Unit 8
Language, Cognition & Intelligence

LEARNING OUTCOME
At the end of this topic you will learn about:

1. Explain the brain mechanisms related to lateralization of language, speech production and comprehension.
2. Describe Broca's aphasia and the three major speech deficits that result from damage to Broca's area: agrammatism, anomia, and articulation difficulties.
3. Describe the symptoms of Wernicke's aphasia, pure word deafness, and transcortical sensory aphasia and explain how they are related.
4. Discuss the brain mechanisms that underlie our ability to understand the meaning of words and to express our own thoughts and perceptions in words.
5. Describe the symptoms of conduction aphasia and anomic aphasia, including aphasia in deaf people.
6. Describe pure alexia and explain why this disorder is caused by damage to twolanguages in the bilingual brain and describe the use of prosody in communication.
7. Describe whole-word and phonetic reading and discuss five categories of acquired dyslexia's.
8. Explain the relation between speaking and writing and describe the symptoms of phonological dysgraphia, orthographic dysgraphia and semantic (direct) dysgraphia.
9. Describe research on the neurological basis of developmental dyslexias.
10. Explain the relationship between the concepts of language, cognition and intelligence.
8.1.1 Lateralization of language

A longitudinal fissure separates the human brain into two, distinct cerebral hemispheres connected by the corpus callosum. The sides resemble each other. Each hemisphere's structure is mirrored by the other side. Yet, despite the strong similarities, the functions of each cortical hemisphere are different.

Verbal behavior is a laterized function. Language functions such as grammar and vocabulary often are lateralized to the left hemisphere of the brain. Most language disturbances occur after a damage to the left side of the brain. For example, dyscalculia and dyslexia are neurological syndrome associated with damage to the left temporo-parietal junction.

Although the circuits that are primarily involved in speech comprehension and production are located in one hemisphere, it would be a mistake to conclude that the other hemisphere has no role in speech. For example, holistic reasoning language functions, such as intonation and accentuation often are lateralized to the right hemisphere of the brain.

Figure 8.2: The location of the primary speech areas of the brain.
8.1.2 Speech Production

Speech consists of the mechanical processes required for vocalization, such as articulation and phonation. Language is the set of arbitrary symbols used for communication, often in the form of words strung together by syntactical rules.

**Broca’s area:** A region located anteriorly in the left hemisphere in the left frontal lobe operculum. It is responsible for production of words and sentences. This area is named after Paul Broca (in 1861).

**Paul Broca:** Among the first scientists to demonstrate the existence of localized functions in the cerebral cortex; concluded that the site of damage was the part of the brain responsible for speech production.

![Figure 8.1: An average plot of PET scans of regional cerebral blood flow, superimposed on an MRI scan, taken while the subjects were reading words aloud. Note that the activation includes subcortical regions as well as the cerebral cortex of Broca’s area. Also note that left and right are reversed.](image)

![Figure 8.3: The insular cortex, normally hidden behind the rostral temporal lobe.](image)
8.1.3 Speech Comprehension

Wernicke’s area

A region located posteriorly in the left hemisphere in the superior temporal gyrus. It is responsible for comprehension of spoken words and sentences. It is also involved in formulation of coherent speech and written language. This area is named after Carl Wernicke (in 1874). Wernicke’s work initiated the study of this brain area and its role in language. It is particularly known to be involved in the understanding and comprehension of spoken language.

The Wernicke-Geschwind model of language

Wernicke created an early neurological model of language, that later was revived by Norman Geschwind. The model is known as the Wernicke-Geschwind model.

For listening to and understanding spoken words, the sounds of the words are sent through the auditory pathways to area 41, which is the primary auditory cortex (Heschl’s gyrus). From there, they continue to Wernicke’s area, where the meaning of the words is extracted. In order to speak, the meanings of words are sent from Wernicke’s area via the arcuate fasciculus to Broca’s area, where morphemes are assembled.

The model proposes that Broca’s area holds a representation for articulating words. Instructions for speech are sent from Broca’s area to the facial area of the motor cortex, and from there instructions are sent to facial motor neurons in the brainstem, which relay movement orders to facial muscles.

In order to read, information concerning the written text is sent from visual areas 17, 18, and 19 to the angular gyrus (area 39) and from there to Wernicke’s area, for silent reading or, together with Broca’s area, for reading out loud.

This model is now obsolete. The neural organization of language is more complex than the Wernicke-Geschwind model of language suggests. The localization of speech in Broca’s area is one of the weakest points of this model.

