I M.Sc. Psychology

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UNIT 3: MEMORY AND LANGUAGE

Memory is the faculty of the mind by which data or information is encoded, stored, and retrieved when needed. It is the retention of information over time for the purpose of influencing future action. If past events could not be remembered, it would be impossible for language, relationships, or personal identity to develop. Memory loss is usually described as forgetfulness or amnesia.

Memory is often understood as an informational processing system with explicit and implicit functioning that is made up of a sensory processor, short-term (or working) memory, and long-term memory. This can be related to the neuron. The sensory processor allows information from the outside world to be sensed in the form of chemical and physical stimuli and attended to various levels of focus and intent. Working memory serves as an encoding and retrieval processor. Information in the form of stimuli is encoded in accordance with explicit or implicit functions by the working memory processor. The working memory also retrieves information from previously stored material. Finally, the function of long-term memory is to store through various categorical models or systems.

Declarative, or explicit, memory is the conscious storage and recollection of data. Under declarative memory resides semantic and episodic memory. Semantic memory refers to memory that is encoded with specific meaning, while episodic memory refers to information that is encoded along a spatial and temporal plane. Declarative memory is usually the primary process thought of when referencing memory. Non-declarative, or implicit, memory is the unconscious storage and recollection of information. An example of a non-declarative process would be the unconscious learning or retrieval of information by way of procedural memory, or a priming phenomenon. Priming is the process of subliminally arousing specific responses from memory and shows that not all memory is consciously activated, whereas procedural memory is the slow and gradual learning of skills that often occurs without conscious attention to learning.

Sensory memory

Sensory memory holds information, derived from the senses, less than one second after an item is perceived. The ability to look at an item and remember what it looked like with just a split second of observation, or memorization, is the example of sensory memory. It is out of cognitive control and is an automatic response. With very short presentations, participants often report that they seem to "see" more than they can actually report. The first precise experiments exploring this form of sensory memory were conducted by George Sperling (1963) using the "partial report paradigm." Subjects were presented with a grid of 12 letters, arranged into three rows of four. After a brief presentation, subjects were then played either a high, medium or low tone, cuing them which of the rows to report. Based on these partial report experiments, Sperling was able to show that the capacity of sensory memory was approximately 12 items, but that it degraded very

quickly (within a few hundred milliseconds). Because this form of memory degrades so quickly, participants would see the display but be unable to report all of the items (12 in the "whole report" procedure) before they decayed. This type of memory cannot be prolonged via rehearsal.

Three types of sensory memories exist. Iconic memory is a fast decaying store of visual information, a type of sensory memory that briefly stores an image that has been perceived for a small duration. Echoic memory is a fast decaying store of auditory information, also a sensory memory that briefly stores sounds that have been perceived for short durations. Haptic memory is a type of sensory memory that represents a database for touch stimuli.

Short-term memory

Short-term memory is also known as **working memory**. Short-term memory allows recall for a period of several seconds to a minute without rehearsal. Its capacity, however, is very limited. Modern perspectives estimate the capacity of short-term memory to be lower, typically on the order of 4–5 items, or argue for a more flexible limit based on information instead of items. Memory capacity can be increased through a process called chunking. For example, in recalling a ten-digit telephone number, a person could chunk the digits into three groups: first, the area code (such as 123), then a three-digit chunk (456), and, last, a four-digit chunk (7890). This method of remembering telephone numbers is far more effective than attempting to remember a string of 10 digits; this is because we are able to chunk the information into meaningful groups of numbers. This is reflected in some countries' tendencies to display telephone numbers as several chunks of two to four numbers.

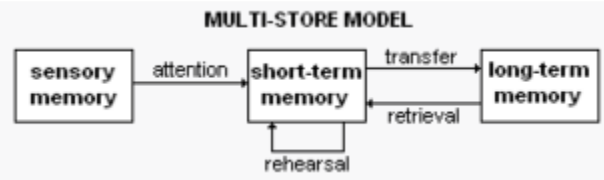
Long-term memory

The storage in sensory memory and short-term memory generally has a strictly limited capacity and duration, which means that information, is not retained indefinitely. By contrast, while the total capacity of long-term memory has yet to be established, it can store much larger quantities of information. Furthermore, it can store this information for a much longer duration, potentially for a whole life span. For example, given a random seven-digit number, one may remember it for only a few seconds before forgetting, suggesting it was stored in short-term memory. On the other hand, one can remember telephone numbers for many years through repetition; this information is said to be stored in long-term memory.

While short-term memory encodes information acoustically, long-term memory encodes it semantically: Baddeley (1966) discovered that, after 20 minutes, test subjects had the most difficulty recalling a collection of words that had similar meanings (e.g. big, large, great, huge) long-term. Another part of long-term memory is episodic memory, "which attempts to capture information such as 'what', 'when' and 'where'". With episodic memory, individuals are able to recall specific events such as birthday parties and weddings.

