Cognition and Language

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THE STRUCTURE OF COGNITION

Cognition

Imagine that you are travelling on a train in a foreign country, heading to visit friends who are living abroad. All of a sudden, the train screeches to a halt, a voice comes on over the loudspeaker to make an announcement in a language you don't understand, and people start exiting the compartment. You ask the man next to you what's going on, and he explains that there is a problem with the engine and everyone must evacuate the train. Luckily, you have broken down near a large city, but unfortunately the next train won't be arriving until morning. Minutes later, you find yourself stranded in the middle of a strange town you have never been to before, hungry, alone, and tired. What do you do?

Dealing with this scenario will require a range of mental abilities that fall under the umbrella of cognition. Broadly speaking, **cognition** refers to all of the processes involved in acquiring, storing, and applying knowledge. This includes aspects of perception, attention, and memory, as well as mental imagery, concepts and categorization, reasoning, problem solving, decision making, and language. Cognition is typically thought of as comprising the "higher-level" mental faculties, which emerged relatively recently in our evolutionary history. This is in contrast to "lower-level" processes, like those that regulate heart rate, breathing, reflex actions, and other basic bodily functions, which are evolutionarily more ancient. Therefore, cognition tends to be associated with the neocortex, the wrinkly outer layer of the cerebral cortex that is the most recent evolutionary addition to the mammalian nervous system.

The distinction between higher- and lower-level processes is not so straightforward, however. First, many cognitive activities are deeply interconnected with processes that are considered to be fairly low-level, like emotion. For centuries, most philosophers and psychologists believed that cognitive processes were totally rational and logical and that cognition stood in stark contrast to gut feelings and emotional reactions. But we now know that proper emotional functioning plays a critical role in cognitive activities such as learning, memory, and decision making (Damasio, 1994). Second, animals such as birds and octopi, and even insects, can exhibit behavior that appears decidedly cognitive, even though they lack a mammalian neocortex. This suggests that cognition as a whole cannot be localized in any singular brain structure, and that researchers are better off examining the functional role that different brain regions play in any given cognitive process, and how these regions work together.

The idea that cognition can be identified with a particular set of internal brain processes is complicated even further by the fact that our bodies and environment often figure into our cognitive lives. For example, you probably learned to count by using your fingers to help keep track of exact quantities. You may be able to navigate your hometown based on memory alone, but if you are in a new place you will probably use a map (or a GPS unit). And we often use external artifacts like computers or a pen and paper to record our thoughts, like when we write up a shopping list, which in essence gives us an increased memory capacity. In sum, we commonly use our bodies and the tools in our environment to enhance our cognitive abilities.

To get a sense of how we exercise our cognitive abilities in everyday life, consider once again the situation you were asked to imagine at the beginning of this section. When you exit the broken-down train you are faced with the problem of finding something to eat and a place to stay the night in an unfamiliar city. In order to solve this problem, you will probably decide to look for a restaurant where you can buy some food and a hotel where you can stay for the night. Of course, you can only look for these places because you know what restaurants and hotels are and you know that they are usually located in cities. You may even know roughly where to look in the city in order to find them (near the center of town, close to the train station and other commercial businesses). Therefore, your conceptual knowledge of cities and businesses, and your ability to generalize based on your past experiences in similar locations are essential cognitive functions in your current set of circumstances.

Once you locate the center of town, your ability to recognize which buildings contain restaurants will again depend on your knowledge of restaurants and your ability to categorize a building as such based on particular features (like whether there are people inside eating at tables). Now imagine that you see two different restaurants, one of which appears to be much fancier than the other. In order to decide on a restaurant, you will have to weigh the consequences of spending more money to get what you surmise will be a higher quality meal at the more upscale establishment. Economic decision-making is a crucial cognitive activity in our modern world. Finally, once you choose a restaurant, your behavior will be dictated by your knowledge of how restaurants work. For instance, you know that you must sit down, look at a menu, and order your food before you can eat, and that you have to pay after you are done eating before you can leave. This organized body of knowledge allows you to enjoy the restaurant even though it may be your first time eating in this country.

Of course, one of the most important cognitive functions we have at our disposal is language. We are always using language to communicate and coordinate our activities with others, and to record, disseminate, and acquire knowledge. In the situation you have been asked to imagine, it should be clear that you would have a much easier time dealing with all of these novel problems if you actually spoke the local language!

For millennia, philosophers, writers, and poets have pondered the nature of thought and reason, meaning and language, but it is only in the last century that researchers have begun to explore these issues scientifically. Cognitive and developmental psychologists, linguists, and neuroscientists use a variety of methods to probe the nature of cognitive processes, how they work and relate to one another, how they develop over the lifespan, how they are instantiated in the brain, and how they interface with the body and the environment. These scientists ask questions like: how do people acquire information about the world through the senses and store this information in memory? How do we organize the information we have into concepts and categories? Are all concepts learned or are we born with some innate ideas about how the world works? How do we apply this knowledge to reason, solve problems, and make decisions, and what role does language play in all of these processes? These are important questions that tap directly into many of the essential features of the human mind and behavior.

Mental Images and Concepts

Please take a moment and consider the following questions:

(1) What shape are a cat's ears?
(2) What do cats like to do for fun?
(3) Is a cat a mammal?