Nevertheless it has been very useful in directing research and organizing research results, because it is based on the idea that language consists of two basic functions: comprehension, which is a sensory/perceptual function, and speaking, which is a motor function.
Aphasia is a loss of the ability to produce and/or comprehend language, due to injury to brain areas specialized for these functions. It is not a result of deficits in sensory, intellect, or psychiatric functioning, nor due to muscle weakness or a cognitive disorder. Depending on the area and extent of the damage, someone suffering from aphasia may be able to speak but not write, or vice versa, or display any of a wide variety of other deficiencies in language comprehension and production, such as being able to sing but not speak. Aphasia may co-occur with speech disorders such as dysarthria or apraxia of speech, which also result from brain damage.
**Broca's aphasia**

An impairment in the physical ability to produce speech sounds, or, in extreme cases, an inability to speak at all. A form of aphasia characterized by agrammatism, anomia, and extreme difficulty in speech articulation.

**Apraxia of speech:** Impairment in the ability to program movements of the tongue, lips, and throat required to produce the proper sequence of speech sounds.

**Wernicke's aphasia**

Wernicke found that damage to the left posterior, superior temporal gyrus (Wernicke's area) caused language comprehension deficits rather than speech production deficits. This syndrome is known as Wernicke's aphasia.

It is an aphasia in which the person's spoken language is fluent, but the content is either vague or incomprehensible to the listener. This condition results in an **impairment of language comprehension and in speech** that has a natural-sounding rhythm and a relatively normal syntax, but otherwise has no recognisable meaning (a condition sometimes called fluent or jargon aphasia).

**Auditory aphasia**

A **Pure Word Deafness** is caused by bilateral damage to the posterior superior temporal lobes or disruption of connections between these areas. It exhibits itself as inability to comprehend the meaning of speech, but (in most cases) still being able to hear, speak, read, and write. It is caused by damage to Wernicke’s area or disruption of auditory input to this region.

Auditory aphasia is often associated with lesions to the left superior temporal lobe. However, no such unilateral case has yet been documented without damage to the white matter tract connecting superior temporal lobes bilaterally or bilateral damage to the superior temporal lobe.

These facts, combined with the existence of cases of damage to these white matter tracts without detectable cortical damage, and with cases of pure word deafness resulting enlargement of the third ventricle alone suggest that the disorder results from **damage to the left-right superior temporal circuit** rather than the superior temporal area on one hemisphere or another.

**Temporal association areas:** House memories and are involved in the interpretation of auditory stimuli; there is a special association area where familiar melodies are stored.

**Cerebrovascular accident:** A stroke or brain damage caused by occlusion or rupture of a blood vessel in the brain.

**Function word:** A preposition, article, or other word that conveys little of the meaning of a sentence but is important in specifying its grammatical structure.
Content word: A noun, verb, adjective, or adverb that conveys meaning.

Agrammatism: One of the usual symptoms of Broca’s aphasia; a difficulty in comprehending or properly employing grammatical devices, such as verb endings and word order.

Anomia: Difficulty finding (remembering) the appropriate word to describe an object, action, or attribute; one of the symptoms of aphasia.

A critical location for the control of speech articulation is the left precentral gyrus of the insula. The insular cortex is located on the lateral wall of the cerebral hemisphere behind the anterior temporal wall.

Figure 8.4: Results of PET scans indicating regions of the superior temporal lobe that respond to speech sounds. Red: Regions that responded to phonetic information. Yellow: Region that responded to only intelligible speech.

Figure 8.5: The brain damage that causes pure word deafness.
**Transcortical sensory aphasia:** A speech disorder in which a person has difficulty comprehending speech and producing meaningful spontaneous speech but can repeat speech; caused by damage to the region of the brain posterior to Wernicke’s area.

**Arcuate fasciculus:** A bundle of axons that connects Wernicke’s area with Broca’s area; damage to these axons causes conduction aphasia.

**Autotopagnosia:** Inability to name body parts or to identify body parts that another person names.

**Conduction aphasia:** An aphasia characterized by the inability to repeat words that are heard but the ability to speak normally and comprehend the speech of others.

**Anomic aphasia:** Aphasia characterized by difficulty in finding words. The speech of patients with this aphasia is fluent and grammatical, and their comprehension is excellent.

**Circumlocution:** A strategy by which people with anomic aphasia find alternative ways to say something when they are unable to think of the most appropriate word.
8.1.4 Prosody: Rhythm, Tone and Emphasis in Speech.

Prosody: the use of changes in intonation and emphasis to convey meaning in speech besides that specified by the particular words; an important means of communication of emotion.