Short-term memory is supported by transient patterns of neuronal communication, dependent on regions of the frontal lobe (especially dorsolateral prefrontal cortex) and the parietal lobe. Long-term memory, on the other hand, is maintained by more stable and permanent changes in neural connections widely spread throughout the brain. The hippocampus is essential (for learning new information) to the consolidation of information from short-term to long-term memory, although it does not seem to store information itself. It was thought that without the hippocampus new memories were unable to be stored into long-term memory and that there would be a very short attention span, as first gleaned from patient Henry Molaison after what was thought to be the full removal of both his hippocampi. More recent examination of his brain, post-mortem, shows that the hippocampus was more intact than first thought, throwing theories drawn from the initial data into question. The hippocampus may be involved in changing neural connections for a period of three months or more after the initial learning.

Multi-store model



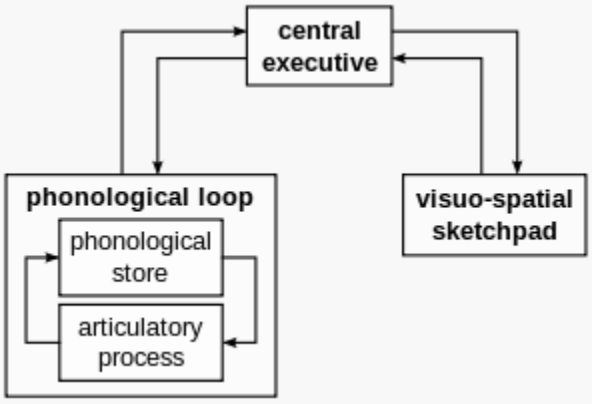
Multi-store model

The multi-store model (also known as Atkinson–Shiffrin memory model) was first described in 1968 by Atkinson and Shiffrin.

The multi-store model has been criticised for being too simplistic. For instance, long-term memory is believed to be actually made up of multiple subcomponents, such as episodic and procedural memory. It also proposes that rehearsal is the only mechanism by which information eventually reaches long-term storage, but evidence shows us capable of remembering things without rehearsal.

The model also shows all the memory stores as being a single unit whereas research into this shows differently. For example, short-term memory can be broken up into different units such as visual information and acoustic information. In a study by Zlonoga and Gerber (1986), patient 'KF' demonstrated certain deviations from the Atkinson–Shiffrin model. Patient KF was brain damaged, displaying difficulties regarding short-term memory. Recognition of sounds such as spoken numbers, letters, words and easily identifiable noises (such as doorbells and cats meowing) were all impacted. Visual short-term memory was unaffected, suggesting a dichotomy between visual and audial memory.

Working memory



The working memory model

In 1974 Baddeley and Hitch proposed a "working memory model" that replaced the general concept of short-term memory with an active maintenance of information in the short-term storage. In this model, working memory consists of three basic stores: the central executive, the phonological loop and the visuo-spatial sketchpad. In 2000 this model was expanded with the multimodal episodic buffer (Baddeley's model of working memory).

The central executive essentially acts as an attention sensory store. It channels information to the three component processes: the phonological loop, the visuo-spatial sketchpad, and the episodic buffer.

The phonological loop stores auditory information by silently rehearsing sounds or words in a continuous loop: the articulatory process (for example the repetition of a telephone number over and over again). A short list of data is easier to remember. The phonological loop is occasionally disrupted. Irrelevant speech or background noise can impede the phonological loop. Articulatory suppression can also confuse encoding and words that sound similar can be switched or misremembered through the phonological similarity effect. the phonological loop also has a limit to how much it can hold at once which means that it is easier to remember a lot of short words rather than a lot of long words, according to the word length effect.

The visuospatial sketchpad stores visual and spatial information. It is engaged when performing spatial tasks (such as judging distances) or visual ones (such as counting the windows on a house or imagining images). Those with Aphantasia will not be able to engage the visuospatial sketchpad.

The episodic buffer is dedicated to linking information across domains to form integrated units of visual, spatial, and verbal information and chronological ordering (e.g., the memory of a story or a movie scene). The episodic buffer is also assumed to have links to long-term memory and semantical meaning.

Types

Researchers distinguish between **recognition** and **recall** memory. Recognition memory tasks require individuals to indicate whether they have encountered a stimulus (such as a picture or a word) before. Recall memory tasks require participants to retrieve previously learned information. For example, individuals might be asked to produce a series of actions they have seen before or to say a list of words they have heard before.

By information type

Topographical memory involves the ability to orient oneself in space, to recognize and follow an itinerary, or to recognize familiar places. Getting lost when traveling alone is an example of the failure of topographic memory.

Flashbulb memories are clear episodic memories of unique and highly emotional events. People remembering where they were or what they were doing when they first heard the news of President Kennedy's assassination, the Sydney Siege or of 9/11 are examples of flashbulb memories.

Anderson (1976) divides long-term memory into *declarative (explicit)* and *procedural (implicit)* memories.