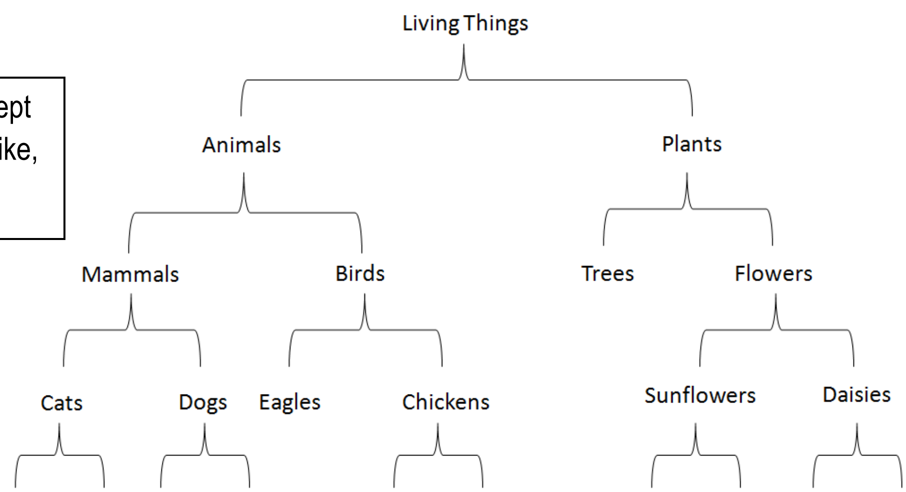
Hopefully this exercise wasn't too challenging (though if you need some help, a cat's ears are triangle-shaped, they like to chase mice and scratch furniture, and they are indeed mammals). You were able to generate these answers because you possess knowledge about what cats look like, how they behave, and what sort of animal they are. Cognitive psychologists often describe this sort of knowledge as consisting of **mental representations**, which are internal states in the mind or brain that carry information about a particular domain (like cats).

The notion of a mental representation is derived from our use of external representations in everyday life, which come in a variety of different formats. For example, a map that you use to find your way around campus is an **analog** or **depictive representation** because it preserves the physical (spatial) relationships between the elements in the map and the elements in the world it represents. If the library is between the science building and the dining hall on campus then the same will be true on the map. Contrast this with the English word, "map," which is a **symbolic representation** because it does not preserve any particular physical features of the object it refers to; there is nothing intrinsic about the letters that make up the word that tells you what sort of thing it represents. Words in a natural language are powerful symbols because we can flexibly combine them into sentences that convey more complex meanings, or **propositional representations**, such as, "the library is to the left of the psychology building." You have probably used both analog and propositional representations to find your way around.

You can think of mental representations as analogous to external representations; they are simply the internal knowledge structures that we use to get by in our daily lives. For example, **concepts** are the mental categories we use to organize our world knowledge so that we can efficiently differentiate and reason about the objects and events that we encounter. If your roommate brings home a small furry creature that scratches the sofa, you will probably place it into the "cat" category, and then conclude that you could distract it with a ball of yarn. If you could not form such a general cat concept, you would have to treat the little fur ball as a unique something-or-other you knew nothing about. Imagine having to learn about each new object or event you experienced without being able to place them into a category with other objects you already knew about!

Many concepts are organized hierarchically, from very broad categories at the highest level to evermore narrow categories as you proceed down the hierarchy. For instance, you know that cats are members of the broader “mammal” category, that mammals are members of the still broader “animal” category, and that animals are members of the extremely broad “living thing” category. This is useful because information you store about a concept at one level will tend to apply to members of all of the categories in the levels below it. If you learn that mammals nurse their young with milk, you can immediately apply that information to cats, dogs, horses, and every other member of the mammal category. Forming conceptual categories in this way is an efficient way of storing information.

A sketch of what your concept of “living things” might look like, organized hierarchically.



A related body of knowledge concerns the structure of actions or events we may experience and participate in. For example, whenever you go to a restaurant you have a pretty good idea about how the event will unfold. This knowledge is not simply a set of abstract facts about restaurants (you eat there, there is a menu to look at), but an organized **script,** which dictates the ordered sequence of actions and events that will occur. For example, you know that you must sit down, look at a menu, and order your food before you can eat, and that you have to pay after you are done eating before you can leave. You have scripts for most of the situations you experience in your daily life, which, much like conceptual knowledge, allows you to effectively cope with new situations by relating them to your prior experiences in similar settings.

Other mental representations seem to have more of an active, experiential character. For instance, when you were thinking about the shape of a cat’s ears earlier, did you feel like you were somehow visualizing a cat or seeing it in your mind’s eye, and then consulting this imagined feline to determine the shape of its ears? If so, you were using **mental imagery***,* which is an experience that is similar to perceptual (or motor) experience, only the object or event you are experiencing is not actually present in your immediate environment. Mental imagery is what allows us to relive our pasts and imagine our futures, and it is typically associated with a particular sensory modality; while you probably used visual imagery to figure out the shape of a cat’s ears, you would have to use auditory imagery to figure out the sound of a cat’s meow, or olfactory imagery to figure out the scent of a cat’s—well, you get the idea.