8.1.5 Language

A language is a means of communicating thoughts and feelings using a system of socially shared but arbitrary symbols (sounds signs or written symbols) arranged according to rules of grammar.

It is a system of visual, auditory, or tactile symbols of communication and the rules used to manipulate them. It can also refer to the use of such systems as a general phenomenon.

Language is considered to be an exclusively human mode of communication. Although other animals make use of quite sophisticated communicative systems, none of these are known to make use of all of the properties that linguists use to define language.

The Structure of Language

- **Psycholinguistics**: the study of how language is acquired, produced, and used and how the sounds and symbols of language are translated into meaning.
- **Phonemes**: the smallest units of sound in a spoken language.
- **Morphemes**: are the smallest units of meaning in language.
- **Syntax**: the aspect of grammar that specifies the rules for arranging and combining words to form phrases and sentences.
- **Semantics**: the meaning or study of meaning derived from morphemes, words, and sentences.
- **Pragmatics**: the patterns of intonation and social roles associated with a language.

Language and Thinking

Linguistic Relativity Hypothesis

The notion that the language a person speaks largely determines the nature of that person’s thoughts:

- Eskimos have 3 words for snow so they think differently about it than languages that have only 1 word for snow
- Rosch color study of Americans and Dani demonstrated no difference in discriminating, thinking, or remembering based on number of words for colors.

Thought does influence and is influenced by language and reflects cultural differences. The use of the word “he” for both males and females. Studies confirm the word “he” is interpreted heavily in favor of males
Learning a Second Language

A second language (L2) is any language learned after the first language or mother tongue (L1). Some languages are used primarily as second languages or lingua francas. Most people around the world speak two or more languages.

Bilingualism is associated with better metalinguistic skills and the capacity to think about language but decreased efficiency in memory tasks involving words. Most bilinguals develop compensatory strategies for word memory tasks but respond more slowly.

According to some researchers, the defining difference between a first language (L1) and a second language (L2) is the age at which the language was learned. There is no age limit on ability to learn a new language, but early starters have increased proficiency and accent. Hyltenstam & Abrahamsson (2003) stated that after childhood, in general, it becomes more and more difficult to acquire native-like-ness.

The earlier you learn second language the better you get at the language. A second language makes you reexamine your native language, its spelling rules, grammar structure, and vocabulary. Growing up in a bilingual home provides distinct advantages in adolescence and adulthood.

It is quite possible that the first language a person learns may no longer be their dominant language, that is, the one he or she uses most or the one with which he or she is most comfortable in.

ACTIVITY 8.1

ii) Examine the benefits of learning a second language.

9.2 READING AND WRITING

Reading is the cognitive process of deriving meaning from written or printed text. It is a means of language acquisition, of communication, and of sharing information and ideas. Effective readers use decoding skills (to translate printed text into the sounds of language), use morpheme, semantics, syntax and context cues to identify the meaning of unknown words, activate prior knowledge, use comprehension, and demonstrate fluency during reading.
Types of reading

- **Whole-word reading**: Reading by recognizing a word as a whole; sight reading.
- **Phonetic reading**: Reading by decoding the phonetic significance of letter strings; sound reading.

**Writing** is the representation of language in a textual medium through the use of a set of signs or symbols (known as a writing system). It is distinguished from illustration, such as cave drawing and painting, and the recording of language via a non-textual medium such as audio recording.

### 9.2.3 Toward an Understanding of Reading Disorders

**Dyslexia** is a disorder that manifests primarily as a difficulty with written language, particularly with reading and spelling. It is separate and distinct from reading difficulties resulting from other causes, such as a non-neurological deficiency with vision or hearing, or from poor or inadequate reading instruction.

Evidence suggests that dyslexia results from differences in how the brain processes written and/or verbal language. Although dyslexia is the result of a neurological difference, it is not an intellectual disability. Dyslexia occurs at all levels of intelligence; sub-average, average, above average, and highly gifted.

According to the findings of a University of Hong Kong study, dyslexia affects different structural parts of children’s brains depending on the language they read. The study focused on comparing children that were raised reading English and children raised reading Chinese. Using MRI technology researchers found that the children reading English used a different part of the brain than those reading Chinese. Researchers were surprised by this discovery and hope that the findings will help lead them to any neurobiological cause for dyslexia.

### Relation to aphasia

**Pure alexia**: Loss of the ability to read without the loss of the ability to write; produced by brain damage. Also known as pure word blindness or alexia without agraphia.