Declarative

Declarative memory requires conscious recall, in that some conscious process must call back the information. It is sometimes called *explicit memory*, since it consists of information that is explicitly stored and retrieved. Declarative memory can be further sub-divided into semantic memory, concerning principles and facts taken independent of context; and episodic memory, concerning information specific to a particular context, such as a time and place. Semantic memory allows the encoding of abstract knowledge about the world, such as "Paris is the capital of France". Episodic memory, on the other hand, is used for more personal memories, such as the sensations, emotions, and personal associations of a particular place or time. Episodic memories often reflect the "firsts" in life such as a first kiss, first day of school or first time winning a championship. These are key events in one's life that can be remembered clearly.

Research suggests that declarative memory is supported by several functions of the medial temporal lobe system which includes the hippocampus. Autobiographical memory – memory for particular events within one's own life – is generally viewed as either equivalent to, or a subset of, episodic memory. Visual memory is part of memory preserving some characteristics of our senses pertaining to visual experience. One is able to place in memory information that resembles objects, places, animals or people in sort of a mental image. Visual memory can result in priming and it is assumed some kind of perceptual representational system underlies this phenomenon.

Procedural

In contrast, procedural memory (or *implicit memory*) is not based on the conscious recall of information, but on implicit learning. It can best be summarized as remembering how to do

something. Procedural memory is primarily used in learning motor skills and can be considered a subset of implicit memory. It is revealed when one does better in a given task due only to repetition – no new explicit memories have been formed, but one is unconsciously accessing aspects of those previous experiences. Procedural memory involved in motor learning depends on the cerebellum and basal ganglia.

A characteristic of procedural memory is that the things remembered are automatically translated into actions, and thus sometimes difficult to describe. Some examples of procedural memory include the ability to ride a bike or tie shoelaces.

FORGETTING

Forgetting or **disremembering** is the apparent loss or modification of information already encoded and stored in an individual's short or long-term memory. It is a spontaneous or gradual process in which old memories are unable to be recalled from memory storage. Problems with remembering, learning and retaining new information are a few of the most common complaints of older adults. Studies show that retention improves with increased rehearsal. This improvement occurs because rehearsal helps to transfer information into long-term memory.

Forgetting curves (amount remembered as a function of time since an event was first experienced) have been extensively analyzed. The most recent evidence suggests that a power function provides the closest mathematical fit to the forgetting function.

Interference theories

Interference theory refers to the idea that when the learning of something new causes forgetting of older material on the basis of competition between the two. This essentially states that memory's information may become confused or combined with other information during encoding, resulting in the distortion or disruption of memories. In nature, the interfering items are said to originate from an over stimulating environment. Interference theory exists in three branches: **Proactive, Retroactive and Output**. Retroactive and Proactive inhibition each referring in contrast to the other. Retroactive interference is when new information (memories) interferes with older information. On the other hand, proactive interference is when old information interferes with the retrieval of new information. This is sometimes thought to occur especially when memories are similar. Output Interference occurs when the initial act of recalling specific information interferes with the retrieval of the original information. Another reason why retrieval failure occurs is due to encoding failure. The information never made it to long-term memory storage. According to the level of processing theory, how well information is encoded depends on the level of processing a piece of information receives. Certain parts of information are better encoded than others; for example, information this visual imagery or that has a survival value is more easily transferred to the long-term memory storage. This theory shows a contradiction: an extremely intelligent individual is expected to forget more hastily than one who has a slow mentality. For this reason, an intelligent individual has stored up more

memory in his mind which will cause interferences and impair their ability to recall specific information. Based on current research, testing interference has only been carried out by recalling from a list of words rather than using situation from daily lives, thus it's hard to generalize the findings for this theory. It has been found that interference related tasks decreased memory performance by up to 20%, with negative effects at all interference time points and large variability between participants concerning both the time point and the size of maximal interference. Furthermore, fast learners seem to be more affected by interference than slow learners. People are also less likely to recall items when intervening stimuli are presented within the first ten minutes after learning. Recall performance is better without interference. Peripheral processes such as encoding time, recognition memory and motor execution decline with age. However proactive interference is similar. Suggesting contrary to earlier reports that the inhibitory processes observed with this paradigm remain intact in older adults.

Trace decay theory

Decay theory states that when something new is learned, a neurochemical, physical "memory trace" is formed in the brain and over time this trace tends to disintegrate, unless it is occasionally used. Decay theory states the reason we eventually forget something or an event is because the memory of it fades with time. If we do not attempt to look back at an event, the greater the interval time between the time when the event from happening and the time when we try to remember, the memory will start to fade. Time is the greatest impact in remembering an event.