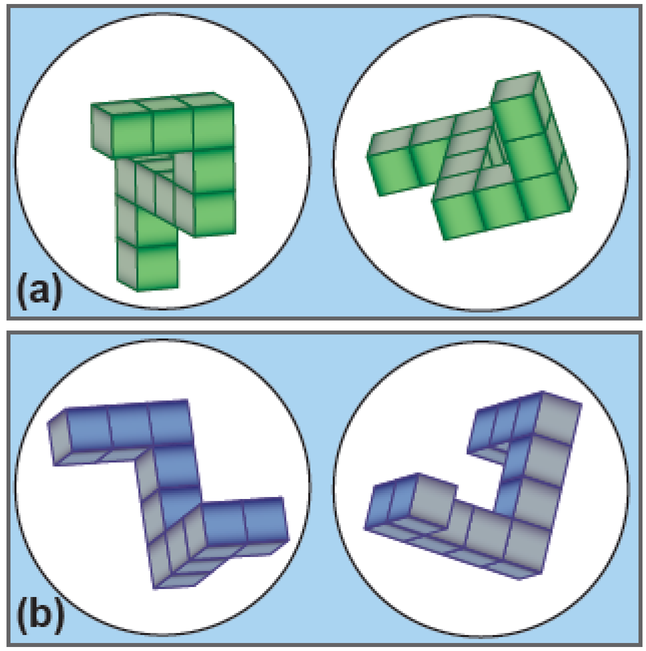
Just how similar is mental imagery to genuine perception and action? Traditionally, psychologists argued that this question concerns the format of the mental representations that support our mental imagery abilities. In other words, is our mental representation of an imagined map depictive/analog like a real map, or is it propositional like a verbal description of a map?

To address this question, researchers devised clever studies that forced participants to manipulate their mental images in the same way they might manipulate or interact with a real-world object. In one experiment, participants first studied a map of a fictional island that contained several key items (like a hut or pond) at different locations (Kosslyn, Ball, & Reiser, 1978). Next, the physical map was removed and they were asked to visualize one of these items and then imagine travelling from that location on the map to the location of one of the other items. The time it took to complete this mental scanning process was linearly proportional to the actual physical distance between those two locations on the real map; the farther apart the items were, the longer it took to imagine travelling between them. This suggests that mental images preserve spatial structure in an analog fashion.

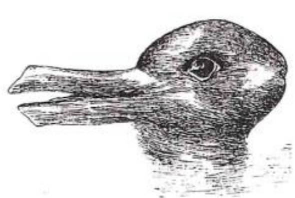
After looking at the island map, close your eyes and imagine "mentally scanning" between two of the locations.

In another experiment, participants saw pictures of two three-dimensional block objects positioned at different angles and had to indicate whether they were the same exact shape or mirror-reflected images of one another (Shepard & Metzler, 1971). Response times in this task were linearly proportional to the angular disparity between the objects; the farther apart the objects were rotated from one another, the longer it took to come up with a response. This suggests that participants were mentally rotating one of the objects until it aligned with the other one in an analog fashion.

Are the objects in (A) the same shape or mirror-reflected images of one another? What about in (B)?
Which pair took longer to figure out?



Taken together, these studies are consistent with the idea that mental imagery is supported by mental representations that are more depictive or analog than propositional. “Looking” at a mental image, however, is not just like looking at a picture. Consider the ambiguous figure depicted in the figure below, which can be perceived as either a duck or a rabbit. Most people can identify both animals if they are told that there are multiple possible interpretations while they are looking at the image. If the figure is taken away before they can spot the second animal, however, they will probably not be able to come up with the second interpretation. In other words, while a picture of an ambiguous figure can be easily reinterpreted when you look at it, a mental image of that figure seems to already come with a particular interpretation (Pylyshyn, 2003).



Is it a rabbit or a duck? While it’s easy to see both animals when you are looking at this image, people find it difficult to reinterpret the picture if they can only use their mental imagery to “inspect” it.

More recently, psychologists have asked whether, and to what extent, perception and mental imagery rely on the same cognitive and neural processes. When you imagine a cat, are you drawing on the same internal mechanisms that are involved with actually seeing a cat? In fact, studies have shown that many of the same brain areas that are active when people see a particular object or execute a particular action are active when they simply imagine that object or action (Kosslyn, Thompson, & Ganis, 2006). In one experiment, participants looked at pictures of faces while undergoing a functional magnetic resonance imaging (fMRI) scan, which tracks blood flow in the brain as a measure of which brain regions are more active during a task (O'Craven & Kanwisher, 2000). The researchers found that the same exact visual brain area was active when participants imagined a face as when they looked at a picture of a face, though in the imagery condition the degree of activation was relatively weaker.

Mental imagery also appears to have some of the same physiological consequences as genuine perception and action. For instance, when you practice a motor skill like shooting a basketball, you get better over time. It turns out that imagining doing that action (mental practice) can also lead to some of the same improvements in performance, though not to the same extent that physical practice does (Driskell, Copper, & Moran, 1994). Taken together, these findings suggest that mental imagery draws on many of the same cognitive and neural mechanisms that we use to actually perceive and act, but that it does so in a somewhat attenuated fashion.

In sum, we all possess a great deal of knowledge about the world that we have acquired over a lifetime of experience. This knowledge consists of mental representations, which, like the familiar external representations we encounter on a regular basis, come in a variety of forms. Categories efficiently structure our knowledge about objects and events, which enables us to easily make sense of new experiences and draw inferences about the novel items by grouping them into categories we already know about. Scripts serve a similar function by structuring our knowledge of what actions and events will occur in what order in familiar situations. Finally, mental imagery allows us to creatively imagine perceptual and motor experiences that can help us solve problems and even improve our motor skills.

Concept Formation

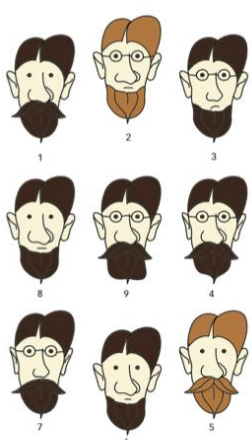
Concepts are the mental categories we use to organize and make sense of the world around us. For example, your concept of a "pet" makes it easy to understand and think about the animals you see walking around the neighborhood with people and living in their homes (and to differentiate between those creatures and the other wild beasts you might encounter).

