Sensorimotor Stage

During the early stages, infants are only aware of what is immediately in front of them. They focus on what they see, what they are doing, and physical interactions with their immediate environment. Because they don't yet know how things react, they’re constantly experimenting with activities such as shaking or throwing things, putting things in their mouths, and learning about the world through trial and error. The later stages include goal-oriented behavior which brings about a desired result.

At about age 7 to 9 months, infants begin to realize that an object exists even if it can no longer be seen. This important milestone -- known as object permanence -- is a sign that memory is developing.

After infants start crawling, standing, and walking, their increased physical mobility leads to increased cognitive development. Near the end of the sensorimotor stage, infants reach another important milestone -- early language development, a sign that they are developing some symbolic abilities.

Preoperational Stage

During this stage, young children are able to think about things symbolically. Their language use becomes more mature. They also develop memory and imagination, which allows them to understand
the difference between past and future, and engage in make-believe. But their thinking is based on intuition and still not completely logical. They cannot yet grasp more complex concepts such as cause and effect, time, and comparison.

**Concrete Operational Stage**

At this time, elementary-age and preadolescent children demonstrate logical, concrete reasoning. Children's thinking becomes less egocentric and they are increasingly aware of external events. They begin to realize that one's own thoughts and feelings are unique and may not be shared by others or may not even be part of reality. Children also develop operational thinking -- the ability to perform reversible mental actions. During this stage, however, most children still can't tackle a problem with several variables in a systematic way.

**Formal Operational Stage**

Adolescents who reach this fourth stage of intellectual development are able to logically use symbols related to abstract concepts, such as algebra and science. They can think about multiple variables in systematic ways, formulate hypotheses, and consider possibilities. They also can ponder abstract relationships and concepts such as justice.

Although Piaget believed in lifelong intellectual development, he insisted that the formal operational stage is the final stage of cognitive development, and that continued intellectual development in adults depends on the accumulation of knowledge.

Limitations of Piagetian theory:

1. Existence of clear-cut stages is doubtful
2. Studies show that children also attend more than one dimension at a time and think in terms of abstraction also
3. Underestimated young minds
4. Failed to distinguish between competence and performance
5. Failed to adequately explain development
6. Paid little attention to social influence on Cognitive development

**VYGOTSKY’S SOCIOCULTURLA APPROACH TO COGNITIVE DEVELOPMENT:**

The work of Lev Vygotsky has become the foundation of much research and theory in cognitive development over the past several decades, particularly of what has become known as Social Development Theory.

Vygotsky’s theories stress the fundamental role of social interaction in the development of cognition. He believed strongly that community plays a central role in the process of "making meaning." Unlike Piaget's notion that children’s development must necessarily precede their learning, Vygotsky argued, "learning is a necessary and universal aspect of the process of developing culturally organized, specifically human psychological function". In other words, social learning tends to precede (i.e. come before) development.

No single principle (such as Piaget's equilibration) can account for development. Individual development cannot be understood without reference to the social and cultural context within which it is embedded. Higher mental processes in the individual have their origin in social processes.

He gave the concept of Zone of proximal development (ZPD). ZPD: The gap between what a learner can accomplish independently and what s/he can accomplish with the guidance and encouragement of a more skilled partner. He also explained that Knowledge is not fixed state. Children have the potential for unlimited growth. They develop Learning through guided participation

**VISUAL DEVELOPMENT:**

Babies learn to see over a period of time, much like they learn to walk and talk. They are not born with all the visual abilities they need in life. The ability to focus their eyes, move them accurately, and use them together as a team must be learned. Also, they need to learn how to use the visual information the eyes send to their brain in order to understand the world around them and interact with it appropriately. Vision, and how the brain uses visual information, are learned skills.

From birth, babies begin exploring the wonders in the world with their eyes. Even before they learn to reach and grab with their hands or crawl and sit-up, their eyes are providing information and stimulation important for their development.

Healthy eyes and good vision play a critical role in how infants and children learn to see. Eye and vision problems in infants can cause developmental delays. It is important to detect any problems early to ensure babies have the opportunity to develop the visual abilities they need to grow and learn.
Parents play an important role in helping to assure their child’s eyes and vision can develop properly. Steps that any parent should take include:

- Watching for signs of eye and vision problems.
- Seeking professional eye care starting with the first comprehensive vision assessment at about 6 months of age.
- Helping their child develop his or her vision by engaging in age-appropriate activities.

**Steps in Infant Vision Development**

At birth, babies can’t see as well as older children or adults. Their eyes and visual system aren’t fully developed. But significant improvement occurs during the first few months of life. The following are some milestones to watch for in vision and child development. It is important to remember that not every child is the same and some may reach certain milestones at different ages.