Trace decay theory explains memories that are stored in both short-term and long-term memory system, and assumes that the memories leave a trace in the brain. According to this theory, short-term memory (STM) can only retain information for a limited amount of time, around 15 to 30 seconds unless it is rehearsed. If it is not rehearsed, the information will start to gradually fade away and decay. Donald Hebb proposed that incoming information causes a series of neurons to create a neurological memory trace in the brain which would result in change in the morphological and/or chemical changes in the brain and would fade with time. Repeated firing causes a structural change in the synapses. Rehearsal of repeated firing maintains the memory in STM until a structural change is made. Therefore, forgetting happens as a result of automatic decay of the memory trace in brain. This theory states that the events between learning and recall have no effects on recall; the important factor that affects is the duration that the information has been retained. Hence, as longer time passes more of traces are subject to decay and as a result the information is forgotten.

One major problem about this theory is that in real-life situation, the time between encoding a piece of information and recalling it, is going to be filled with all different kinds of events that might happen to the individual. Therefore, it is difficult to conclude that forgetting is a result of only the time duration. It is also important to consider the effectiveness of this theory. Although it seems very plausible, it is about impossible to test. It is difficult to create a situation where there is a blank period of time between presenting the material and recalling it later.

This theory is supposedly contradicted by the fact that one is able to ride a bike even after not having done so for decades. "Flashbulb memories" are another piece of seemingly contradicting evidence. It is believed that certain memories "trace decay" while others don't.[*citation needed*] Sleep is believed to play a key role in halting trace decay, although the exact mechanism of this is unknown.

Physical and chemical changes in our brain lead to a memory trace, and this is based on the idea of the trace theory of memory. Information that gets into our short-term memory lasts a few seconds (15–20 seconds), and it fades away if it is not rehearsed or practiced as the neurochemical memory trace disappears rapidly. According to the trace decay theory of forgetting, what occurs between the creation of new memories and the recall of these memories is not influenced by the recall. However, the time between these events (memory formation and recalling) decides whether the information can be kept or forgotten. As there is an inverse correlation that if the time is short, more information can be recalled. On the other hand, if the time is long less information can be recalled or more information will be forgotten. This theory can be criticized for not sharing ideas on how some memories can stay and others can fade, though there was a long time between the formation and recall. Newness to something plays a crucial role in this situation. For instance, people are more likely to recall their very first day abroad than all of the intervening days between it and living there. Emotions also play a crucial role in this situation.

Impairments and lack of forgetting

Forgetting can have very different causes than simply removal of stored content. Forgetting can mean access problems, availability problems, or can have other reasons such as amnesia caused by an accident.

An inability to forget can cause distress, as with posttraumatic stress disorder and hyperthymesia (in which people have an extremely detailed autobiographical memory).

Social forgetting

Psychologists have called attention to "social aspects of forgetting".Though often loosely defined, social amnesia is generally considered to be the opposite of collective memory. "Social amnesia" was first discussed by Russell Jacoby, yet his use of the term was restricted to a narrow approach, which was limited to what he perceived to be a relative neglect of psychoanalytical theory in psychology. The cultural historian Peter Burke suggested that "it may be worth investigating the social organization of forgetting, the rules of exclusion, suppression or repression, and the question of who wants whom to forget what". In an in-depth historical study spanning two centuries, Guy Beiner proposed the term "social forgetting", which he distinguished from crude notions of "collective amnesia" and "total oblivion", arguing that "social forgetting is to be found in the interface of public silence and more private

remembrance". The philosopher Walter Benjamin sees social forgetting closely linked to the question of present-day interests, arguing that “every image of the past that is not recognized by the present as one of its own concerns threatens to disappear irretrievably”. Building on this, the sociologist David Leupold argued in the context of competing national narratives that what is suppressed and forgotten in one national narrative "might appear at the core of past narrations by the other" - thus often leading to diametrically opposed, mutually exclusive accounts on the past.

LANGUAGE

Language is a system of communication using gestures, sounds, or written symbols that have significance for those who use the language and follow its rules. In speech, **phonemes** are the smallest units of sound in a language, and although they individually have no meaning, they acquire it when combined. For example, the phonemes *k* and *r* alone convey no meaning (other than that they are letters), but together they sound like *car*, which is a meaningful sound in the English language.

Semantics. The term **semantics** refers to the study of meaning in a language. The smallest unit of meaning in spoken language is called a **morpheme**, which in many instances is itself a word. The word **overcoat** is composed of two morphemes, *over* and *coat.* Language rules govern the combination of morphemes to create meaning; *overcoat*, for example, means something different than does *coatover*.

Sentences. Language rules also dictate **syntax**, how morphemes are put together to form **sentences**, groups of words that make meaningful statements. **Pragmatics** is the study of language as used in particular situations, which may affect its meaning. Consider the statement, “What a wonderful day!” and its various meanings if the sun is shining, if the rain is pouring down, and if the speaker has just received a traffic ticket.

Acquisition of language. B. F. Skinner believed that language acquisition, an important development in childhood, occurs because of reinforcement, that is, because childrens' parents or other caregivers reward them when their initially random sounds most resemble speech. Linguist Noam Chomsky contested Skinner's approach and proposed the well-known, but controversial, theory that children have an innate neural mechanism called a **language acquisition device (LAD)** (not yet discovered), which allows them to master language.