Where do our concepts come from? One possibility is that knowledge is largely innate and that we are born with most of the concepts we will ever use, a perspective known as concept **nativism**. The ancient Greek philosopher Plato was one of the earliest proponents of this view. A believer in reincarnation, Plato suggested that what we think of as learning is really the soul recollecting the knowledge it has forgotten as a result of the shock of being reborn into a new body. Though modern psychologists do not endorse the theory of traumatized reincarnating souls, some scholars still believe that certain basic concepts are innate—a product of evolution acting on the structure of the human mind. In contrast to this view, others have argued that we acquire concepts during our lifetime by learning from our experiences, a perspective known as concept **empiricism**. Interestingly, Plato's own student, Aristotle, was an early empiricist.

But what makes something a concept in the first place, and how do we classify novel objects or events as belonging to a particular conceptual category? A variety of different theories of concept formation have been advanced to address these questions, each of which has their own unique strengths and weaknesses.

According to the **classical theory,** which can be traced back to Aristotle, concepts are defined by a particular set of necessary and sufficient conditions that are required for category membership. For example, a person is a "bachelor" only if they are adult, single, and male; and a shape is a "triangle" only if it has three sides and the interior angles add up to 180 degrees. We can determine when a novel item belongs to a particular conceptual category by checking to see whether it possesses just those features that define the concept, a straightforward process that is one of the attractive elements of this theory. If a man is married, then he surely isn't a bachelor, and if a shape has six sides then you better believe it isn't a triangle! This rule-based nature of the classical theory has an undeniably intuitive appeal because it is consistent with our habit of looking up definitions for words in a dictionary.

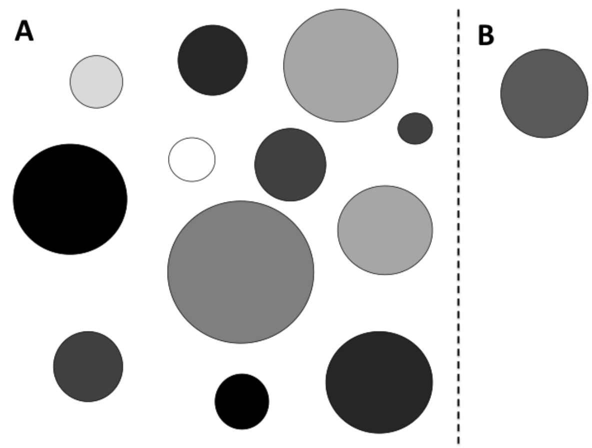
One major limitation of the classical theory, however, is that it is difficult or impossible to come up with a precise definition for many concepts. Even concepts that seem to have pretty clear-cut rules for membership may actually have fuzzy boundaries upon closer examination. For instance, the pope is an unmarried adult male, but you would probably not call him a "bachelor." The Austrian philosopher Ludwig Wittgenstein (1889-1951) was one of the first scholars to raise this concern. He famously used the concept of a "game" to illustrate the problem: though we can readily categorize many different activities as "games," there is not a single feature that is common to every member of this group (Wittgenstein, 1953). If this analysis seems suspect, go ahead and try it for yourself: what feature does every board game, sporting game, card game, and video game share that makes them all games? Wittgenstein suggested that members of a conceptual category are grouped together not by rigid rules or necessary and sufficient conditions, but by **family resemblances**—broad similarities and overlapping features that category members tend to share, but which are not common to all of them (or required for category membership). He used this term because people who belong to the same family tend to look alike, but no particular facial feature will be shared by all family members.



These gentlemen are all unmistakably related, yet there is not a single specific feature that they all have in common—they are related via family resemblances.

The psychologist Eleanor Rosch built on this idea to develop a novel theory of concept formation based on similarity rather than rigid definitions. According to Rosch's **prototype theory**, concepts are organized around an ideal or prototype, which can be thought of as an average of all category members or as an item consisting of all of the representative features associated with the category (Rosch, 1975, 1978; Rosch & Mervis, 1975). For example, the prototypical "bird" would be a small animal covered in feathers that lives in trees and can fly because those are the features that birds commonly possess (although any particular bird might not possess *all* of these characteristics). The prototype of the items depicted in the figure below would be a medium-sized, medium-gray circle because it is the average of all of the shapes in the category in terms of color and size.

A particular shape category consists of all of the exemplars shown in (A). The medium-sized, medium-gray circle in (B) is the prototype of this category because it is an average of all of the exemplars in terms of size and color.



According to the prototype theory, we categorize new items by calculating how similar they are to the prototype of each concept. One advantage of this approach is that it allows for fuzzy boundaries between concepts since there are no hard and fast rules for category membership. In particular, prototype theory accounts for the fact that some items are judged to be better or more representative category members than others. This is known as the **typicality effect** in categorization. For instance, people rate robins as better "birds" than ostriches because they are more similar to the prototypical bird (they are small and can fly and live in trees). Similarly, the actor George Clooney would be a better bachelor than the pope. The classical theory cannot account for these findings because it considers all members of a category to be equally good examples as long as they meet the necessary and sufficient conditions.