**Birth to four months**

Up to about 3 months of age, babies' eyes do not focus on objects more than 8 to 10 inches from their faces.

- At birth, babies' vision is abuzz with all kinds of visual stimulation. While they may look intently at a highly contrasted target, babies have not yet developed the ability to easily tell the difference between two targets or move their eyes between the two images. Their primary focus is on objects 8 to 10 inches from their face or the distance to parent's face.
- During the first months of life, the eyes start working together and vision rapidly improves. Eye-hand coordination begins to develop as the infant starts tracking moving objects with his or her eyes and reaching for them. By eight weeks, babies begin to more easily focus their eyes on the faces of a parent or other person near them.
- For the first two months of life, an infant's eyes are not well coordinated and may appear to wander or to be crossed. This is usually normal. However, if an eye appears to turn in or out constantly, an evaluation is warranted.
- Babies should begin to follow moving objects with their eyes and reach for things at around three months of age.

**Five to eight months**

- During these months, control of eye movements and eye-body coordination skills continue to improve.
- Depth perception, which is the ability to judge if objects are nearer or farther away than other objects, is not present at birth. It is not until around the fifth month that the eyes are capable of working together to form a three-dimensional view of the world and begin to see in depth.
- Although an infant's color vision is not as sensitive as an adult's, it is generally believed that babies have good color vision by five months of age.
- Most babies start crawling at about 8 months old, which helps further develop eye-hand-foot-body coordination. Early walkers who did minimal crawling may not learn to use their eyes together as well as babies who crawl a lot.

**Nine to twelve months**

By the age of nine to twelve months, babies should be using their eyes and hands together.

- At around 9 months of age, babies begin to pull themselves up to a standing position. By 10 months of age, a baby should be able to grasp objects with thumb and forefinger.
- By twelve months of age, most babies will be crawling and trying to walk. Parents should encourage crawling rather than early walking to help the child develop better eye-hand coordination.
- Babies can now judge distances fairly well and throw things with precision.

**One to two years old**

- By two years of age, a child's eye-hand coordination and depth perception should be well developed.
- Children this age are highly interested in exploring their environment and in looking and listening. They recognize familiar objects and pictures in books and can scribble with crayon or pencil.
AUDITORY DEVELOPMENT:

Some partial description is possible though. Sound waves travel down the ear canal in the form of compression pressure waves. These pressure waves induce deflection of the eardrum, and the various structures attached to it. Part of this structure is coupled to the inner ear in a way which seems to produce an outward deflection in reaction to an inward pressure force. The inner ear is configured as a spiral with two chambers. One of the chambers is connected to the eardrum through the mechanism described above, while the other is in acoustic contact with the eardrum. The apparent result of all of this complexity is the development of an oscillating force between the chambers of the inner ear.

The inner ear is a seashell-like spiral structure, in which the two chambers are separated by a thin diaphragm impregnated with rapid adapting mechanoreceptors. Acoustic signals produce oscillations in this diaphragm. One effect of the shape of the spiral diaphragm is that the resonant frequency is a function of position along the spiral. As a result, any particular acoustic signal frequency will produce a mechanical oscillation in the inner ear at a particular physical location. In this way, the inner ear acts as an acoustic spectrum analyzer, with individual mechanoreceptors configured for detection of particular audio frequencies. The central nervous system receives all of these signals and processes them into recognizable patterns.

The semicircular canals are three fluid filled ring-like structures with hairs that are sensitive to motion of the fluid. A rotational acceleration will be detected by the canals, making them useful for maintaining balance. The three canals are oriented orthogonally to one another, providing information about all three axes. It is rather impressive to realize that humans are walking around with a couple of 3-axis rotational accelerometers in their heads whose output is automatically processed by the brain to provide information about any rotational accelerations that are experienced.

This mechanical system is capable of reasonable resolution for audio signals. Experiments have shown that particular mechanoreceptors are sensitive to audio frequencies in a 10-20% band around their primary peak. Clearly, the nervous system has acquired substantial post-processing because humans are capable of resolving tones to a much higher degree of accuracy (<1%).

One interesting experiment to perform is to study the capability for spatial location of signal sources. With your eyes closed in a quiet location, concentrate on the location of particular signals. It is best if you can have some new signal produced in random locations. In class, I ask everyone to close their eyes, and I sneak to some new location, and then say something. Without opening their eyes, I ask the class to point in my direction. Remarkably, the class is accurate to within a couple of degrees.

Infants can hear even in womb. They can localize sound and know the direction of where it's coming from. However, they are less sensitive to soft sound and are more attentive to female voice. Infants also can recognize mother's voice soon after birth, recognize rhythm of story read before birth and source of sound.