### Types of dyslexia

**Surface dyslexia**: A reading disorder in which a person can read words phonetically but has difficulty reading irregularly spelled words by whole-word reading.

**Phonological dyslexia**: A reading disorder in which a person can read familiar words but has difficulty reading unfamiliar words or pronounceable nonwords.
**Direct dyslexia:** A language disorder caused by brain damage in which the person can read words aloud without understanding them.

Many methods and measuring instruments have so far been employed to either prove or disprove that dyslexia has a biological basis, ranging from autopsies on the brains of deceased dyslexics, to advanced technological tools such as the computerized axial tomography (CAT) scan, magnetic resonance (MR) imaging, functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and single photon emission computerized tomography (SPECT).

**Why Some Dyslexics Read ‘b’ when it is ‘d’**

The word “dyslexia” means “difficulty with words or language.” A telltale sign of dyslexia is reversals. People with this kind of problem often confuse letters like b and d, either when reading or when writing, or they sometimes read (or write) words like “rat” for “tar,” or “won” for “now.”

A popular theory is that reversals are caused by a neurological deficit. In other words, there is something wrong inside the brain of the person. While many factors can contribute to dyslexia, one should not overlook the principle that perception of anything depends on our past experiences.

Before one can read or learn anything, one has to become aware of it through one of the senses. Usually one has to hear or see it. In other words, perception must take place. Subsequently one has to interpret whatever one has seen or heard. In essence then, perception means interpretation. Of course, lack of experience may cause a person to misinterpret what he has seen or heard.

In order to be able to interpret size constancy, one must have had enough exposure to wide vistas and distant horizons. In the same way, in order to be able to interpret position in space, one must have had enough exposure to relevant experiences. Relevant experiences include the ability to distinguish left and right and the ability to cross the midline.

The human body consists of two halves, a left side and a right side. The human brain also has two halves, which are connected by the corpus callosum. Mindful of the wise words of Immanuel Kant that man does not see things as they are but as he is, it is inevitable that a person will interpret everything in terms of his own sidedness.

A child or adult, who has not learned to interpret correctly in terms of his sidedness yet, who has not learned to distinguish properly between left and right, will inevitably experience problems when he finds himself in a situation where he is expected to interpret sidedness.

**Direct dyslexia:** A language disorder caused by brain damage in which the person can read words aloud without understanding them.
9.2.3 Toward an Understanding of Writing Disorders

Dysgraphia (or agraphia) is a deficiency in the ability to write, regardless of the ability to read, not due to intellectual impairment. People with dysgraphia often can write on some level, but often lack co-ordination, and may find other fine motor tasks such as tying shoes difficult.

Dysgraphia often does not affect all fine motor skills. People with dysgraphia can also lack basic spelling skills (having difficulties with p,q,b,d), and often will write the wrong word when trying to formulate thoughts (on paper).

In children, the disorder generally emerges when they are first introduced to writing. They make inappropriately sized and spaced letters, or write wrong or misspelled words despite thorough instruction. Children with the disorder may have other learning disabilities; however, they usually have no social or other academic problems.

Cases of dysgraphia in adults generally occur after some neurological trauma or it might be diagnosed in a person with Tourette syndrome, ADHD or an autism spectrum disorder such as Asperger's. The DSM IV identifies dysgraphia as a "Disorder of Written Expression" as "writing skills (that) ...are substantially below those expected given the person's ...age, measured intelligence, and age-appropriate education."

Types of dysgraphia

**Dyslexic dysgraphia:** With dyslexic dysgraphia, spontaneously written work is illegible, copied work is fairly good, and spelling is bad. Finger tapping speed (a method for identifying fine motor problems) is normal, indicating the deficit does not likely stem from cerebellar damage. A Dyslexic Dysgraphia does not necessarily have dyslexia. (dyslexia and dysgraphia appear to be unrelated)

**Phonological dysgraphia:** A writing disorder in which the person cannot sound out words and write them phonologically.

**Motor dysgraphia:** Dysgraphia due to motor clumsiness has illegible spontaneously written work, illegible copied work, normal spelling, and abnormal finger tapping speed.

**Spatial dysgraphia:** Dysgraphia due to a defect in the understanding of space has illegible spontaneously written work, illegible copied work, normal spelling, but normal tapping speed. Some children may have a combination of any two or all three of these. Symptoms in actuality may vary in presentation from what is listed here

**Orthographic dysgraphia:** A writing disorder in which the person can spell regularly spelled words but not irregularly spelled ones.