However, prototype theory fails to account for the fact that we seem to know a great deal about specific category members (exemplars). You can almost certainly recall any number of individual birds or pets or games you have encountered, so your ability to think about the world in terms of these concepts does not appear to be limited or constrained by an ideal or prototype. According to the **exemplar theory**, our concepts actually consist of all the individual instances of the category that we have ever experienced. Like the prototype theory, this is a similarity-based view of concept formation. The exemplar theory suggests that we categorize new items by calculating how similar they are to each exemplar that we have stored in memory. Exemplars that are similar to one another (because of shared features or family resemblances), will tend to be clustered together into a particular category, and as in the prototype theory, there will be no rigid boundaries between different conceptual categories. For this reason, the exemplar theory can also account for typicality effects. One weakness of this theory, however, is that it is somewhat unrealistic to think that we can remember every exemplar we come across, and compare each new item we encounter to all of these stored instances.

Ultimately, our capacity for categorization and conceptual thought is undoubtedly too complicated to be captured by any single basic theory. We can probably form concepts based on classical rules, prototypes, and exemplars, not to mention any of a number of additional theories that have been proposed by other researchers. Indeed, we commonly use other types of concepts that none of the basic theories described in this section can readily explain. For example, we can easily create and understand novel concepts "on the fly" based on combinations of other concepts we have stored in memory, such as "pet bird" or "activities I would like to do on my break from reading about psychology." Furthermore, though this section has focused on concrete concepts like shapes, animals, and other objects we can detect with our senses, many of our most cherished concepts are more abstract, like "time," "justice," and "the mind" —none of which can be experienced so directly. Additional theories of concept formation are needed to help account for our ability to generate, understand, and make use of concepts like these.

LANGUAGE

Introduction to Language

Imagine having the ability to take a thought from your brain and transmit it directly into someone else's brain—with little to no loss of information. This type of thought transmission is not fodder for science fiction; it is something you do every day. Language affords us the ability to transmit our thoughts into the minds of others—and vice versa. Human have evolved this remarkable system of communication, wherein vocal sounds and hand motions are arbitrarily linked to meaning and these arbitrary associations are used consistently within a culture so that anyone within the culture can utilize this coding scheme to engage in this system of thought transference.

The power of language becomes particularly apparent when one is unable to use it. Imagine traveling to a foreign country where you don't know the language spoken by the locals and they don't know your language. Think of how challenging it would be to navigate the country. Imagine trying to take a taxi to your hotel. You're armed with the name of the hotel and an address, but suppose you botch the pronunciation and the driver doesn't understand what you're trying to say. Suppose he asks a question and looks at you expectantly. Without knowing what he is asking, you are completely helpless. Imagine trying to pay the cab fare. The driver tells you the cost, but you don't know what he's saying. How would you know how much to pay? Imagine trying to order a meal in a restaurant. There are no pictures on the menu, and you can't read any of the words. How would you communicate what you want? At the end of your meal, how would you request the bill? Consider the following anecdote about an American's experience dining in Japan:

> After I had finished my meal (which I'd been able to successfully order using one of the five words in my Japanese vocabulary—sushi), the waitress cleared my plates and asked a question that didn't contain any of those five words. Assuming she'd asked if I was ready for the bill, I nodded and said, "Hai," pleased that I was able to navigate this exchange. To my surprise, she returned to the table not with the bill, but with a pot of tea. I drank the tea and when I had finished, the waitress returned and asked another question. Not learning from my first failed attempt to get the bill, I smiled and nodded. Moments later, she returned with a second pot of tea! Not wanting to be rude or wasteful, I drank as much of it as I could. When my stomach felt ready to burst (and cursing myself for not knowing how to say "bathroom" in Japanese), I pulled some yen (Japanese money) out of my wallet and placed it on the table. With a few gestures, I was finally able to communicate that I wanted to pay.

Maybe you've personally experienced the helplessness of such a situation. Or maybe you've experienced similar frustration when playing Pictionary or charades, games that require you to communicate without using spoken language. Perhaps only when deprived of linguistic communication does one truly appreciate this remarkable system that allows us to effortlessly transmit our thoughts into the minds of others.

Language not only provides a window into the thoughts that occupy a person's mind, but it also has the power to transmit information about objects and events that aren't contained in the immediate context. We don't use language solely to refer to the here and now; we can also use it to reminisce about the past, surmise about the future, and discuss abstract concepts. To the best of our knowledge, humans are the only species with the ability to do these things. Some other species have developed acoustic signals to communicate about things in the immediate environment, such as the presence of a predator or the quality of food. They don't have the ability to communicate about a predator who threatened them long ago, to discuss a projected future food shortage, or to confide in a friend about their crush on a certain female (or to swear that friend to secrecy). While other species do have systems of communication, these systems are lacking the sophistication of language. Therefore, any definition of language needs to capture the sophistication and complexity of this system of communication.

Defining Language

Language is a dynamic, structured system of communication in which arbitrary symbols are combined, according to the rules of grammar, to convey an infinite number of possible meanings. This definition includes five of the most critical components of language (Clark & Clark, 1977). To better understand these components, we'll break this definition down and examine each component in detail.

Languages are **communicative**. They support the transmission of information. This transmission can take place through vocalizations, signs made with the hands, or written symbols. Some individuals may use only one of these three methods of transmission to achieve linguistic communication, while others may use a combination of two methods or all three.