Developmental psychologists have subsequently documented the general process of language acquisition, which is usually thought to progress through the stages shown in Table 1.

Language

Language is a communication system that involves using words and systematic rules to organize those words to transmit information from one individual to another. Along with music, language is one of the most common and universal features of human culture and society. While language is a form of communication, not all communication is language. Many species communicate with one another through their postures, movements, odors, or vocalizations. This communication is crucial for species that need to interact and develop social relationships with their non-specific's. However, many people have asserted that it is language that makes humans unique among all of the animal species. This section will focus on what distinguishes language as a special form of communication, how the use of language develops, and how language affects the way we think.

COMPONENTS OF LANGUAGE

Language, be it spoken, signed, or written, has specific components: a lexicon and grammar. Lexicon refers to the words of a given language. Thus, lexicon is a language's vocabulary. Grammar refers to the set of rules that are used to convey meaning through the use of the lexicon (Fernández & Cairns, 2011). For instance, English grammar dictates that most verbs receive an "-ed" at the end to indicate past tense. English is mainly a subject verb object (SVO) language where the subject comes first, followed by the verb, and then the object of the statement as in the english sentence "The boy eats the apple". Standard Mandarin is an SVO language although for simple sentences with clear context Mandarin can be flexible by using SOV or OSV organization. Dutch and German are also SVO languages in conventional sentences, but SOV when the noun class "that" or "who" are used ("dat" or "wie" in Dutch and "das" or "wer" in German). For example, in Dutch, a basic sentence such as "Ik zeg iets over Ben" ("I say something about Ben") is in SVO word order. However when the "das" or "wie" ("that" or "who") is used the verb gets shifted to the end of the sentence and the sentence becomes SOV. An example of an SOV sentence in Dutch would be "Ik zeg dat Ben een riem gekocht heeft ("I say that Ben a belt bought has" which is difficult to understand in English). Although our familiar organization of SVO is widely used, among natural languages where word order is meaningful, SOV is the most common language type followed by SVO and these two language types account for more than 75% of the natural languages with preferred order (Crystal, 2004). Among the many SOV languages spoken throughout the world examples include Asian languages such as Ancient Greek, Hittite, Mongolian, Napali, Japanese, Korean, Turkish, Uzbek, European languages such as virtually all Caucasian languages (Indo-European), Sumerian, Sicilian, and many Native American and Native Mexican languages such as Cherokee, Dakota, Hopi, and Uto-Aztecan. There are very rare uses of SOV in English one example being the phrase "I thee wed" in commonly recited wedding vows "With this ring, I thee wed" (see Fischer, 1997 for an interesting history lesson on verbs related to marriage throughout history).

Phonemes or **Cheremes** as in the case of sign languages make up the sounds we use as building blocks for creating words. Words are formed by combining the various phonemes that make up meaning to be constructed within a given language. A phoneme (e.g., the sounds "ah" vs. "eh") is a basic sound unit of a given language, and different languages have different sets of phonemes. Phonemes are combined to form morphemes, which are the smallest units of language that convey some type of meaning (e.g., "I" is both a phoneme and a morpheme). We use **semantics** and **syntax** to construct language. Semantics and syntax are part of a language's grammar. Semantics refers to the process by which we derive meaning from morphemes and words. As a field of study, semantics has ties to many representational theories of meaning that are beyond the scope of the current chapter but include truth theories of meaning, coherence theories of meaning, and correspondence theories of meanings which are all generally related to the philosophical study of reality and the representation of meaning. Syntax refers to the the study of the combinatorics of units of language and how phonetic units organized into sentences without reference to meaning (Chomsky, 1965; Fernández & Cairns, 2011). The study of syntax examines sets of rules, principles and processes that govern the structure of sentences in a language including the order and arrangement of the pieces which make up a message.

We apply the rules of grammar to organize the lexicon in novel and creative ways, which allow us to communicate information about both concrete and abstract concepts. We can talk about our immediate and observable surroundings as well as the surface of unseen planets. We can share our innermost thoughts, our plans for the future, and debate the value of a college education. We can provide detailed instructions for cooking a meal, fixing a car, or building a fire. The flexibility that language provides to relay vastly different types of information is a property that makes language so distinct as a mode of communication among humans.