**Symptoms of dysgraphia**
A mixture of upper/lower case letters, irregular letter sizes and shapes, unfinished letters, struggle to use writing as a communications tool, odd writing grip, many spelling mistakes (some times), decreased or increased speed of writing and copying, talks to self while writing, and general illegibility.
Developmental dyslexia: A reading difficulty in a person of normal intelligence and perceptual ability; of genetic origin or caused by prenatal or perinatal factors.

The mental processes that are involved in acquiring, storing, retrieving, and using information include sensation, perception, imagery, concept formation, reasoning, decision making, problem solving, and language.

9.3 COGNITION

Imagery: The representation in the mind of a sensory experience; visual, auditory, gustatory, motor, olfactory, or tactile. Useful in learning or maintaining motor skills; same brain areas used when rehearsing or performing a skill.

Concept: A mental category used to represent a class or group of objects, people, organizations, events, situations, or relations that share common characteristics or attributes. Concepts help us order our world and to think and communicate with speed and efficiency.

Formal Concept: A concept clearly defined by a set of rules, a formal definition, or a classification system. Also known as an artificial concept.

Natural Concept: Acquired through everyday perceptions and experiences.

Prototype: An example that embodies the most common and typical features of a concept. Usually fits close to a natural concept.

Exemplars: The individual instances, or examples, of a concept that are stored in memory from personal experience.

9.3.1 Making Decisions: Choosing among Alternatives

Representativeness Heuristic: A prototype that guides your expectations.

Decision Making: The process of considering alternative and choosing among them.

Bounded Rationality: Boundaries or limitations around the decision making process prevent it from being entirely logical.

Elimination by Aspects: A decision-making approach in which alternatives are evaluated against criteria that have been ranked according to importance. Usual ranking, from most important to least important.

Heuristics: A rule of thumb that is derived from experience and used in decision-making and problem solving, even though there is no guarantee of its accuracy or usefulness.
Availability Heuristic: A cognitive rule of thumb that says that the probability of an event or the importance assigned to it is based on its availability in memory.

Representative Heuristic: A thinking strategy based on how closely a new object or situation is judged to resemble or match an existing prototype of that object or situation.

Recognition Heuristic: A strategy in which decision-making stops as soon as a factor that moves one toward a decision has been recognized.

Framing: The way information is presented so as to emphasize either a potential gain or loss as the outcome. Positive framing leads people to prefer an option.

Intuition: Rapidly formed judgments based on “gut feelings” or “instincts.” Usually based on a mental representation of the gist of a body of information rather than on its factual details. Can lead to errors in reasoning about decisions.

9.3.2 Problem Solving: Finding Paths to Desired Goals

Problem-Solving: Thoughts and actions required to achieve a desired goal that is not readily attainable.

Analogy Heuristic: Applies a solution that solved a problem in the past to a current problem that shares many features with the past problem.

Working Backward: A heuristic strategy in which a person discovers the steps needed to solve a problem by defining the desired goal and working backward to the current condition.

Means-end analysis: The current position is compared with a desired goal, and a series of steps is formulated and then taken to close the gap between the two.

Algorithm: A systematic, step-by-step procedure that guarantees a solution to a problem of a certain type if applied appropriately and executed properly.

Impediments to Problem-Solving

Functional fixedness: The failure to use familiar objects in novel ways to solve problems because of a tendency to view objects only in terms of their customary functions.

Mental set: The tendency to apply a familiar strategy to the solution of a problem without carefully considering the special requirements of that problem.

Artificial Intelligence

The programming of computer systems to simulate human thinking in solving problems and in making judgments and decisions.

Artificial Neural Networks: Computer systems that are intended to mimic human brains.
Expert Systems: Computer programs designed to carry out highly specific functions within a limited domain; work best when an assistant to a human.

### 9.4 INTELLIGENCE

An individual’s ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, and to overcome obstacles through mental effort.

**Intelligence** is a term used to describe a property of the mind that include many related abilities, such as the capacities to reason, to plan, to solve problems, to think abstractly, to comprehend ideas, to use language, and to learn.

There are several ways to define intelligence. In some cases, intelligence may include traits such as creativity, personality, character, knowledge, or wisdom. However, some psychologists prefer not to include these traits in the definition of intelligence.

### 9.4.1 Intelligence: Contrasting Views of its Nature

**Intelligence: Unitary of Multifaceted?**

Charles Spearman (1924) is credited with having developed the concept of $g$. $g$ can be derived as the principal factor using the mathematical method of factor analysis. One common view is that these abilities are hierarchically arranged with $g$ at the vertex (or top, overlaying all other cognitive abilities). $g$ itself is sometimes considered to be a two part construct, $g_F$ and $g_C$, which stand for fluid and crystallized intelligence.