Languages utilize **arbitrary symbols**. The word that we use to symbolize a particular concept is arbitrary, an idea first articulated by linguist Fernando de Saussure (1857-1913). Very few words are linked to concepts in a systematic way. For instance, the word "pencil" symbolizes those hand-held wooden devices with which we write and draw, but the association between this word and the object is arbitrary. We could have chosen *any* combinations of sounds to symbolize the concept of pencil; the word itself doesn't matter. What does matter is that all speakers of English use the same word to symbolize pencil. The association is arbitrary, but it is used consistently within the language. While most words are arbitrarily linked to the things they symbolize, there are some exceptions, such as many of the words that we use to talk about sounds. Some words sound like imitations of the sounds that they symbolize, such as "buzz," "meow," and "woof." These types of words are called *onomatopoeias*.

Languages are *structured.* There are multiple levels of structure, including sounds, components of words, words, and sentences. Formal systems of rules are used to organize the information at various levels of structure, such as rules for how to combine components to form words and rules for how to organize those words into sentences.

Languages use a *generative grammar*. Words can be combined in an infinite number of ways to generate an infinite number of sentences. This combinatorial system is called **grammar**. The meaning that arises from the word order of a sentence is greater than the meaning of the individual words. For instance, the meaning of "The batter hit the ball" is quite different from "The ball hit the batter," yet both meanings emerge from the same set of words. Generative grammar allows us to translate word order into concepts that surpass the meaning of each individual word (Pinker, 1994).

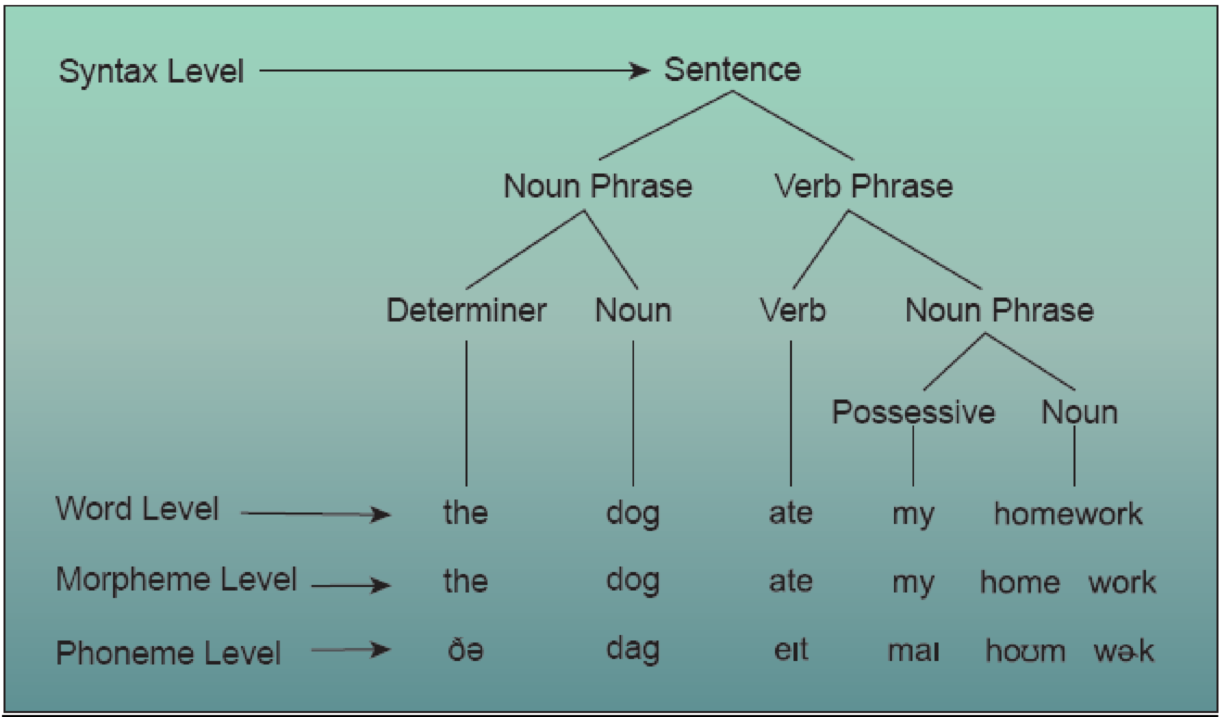
Languages are *dynamic*. Languages change over time. The **lexicon**—the words that comprise the vocabulary of a language—changes rapidly. Just think of the new words that have been added to English in your lifetime. The word *email* was meaningless to the general population before the '90s. The last decade has introduced the words *iPod*, *app*, and *Skype*, just to name a few. The word *text* has taken on a new meaning, now functioning as a verb and a noun. The term *social network* has been around for awhile, but its primary usage has changed.

It is obvious that technological advances cause languages to change rapidly, but languages change for other reasons as well. Sometimes a language changes because each generation wants to distinguish itself from the last. For instance, think of the different words that have been used to convey the concept "cool" over the last few decades. When your parents were younger, they may have used words like *rad*, *sick*, and *killer*. Your grandparents may have used words like *spiffy* and *swell*.

Sometimes languages change because the standard usage of a word changes. For instance, do you know what the word *peruse* means? You probably think that it means to read something over very quickly, getting the gist without absorbing the details. While this is how most people use this word, a dictionary will tell you that the word means to read something carefully and thoroughly. But is this what the word really means? If most people use *peruse* as a synonym for *skim* or *browse* and most people interpret the word this way, hasn't this become the meaning agreed upon within the culture? This is one way that languages change over time.

The Structure of Language

Language is structured on multiple levels, from the sound itself to the meaning derived from a passage of text or multiple statements tied together. These levels of structure are outlined in the illustration below. We'll examine each level in detail.