Hockett's Linguistic Universals

1.) Vocal-auditory channel : The channel or means of transmission for all linguistic communication is vocal-auditory. Hockett excluded written language by this universal because it is a recent invention and because it is not found in all language cultures.**2.) Broadcast transmission and directional reception** : Linguistic transmissions are broadcast, that is, transmitted in all directions from the source, and can be received by any hearer within range; therefore, the transmission is public. By virtue of binaural hearing, the direction or location of the transmission is conveyed by the transmission itself.**3.) Transitoriness: rapid fading** : The linguistic transmission is of a transitory nature as in it has to be received at exactly the right time, or it will fade (as contrasted with a message transmitted to a recording device which preserves the information). This implies that the hearer must perform the message preservation task by recording the message on paper or storing information in memory.**4.) Interchangability** : If you understand the message that is being sent, you can reproduce it and send it back. We can both receive and transmit any message, whereas in some animals males and females have different calls which are not reproduced by the opposite sex.**5.) Total feedback** : We have the total of all

auditory information being sent in a message at the same time that the listener receives the message, and feedback can be used for moment to moment alterations to the information being sent.**6.) Specialization** : The sounds in language are created in a special way to convey a specific meaning, creating what is known as linguistic intent. We can use language in different ways to convey either an extremely specific message or convey generality which can provide additionally information regarding the linguistic intent.**7.) Semanticity** : Meaning is conveyed through symbols. Even emogis are created with the specific intent to convey specific meaning. Specifically in terms of language though, letters are symbolic representations of phonemes which can be organized to create sounds that represent specific shared concepts and ideas.**8.) Arbitrariness** : There is no inherent connection between a symbol and the concept or object to which it refers; there is only an arbitrary connection between sound and meaning. A contrary example of this would be the honey bee's waggle dance which relies on symbolic representations of the angles of dance start and finish, number of loops made, and frequency of shakes during the dance to directly symbolize direction to food source based on where the sun is located, distance of the hive from the food source, and wealth of the food source respectively.**9.) Discreteness** : Language uses only a small number of discrete ranges of sounds to create messages and communicate. Languages do not rely on continuous variation of vowel duration to represent changes in meaning for example.**10.) Displacement** : Linguistic messages are not tied directly to the current time and place and can refer to the past, present or future. Language allows us to discuss past events and things that have not happened yet. Hypotheticals are a main characteristic of human language.**11.) Productivity** : We are able to create new words, phrases and sentences with language. We can use utterances that have never been used to create linguistic units and meaning that can change with the dynamics of culture.**12.) Duality of patterning (duality of structure)** : A small collection of sounds and symbols can be combined and recombined to create an infinitely large set of meanings and sentences. The sounds themselves do not have an inherent meaning but are able to be changed to invent new messages or meanings.**13.) Cultural or traditional transmission** : Language is acquired through exposure to culture and the language of the surrounding groups. Contrast this with the many courtship dances and mating communications found in animals where specific behaviors that convey messages are genetically governed.

LANGUAGE DEVELOPMENT

Given the remarkable complexity of a language, one might expect that mastering a language would be an especially arduous task; indeed, for those of us trying to learn a second language as adults, this might seem to be true. However, young children master language very quickly with relative ease. **B. F. Skinner** (1957) proposed that language is learned through reinforcement. **Noam Chomsky** (1965) criticized this behaviorist approach, asserting instead that the mechanisms underlying language acquisition are biologically determined. The use of language develops in the absence of formal instruction and appears to follow a very similar

pattern in children from vastly different cultures and backgrounds. It would seem, therefore, that we are born with a biological predisposition to acquire a language (Chomsky, 1965; Fernández & Cairns, 2011). Moreover, it appears that there is a **critical period** for language acquisition, such that this proficiency at acquiring language is maximal early in life; generally, as people age, the ease with which they acquire and master new languages diminishes (Johnson & Newport, 1989; Lenneberg, 1967; Singleton, 1995).

Children begin to learn about language from a very early age (table below). In fact, it appears that this is occurring even before we are born. Newborns show preference for their mother's voice and appear to be able to discriminate between the language spoken by their mother and other languages. Babies are also attuned to the languages being used around them and show preferences for videos of faces that are moving in synchrony with the audio of spoken language versus videos that do not synchronize with the audio (Blossom & Morgan, 2006; Pickens, 1994; Spelke & Cortelyou, 1981).

Stages of Language and Communication Development

Stage	Age	Developmental Language and Communication
1	0–3 months	Reflexive communication
2	3–8 months	Reflexive communication; interest in others
3	8–13 months	Intentional communication; sociability
4	12–18 months	First words
5	18–24 months	Simple sentences of two words
6	2–3 years	Sentences of three or more words
7	3–5 years	Complex sentences; has conversations

After the first few months of life, babies enter what is known as the babbling stage, during which time they tend to produce single syllables that are repeated over and over. As time passes, more variations appear in the syllables that they produce. During this time, it is unlikely that the babies are trying to communicate; they are just as likely to babble when they are alone as when they are with their caregivers (Fernández & Cairns, 2011). Interestingly, babies who are raised in environments in which sign language is used will also begin to show babbling in the gestures of their hands during this stage (Petitto, Holowka, Sergio, Levy, & Ostry, 2004).

Generally, a child's first word is uttered sometime between the ages of 1 year to 18 months, and for the next few months, the child will remain in the "one word" stage of language

development. During this time, children know a number of words, but they only produce one-word utterances. The child's early vocabulary is limited to familiar objects or events, often nouns. Although children in this stage only make one-word utterances, these words often carry larger meaning (Fernández & Cairns, 2011). So, for example, a child saying "cookie" could be identifying a cookie or asking for a cookie.