1. **$g$ Factor**
   - Spearman’s term for a general intellectual ability that underlies all mental operations to some degree. People who are bright in one area tend to be bright in others
2. **$s$ factor**
   - Specific intellectual abilities. Spearman’s influence seen in intelligence tests such as Stanford-Binet that yield one IQ score to indicate the level of general intelligence

**ACTIVITY**

a) Describe the various strategies for making decisions.
b) Explain the differences among the various problem solving strategies.
Primary Mental Abilities: Thurstone’s seven relatively distinct capabilities that singly or in combination are involved in all intellectual activities.

- Verbal comprehension
- Numerical ability
- Spatial relations
- Perceptual speed
- Word fluency
- Memory
- Reasoning

All intellectual activities involve one or more of these areas. He believes a single IQ score obscures more than it reveals. He suggests a profile indicating strength and weak areas.

Gardner’s Study’s of Intelligence

Howard Gardner’s theory argues that intelligence, as it is traditionally defined, does not adequately cover the wide variety of abilities humans display. Gardner developed theory by studying patients with different types of brain damage affecting some forms of intelligence but left others intact. He studied savant syndrome, a combination of mental retardation and unusual talent and abilities.

In his conception, a child who masters the multiplication table easily is not necessarily more intelligent overall than a child who struggles to do so. The second child may be stronger in another kind of intelligence. Therefore, he/she may best learn the given material through a different approach, may excel in a field outside of mathematics, or may even be looking through the multiplication learning process at a deeper level that hides a potentially higher mathematical intelligence than in the one who memorizes the concept easily.

Figure 8.6: Gardner’s components of intelligence.
He believes all forms of intelligence are equally important and that cultures assign varying degrees of importance to types of intelligence. Various abilities and skills have been valued differently in other cultures and periods of history. The theory suggests that, rather than relying on a uniform curriculum, schools should offer "individual-centered education", with curriculum tailored to the needs of each child.

Gardner’s theory of intelligence added such components as musical intelligence and bodily-kinesthetic intelligence as well as interpersonal intelligence.

Sternberg’s Triarchic Theory of Intelligence

Many descriptions of intelligence focus on mental abilities such as vocabulary, comprehension, memory and problem-solving that can be measured through intelligence tests. This reflects the tendency of psychologists to develop their understanding of intelligence by observing behaviour believed to be associated with intelligence. Sternberg believes that this focus on specific types of measurable mental abilities is too narrow. He believes that studying intelligence in this way leads to an understanding of only one part of intelligence and that this part is only seen in people who are 'school smart' or 'book smart'.

According to Sternberg, there are actually three basic types of human intelligence:

1. Componential or analytical intelligence – the ability to complete academic, problem-solving tasks, such as those used in traditional intelligence tests. These types of tasks usually present well-defined problems that have only a single correct answer.

2. Experiential or creative intelligence – the ability to successfully deal with new and unusual situations by drawing on existing knowledge and skills.

3. Contextual or practical intelligence – the ability to adapt to everyday life by drawing on existing knowledge and skills. Practical intelligence is involved when dealing with everyday personal or practical problems. It may also be involved when dealing with new and unusual situations in everyday life.

Figure 8.7: Components of Sternberg’s Triarchic Theory.
Sternberg argues that IQ-test performance and real-world success are based on two different types of knowledge:

- **Formal Academic Knowledge**: Knowledge acquired in school.
- **Tacit Knowledge**: Action oriented and acquired without direct help from others.

Educators use teaching methods designed to tap into all three types of intelligence that is effective with low achievers in school. Teachers need to emphasize the practical relevance of formal academic knowledge and help students apply it to real-world problems.

### 9.4.2 Measuring Intelligence

**Binet-Simon Test: The first IQ Test**

It was developed to aid schools in France and used a score called mental age. Based on number of items a child got right compared with the number right of various ages.

If number right equaled the average of 8 year olds was assigned the mental age of 8 regardless of chronological age. However there were flaws with scale, a 4 year old with mental age of 2 was more retarded than a 10 year old with a mental age of 12.

**Stanford-Binet Intelligence Scale**

An individually administered IQ test for ages 2-23 with an overall IQ score.

Four subscales;
- Verbal reasoning
- Quantitative reasoning
- Abstract visual reasoning
- Short term memory

This scale could not be applied to adults.