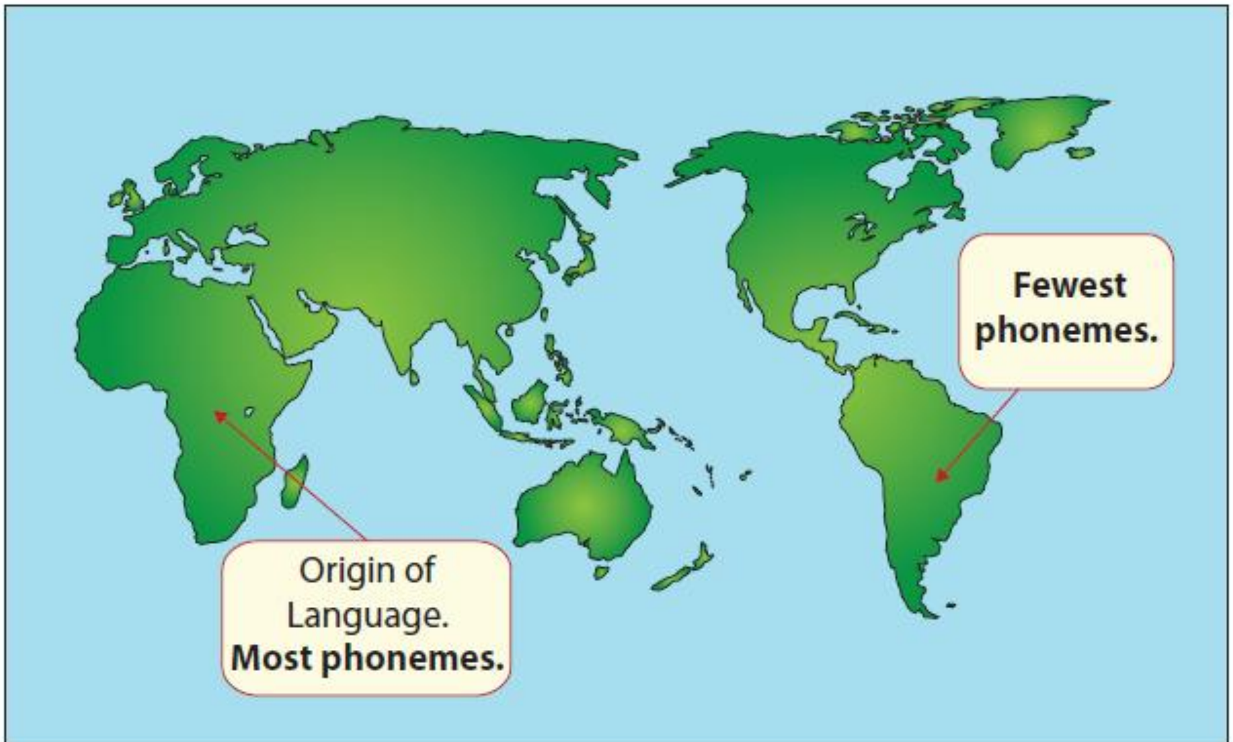
Language contains multiple levels of structure, depicted here for the sentence, "The dog ate my homework."

A **phoneme** is the smallest unit of sound used in a language. Many phonemes correspond to the letters and sounds of the alphabet. For instance, the phoneme /k/ sounds exactly like you would expect it to—like the "k" in *kayak*. However, we don't have enough letters in the alphabet to symbolize each of the roughly 45 phonemes used in the English language, so some phonemes are represented by symbols that don't appear in our alphabet. For instance, /ʃ/ sounds like the "sh" sound in *she*. Some of the letters in the English alphabet actually correspond to more than one phoneme. The letter "a" for instance, is pronounced several different ways in English, corresponding to multiple phonemes. Imagine the challenge this poses when learning to read! To become a skilled reader, one needs to learn that this letter sounds pretty different in the words *cat* (æ), *day* (eɪ), *father* (ɑ), and *America* (ə).

Vowels		Consonants	
Phoneme	Sounds like	Phoneme	Sounds like
æ	apple, sat	b	baby, bed
ɑ	got, saw	d	dog, dad
ɛ	let, mess	ʤ	judge, gentle
ə	about, America	f	fall, rough
i	any, penny	g	got, tag
i:	eat, meat	h	head, hope
ɪ	in, sit	j	yard, yell
ʊ	could, foot	k	soccer, talk
u:	boot, to	l	let, yellow
ʌ	mud, umbrella	m	hum, milk
ɚ	bird, urge	n	net, tenor
eɪ	eight, way	ŋ	rang, sing
aɪ	bite, mice	p	spear, stop
aʊ	frown, out	r	ring, run
oɪ	foil, joy	s	miss, sell
oʊ	coat, glow	ʃ	push, shop
		t	date, hat
		ʧ	future, hatch
		θ	bath, this
		v	have, vet
		w	wear, will
		z	fuzz, zoo

Many of the phonemes used in English are shown here along with words containing each phoneme sound.

Not all languages share the same phonemes. The English language uses approximately 45 phonemes, many of which are shown in the illustration above. Some languages use very few phonemes, such as Rotokas, a language spoken in Papua New Guinea that is reported to have only 11 phonemes (Robinson, 2006). The language !Xóõ, which is spoken in Botswana, has over 100 phonemes, including tongue clicks (Traill, 1985). Why do different languages use different numbers of phonemes? It has been theorized that the languages with the most phonemes are located in the geographical region where language evolved (Atkinson, 2011). Language is thought to have originated in Africa. As people and languages spread out from the region of origin, languages utilized fewer and fewer phonemes. The languages with the fewest phonemes are found in regions of South America and Polynesia; of the habitable regions on the planet, these are among the most geographically distant from Africa—where languages have the greatest number of phonemes.