As a child's lexicon grows, she begins to utter simple sentences and to acquire new vocabulary at a very rapid pace. In addition, children begin to demonstrate a clear understanding of the specific rules (grammar and semantics) that apply to their language(s). Even the mistakes that children sometimes make provide evidence of just how much they understand about those rules. This is sometimes seen in the form of overgeneralization. In this context, overgeneralization refers to an extension of a language rule to an exception to the rule. For example, in English, it is usually the case that an "s" is added to the end of a word to indicate plurality. For example, we speak of one dog versus two dogs. Young children will overgeneralize this rule to cases that are exceptions to the "add an s to the end of the word" rule and say things like "those two gooses" or "three mouses." Clearly, the rules of the language are understood, even if the exceptions to the rules are still being learned (Moskowitz, 1978).

LANGUAGE AND THOUGHT

When we speak one language, we agree that words are representations of ideas, people, places, and events. The given language that children learn is connected to their culture and surroundings. But can words themselves shape the way we think about things? Psychologists have long investigated the question of whether language shapes thoughts and actions, or whether our thoughts and beliefs shape our language. Two researchers, Edward Sapir and Benjamin Lee Whorf, began this investigation in the 1940s. They wanted to understand how the language habits of a community encourage members of that community to interpret language in a particular manner (Sapir, 1941/1964). Sapir and Whorf proposed that language determines thought, suggesting, for example, that a person whose community language did not have past-tense verbs would be challenged to think about the past (Whorf, 1956). Researchers have since identified this view as too absolute, pointing out a lack of empiricism behind what Sapir and Whorf proposed (Abler, 2013; Boroditsky, 2011; van Troyer, 1994). Today, psychologists continue to study and debate the relationship between language and thought.

COGNITIVE PROCESSING OF LANGUAGE – EEG AND ERP

Modern advancements in electrical recording systems and computer science have lead to advanced cognitive neuroscientific techniques such as electroencephalography (EEG) that allows researchers to measure electrical brain activity in real time while participants perform language task. This allows for further evidence for models of language that describe the timeline of

cognitive processing from sensory perception to meaning interpretation and response production. Specifically, EEG data can be broken down to be analyzed in two different ways known as **spectral analysis** and **event related potentials (ERP)** which both compliment each other in terms of providing evidence the other method may lack. In the case of spectral analysis, patterns of specific electrical frequency bands can be viewed over periods of time from fractions of a second to minutes or hours in the case of many sleep studies that incorporate EEG data recording. Changes in power (defined as the change in squared magnitude of electrical activity at the given frequency band) has been a well established practice in electrophysiological research and many changes of spectral activity over the period of a second and wider time windows have been documented as being related to specific behavioral patterns (Jung et al., 1997; Klimesch et al., 1998; Aftanas & Golocheikine, 2001). Spectral analysis can be additionally be used to benefit the event related potential technique (ERP) of EEG data analysis in which the EEG data is analyzed on a much smaller time scale. Typically within ERP analysis, the electrical activity of the brain in response to a stimulus is evaluated on a millisecond or smaller scale which allows for sub-conscious mechanisms such as the processing of language to be tracked in order to identify specific **components** (electrical inflections that are thought to be related to specific cognitive activities) that represent different stages of language processing. ERP components are usually, but not always as in the case of the contingent negative variation (CNV) and lateral readiness potential (LRP), labeled as acronyms with a letter indicating a positive or negative deflection and a number representing the time elapsed (ms) from the presentation of a stimulus differences between conditions tend to occur. Examples of ERP components include early visual processing components such as the P100 and the N100 occurring around 100 ms after the presentation of a stimulus related to early sensory processing (Hillyard, Vogel & Luck, 1998; Luck, Woodman & Vogel, 2000), the P300 referring to a positive inflection that tends to occur between 250 to 400 ms after the presentation of a stimulus (auditory or visual) related to infrequent or unpredictable stimuli as well as other processes (Squires, Squires & Hillyard, 1975; Polich, 2012), and the N400 commonly studied in terms of language semantics occurring around 400 ms after the presentation of a word which has been found to appear when words are presented that are incongruent with what is expected to be presented in the context of a sentence (Swaab et al., 2012).

Related to the processing of meaning expectations, Lee and Federmeier (2009) compared the effects of syntactic and semantic cues used in sentences while recording EEG in order to determine whether processing consequences of word ambiguity are qualitatively different in the presence of syntactic or semantic constraints on sentence meaning. In order to make these comparisons, they evaluated ERP responses for noun-verb homographs (words of the same spelling having different meanings) at the end of sentences where the final word made sense for both syntax and semantics (*After walking around on her infected foot, she now had a boil)* compared to sentences that make syntactic sense (sentence structure) but do not make semantic sense (*After trying around on her important jury, she now had a boil)*. ERP responses to sentence final noun-verb homographs and unambiguous words in the syntacticly congruent

only or syntactic and semantically congruent sentences indicated early perceptual components were the same across conditions, but a centro-posteriorly located N400 component that appeared to be notably reduced in conditions of syntactic and semantic congruency. N400 amplitudes to final words in the congruent sentences were overall reduced relative to those in the syntactic only congruence suggesting less ambiguity resolution in conditions where syntax and semantics were congruent with the final word as reflected by the reduced negative amplitude in syntax and semantically congruent conditions at 400 ms after the final word was presented.