**Intelligence quotient**

In 1912, a German psychologist William Stern proposed a simple formula for calculating an index of children’s intelligence, based on intelligence tests such as those developed by Alfred Binet and Simon Theodore. Terman perfected Intelligence quotient and published Binet-Simon Scale, with items adapted for American children.

**Norms**: Standards based on the range of test scores of a large group of people who are selected to provide the bases of comparison for those who take the test later.

**Intelligence Quotient (IQ)**: An index of intelligence, originally derived by dividing mental age by chronological age and then multiplying by 100, but now derived by comparing an individual’s score with the scores of others of the same age.
Wechsler Adult Intelligence Scale (WAIS-R)

The first successful individual intelligence test for adults and the most widely used psychological tests. Scores are based on how much an individual deviates from the average score for adults not mental and chronological ages.

It compares verbal and performance (nonverbal) subtests with the overall IQ score and IQ score for each subtest area.

**Verbal:**
- Information
- Digit span
- Vocabulary
- Arithmetic
- Comprehension
- Similarities

**Performance:**
- Picture completion
- Picture arrangement
- Block design
- Object assembly
- Digit symbol

Wechsler Intelligence Scale for Children third edition published for ages 6-17. Wechsler Preschool and Primary Scale of Intelligence published for children ages 4-6 ½. Administered to one person at a time by a psychologist or educational diagnostician.

**Group intelligence tests**

Are administered to large numbers of people in a short period of time.
- California Test of Mental Maturity
- Cognitive Abilities Test
- Otis-Lennon Mental Ability Test

**Culture-Fair Test Example Item**

The Range of Intelligence, a bell curve AKA normal curve; the majority of scores cluster around the mean. The further away from the mean score the fewer there are; less than 2% are classified as genius or mentally retarded.

**Mental Retardation:** Subnormal intelligence reflected by an IQ below 70 and by adaptive functioning severely deficient for one’s age:
- Mildly retarded: IQ 55-70
- Moderately retarded: IQ 40-55
- Severely retarded: IQ 25-40
- Profoundly retarded: IQ below 25
Inclusion or Mainstreaming
Educating mentally retarded students in regular rather than special schools and placing them in regular classes for part of the day or having special classrooms in regular schools. This relies heavily on behavior modification techniques.

The IQ Controversy
By what degree can variations in intelligence be accounted for by genetics, biology, and inheritance?

Nature-Nurture controversy
The debate over whether intelligence and other traits are primarily the result of heredity or environment; Sir Francis Galton initiated the debate and concluded intelligence was inherited. Environmentalists insists that intelligence is influenced primarily by one’s environment, the results of nurturing by parents, teachers, friends, etc.
**Heritability**

An index of the degree to which a characteristic is estimated to be influenced by heredity. Some research using the adoption study method supports that genes/heritability influence IQ scores.

![Figure 8.9: The correlation between genetics and IQ scores](image)

**Enriched Environment**

IQ scores can be modified with an enriched environment. These advantages persist into adulthood. The earlier children are adopted, the higher their IQ’s. Infants and children of low IQ, low income mothers who attend education programs scored higher on IQ tests.

**Race and IQ**

Historically Blacks score about 15 points lower than whites on IQ tests; 1969 Jensen attributed the IQ gap to genetic differences and that environment would not change test scores.

Mid 1990s Hernstein & Murray - lower IQ scores are 60% genetic and 40% environmental due to social ills of modern society (poverty, welfare dependency, crime, and illegitimacy).

Ramey and others suggest that racial differences are more likely due to results of poverty and lack of access to educational opportunities. Dynamic assessment supports environmental effects on IQ.
Examinees are taught the goal and format of each IQ subtest before testing. Children from middle class already have exposure to these concepts and thus demonstrate competency.

**Stereotype threat:** Minority individuals assume inferiority and testing becomes self-fulfilling prophecy as they disengage

**Gender Differences**

Cognitive Abilities

The differences that exists within the genders are greater than the difference between the genders. Even though gender differences in cognitive abilities are generally small, there tends to be more variation in such abilities among males than among females.

- Girls from 18 months on have a larger vocabulary
- Females outperformed males in reading and writing
- Males out performed females in science and math
- Males were nearer the bottom in writing and reading comprehension

The factors affecting this may be:

- Hormonal differences may contribute to boys higher math scores
- Social differences, a greater contributor to math score differences
- Parental expectations – boys are expected to do better in math
- Boys who do well at math are considered ‘talented’; girls who do well at math are considered ‘hard workers’.

Parent’s beliefs about their children’s talents by age 6 predict the child’s belief about their own abilities at age 17; this belief is smaller today than in previous years.