This all may be completely overwhelming and and complex in terms of information if you were previously unfamiliar with EEG and ERP research, however the main take-away to all this is that EEG and ERP data can be used to understand the time course of how our brains process syntax and semantics. Basic visual or auditory information is processed at a sensory level and processed as task relevant or not around 200 ms as reflected by the N200 (Renault et al., 1982). Then in terms of language and reading, syntax and basic semantics of words within sentences appear to be processed around 400 ms as demonstrated by differences in the N400 (also see Hagoot, Wasenaar & Brown, 2003 for ERPs related to syntax and semantics). Further processing of meaning can be additionally found by measuring differences in still later ERP components such as the P600 (occurring 600 ms after the presentation of a word) which has been suggested to also reflect violations of semantic expectations (van Herten, Kolk & Chwilla, 2004). Overall it is important to recognize that modern methods in cognitive neuroscience such as EEG as well as functional magnetic resonance imaging (fMRI), magnetencephalography (MEG), positron emission tomography (PET) and other technologies allow us to tease apart and analyze different aspects of language processing such as syntax and semantics.

THE MEANING OF LANGUAGE

Think about what you know of other languages; perhaps you even speak multiple languages. Imagine for a moment that your closest friend fluently speaks more than one language. Do you think that friend thinks differently, depending on which language is being spoken? You may know a few words that are not translatable from their original language into English. For example, the Portuguese word *saudade* originated during the 15th century, when Portuguese sailors left home to explore the seas and travel to Africa or Asia. Those left behind described the emptiness and fondness they felt as *saudade* (figure below). The word came to express many meanings, including loss, nostalgia, yearning, warm memories, and hope. There is no single word in English that includes all of those emotions in a single description. Do words such as *saudade* indicate that different languages produce different patterns of thought in people? What do you think??

Language may indeed influence the way that we think, an idea known as linguistic determinism. One recent demonstration of this phenomenon involved differences in the way that English and Mandarin Chinese speakers talk and think about time. English speakers tend to talk about time using terms that describe changes along a horizontal dimension, for example, saying something like "I'm running behind schedule" or "Don't get ahead of yourself." While Mandarin Chinese speakers also describe time in horizontal terms, it is not uncommon to also use terms associated with a vertical arrangement. For example, the past might be described as being "up" and the future as being "down." It turns out that these differences in language translate into differences in performance on cognitive tests designed to measure how quickly an individual can recognize temporal relationships. Specifically, when given a series of tasks with vertical priming, Mandarin Chinese speakers were faster at recognizing temporal relationships between months. Indeed, Boroditsky (2001) sees these results as suggesting that "habits in language encourage habits in thought" (p. 12).

One group of researchers who wanted to investigate how language influences thought compared how English speakers and the Dani people of Papua New Guinea think and speak about color. The Dani have two words for color: one word for *light* and one word for *dark*. In contrast, the English language has 11 color words. Researchers hypothesized that the number of color terms could limit the ways that the Dani people conceptualized color. However, the Dani were able to distinguish colors with the same ability as English speakers, despite having fewer words at their disposal (Berlin & Kay, 1969). A recent review of research aimed at determining how language might affect something like color perception suggests that language can influence perceptual phenomena, especially in the left hemisphere of the brain. You may recall from earlier chapters that the left hemisphere is associated with language for most people. However, the right (less linguistic hemisphere) of the brain is less affected by linguistic influences on perception (Regier & Kay, 2009)

SUMMARY

Language is a communication system that has both a lexicon and a system of grammar. Language acquisition occurs naturally and effortlessly during the early stages of life, and this acquisition occurs in a predictable sequence for individuals around the world. Behaviorists such as B.F. Skinner suggested language is a learned process we obtain through years of reinforcement, whereas linguists such as Noam Chompsky and cognitive psychologists tend to believe language may be an innate process who's mechanisms we are born with. Language has a strong influence on thought, and the concept of how language may influence cognition remains an area of study and debate in psychology.

TABLE 1 Language Development

Approximate Age	Language Response
4 months	Babbling—a variety of sounds, often repeated
10 months	Babbling that includes language used in the household
12 to 18 months	Single words (sometimes one word has a variety of meanings—**holophrastic speech**)
18 to 24 months	Two-word statements (often a noun and a verb— **telegraphic speech**)
30 + months	More complex sentences, greater vocabulary, rapid language expansion