**Spatial tasks** - Males tend to perform better on some than females. Spatial abilities may be enhanced by prenatal exposure to androgen; high blood levels of testosterone are associated with good performance on spatial tasks.

## 9.4.3 Creativity

The ability to produce original, appropriate, and valuable ideas and/or solutions to problems.

There is a weak to moderate correlation between creativity and IQ; high intelligence does not necessarily mean high creativity.

Genuine creativity rarely appears in sudden flashes. Four stages in creative problem-solving process:

1. Preparation-searching for information to help solve the problem
2. Incubation-letting the problem “sit” while the relevant information is digested
3. Illumination-being suddenly struck by the right solution
4. Translation-transforming the insight into useful action
Divergent Thinking

The ability to produce multiple ideas, answers, or solutions to a problem for which there is no agreed-on solution.

Is novel, original, and involves the synthesis of an unusual association of ideas; is flexible, switching quickly and smoothly from one stream of thought or set of ideas to another; it requires fluency, the ability to formulate an abundance of ideas.

High degree of divergent thinking demonstrated by creative thinkers; both brain hemispheres highly active during creative thinking.

Convergent Thinking

The type of mental activity measured by IQ and achievement tests and consists of solving precisely defined, logical problems for which there is a known correct answer.

Demonstrated by greater activity in the left frontal cortex. Highly creative thinking is associated with activity in both hemispheres, but with significantly higher levels in the right hemisphere (a). During thinking that is not creative (b) activity is largely restricted to the left hemisphere.

Measuring individual differences in creativity

Tests emphasize original approaches to arriving at solutions for open ended problems or for producing artistic works

Unusual Uses Test
Asks respondents to name as many uses as possible for an ordinary object (such as a brick)

Consequences Test
Asks test takers to list as many consequences as they can that would be likely to follow some basic change in the world (gravity being reduced by 50%)

Remote Associations Test
The essences of creativity is the thinker’s ability to fit together ideas that to the noncreative thinker might appear remote or unrelated.

ACTIVITY 8.3

(a) Explain the theories of intelligence proposed by Spearman, Thurstone, Gardner, and Sternberg.

(b) What does the term "bell curve" mean when applied to IQ test scores?
1. The ability to mentally represent a sensory experience is ________________.

2. Furniture, trees, students and weddings are all examples of and ________________.

3. Rules of thumb that are derived from experiences and used in decision-making and problem solving because they usually work are:

4. The _______ is a thinking strategy in which the individual bases their decision upon how closely the situation matches an existing prototype.

5. Trial and error is an example of _________________.

6. _______ refers to the programming of computer systems to simulate human thinking in solving problems and in making judgments and decisions.

7. Research suggests the optimal time to learn a second language is in:

8. According to Spearman, intelligence is composed of a general ability which underlies all intellectual functions.

9. Instead of looking for underlying factors of intelligence, _______ proposed there are eight independent and equally important forms of intelligence.

10. The three types of intelligence proposed by Robert Sternberg are experiential, contextual and _________________.

11. The first successful intelligence test was the ________________.

12. Roughly about ______ of the population scores either above 130 or below 70 on the Wechsler intelligence scale.

13. Aphasia refers ________________.

14. Broca's area is in the ________________.

15. A specific pathological difficulty in reading is termed ________________.

16. William Stern developed a method for assessing similar degrees of retardation in children of different ages when he devised the ________________.

17. Apraxia is usually associated with ________________.

18. A systematic, step-by-step procedure that guarantees a solution to a problem of a certain type is called ________________.

19. Computer systems that are intended to mimic the human brain are called ________________.

20. The smallest units of sound in a spoken language are known as ________________. 
Suggested Text and References

Required Reading:


Suggested Readings


Suggested Web Sites

Sleep and Language
http://thalamus.wustl.edu/course/sleep.html

Dyslexia Web Resources
http://www.krgraphics.co.uk/texthelp/d_web.htm

Aphasia: Treatment, Prevention, and Cure
http://www.healthlink.com/A.html
Self-check

1. mental imagery
2. concepts
3. heuristics.
4. representativeness heuristic
5. problem solving
6. Artificial intelligence
7. childhood.
8. g factor.
9. Howard Gardner
10. componential.
11. Binet-Simon Test
12. 2%
13. generally to deficits in the ability to produce or comprehend language, or both.
14. left frontal lobe.
15. dyslexia.
16. intelligence quotient.
17. left-hemisphere lesions.
18. an algorithm.
20. phonemes.