Africa is thought to be where language evolved, as African languages have the most phonemes. As language spread to other regions, people used fewer and fewer phonemes. The continent furthest from Africa uses the fewest phonemes.

A **morpheme** is the smallest meaningful unit in a language. Words are built from morphemes. For instance, the word *unfortunately* contains four morphemes—the root *fortun(e)*, the prefix *un-*, and the suffixes *–ate* and *–ly*. The word *homework* contains two morphemes—*home* and *work*. We can combine multiple morphemes to generate words that have highly nuanced meanings. New words are often created by combining morphemes in novel ways. The following sentence contains several "words" that you won't find in a dictionary, but you should be able to understand them because you're familiar with their morphemes. "As I watched the mathemagician amazify the classroom, I was struck by the seriosity of my geekening." You may be able to think of a few words that you've created by combining morphemes for new *wordification*.

Words are sounds, signs, and written forms that are arbitrarily linked to concepts. When different individuals use the same sound to symbolize the same concept, communication is possible. Within a language, speakers sample from the same lexicon—the set of words comprising the vocabulary of the language. To achieve communication, the associations between sounds and meanings must be used in a manner that is consistent across different speakers.

Words are the foundation of **semantics**, the interpreted meaning of words and sentences. As we've already observed, word order influences the concepts conveyed by a sentence, so semantic meaning exists at the level of the individual words and also at the sentence level, which is when the relationship between the words becomes evident. Consider the difference in meaning between the sentences “I want you to know” and “I want to know you.” The semantics of the individual words are the same, but at the sentence level, the semantics are quite different.

People often choose their words with the intent to influence the attitudes and emotions of others, a technique known as **semantic slanting**. Have you ever bought a concert ticket online and paid a *convenience charge*? Ticketing agencies use semantic slanting in attempt to influence the consumer attitudes towards fees, reminding us of the convenience of online purchases. The U.S. military uses semantic slanting to shape public opinion about offensive actions. People regard *preemptive strikes* with less negativity than they regard *invasions*.

A sentence contains a set of words organized according to a formal system of rules called syntax. **Syntax** allows us to understand the relationship between the words in a sentence, allowing us to determine who did what to whom. By changing the order of words, we can change the meaning. The meaning that we extract from the word order reflects the rules of syntax, and syntax supports the meaning we derive from a sentence. English uses a subject, verb, object (SVO) word order. Knowledge of these word order rules allows one to easily determine who (subject) is doing what (verb) to whom (object). This is why two very different meanings emerge from “The dog ate my homework” and “My homework ate the dog.”

The rules of word order are used so consistently in the English language that any deviation from this word order is noteworthy. The character Yoda from the Star Wars films is distinctive and memorable because he deviates from SVO word order, instead using an approximation of object, subject, verb (OSV) word order, which is also used in some languages of the Amazon Basin (Crystal, 1997). Understand him we can, but to us strange he sounds.

When we process a sentence, our goal is to understand the sentence’s **deep structure**—the meaning that emerges from the sentence. Information can often be expressed in multiple ways. The words that are used and the ordering of those words is the **surface structure**. A single deep structure, or meaning, can be communicated through multiple surface structures. For instance, we can express the concept of a dog biting a man as “The dog bit the man” and as “The man was bit by the dog.” These two surface structures can be used to communicate the same deep structure.

Sometimes we encounter a sentence whose meaning is ambiguous because the surface structure—the sentence itself—can be mapped to multiple deep structures. Linguist Noam Chomsky (1957) offered the example sentence, “Visiting relatives can be a nuisance.” We can map this surface structure to two different deep structures: it can be a nuisance to visit relatives, and relatives who are visiting can be a nuisance. The following actual newspaper headlines are amusing because the surface structures map to multiple deep structures.

Gator Attacks Puzzle Experts
Red Tape Holds Up New Bridge
NJ Judge to Rule on Nude Beach

Hershey Bars Protest
Complaints about NBA Referees Growing Ugly

Red tape holds up new bridge.

Thematically related spoken and written sentences are often strung together to achieve a communicative goal. This group of related sentences is called **discourse**. Once we have extracted the meaning from a sentence or string of sentences, we may be able to draw an inference that was not explicitly stated in the information provided. Imagine that a friend says to you, “You missed a killer party last night. I’m paying for it today, though.” What would you infer about what your friend did at the party and specifically how his actions are affecting him today?

Stages of Language Acquisition

The word infant is derived from the Latin word *infans*, which means “without speech.” Although infants generally don’t begin to produce words until they are about a year old, they begin learning about their language before they’re even born. The sounds that can be heard in the womb are somewhat muffled, but the neonate can nonetheless perceive sound patterns in the language spoken around her. The behaviors exhibited by newborns suggest that a considerable amount of learning has already taken place in the womb. A newborn infant will pay more attention to the sounds of her parents' language than to the sounds of an unfamiliar language (Moon, Panneton-Cooper, & Fifer, 1993). A newborn can recognize the sound of her mother's voice (DeCasper & Fifer, 1980) and can even recognize stories that were read aloud to her on repeated occasions while she was still in the womb (DeCasper & Spence, 1986). The recognition skills of the newborn demonstrate two fundamental principles of language acquisition: infants have the cognitive capacity to learn the regularities and patterns of their environments, and infants develop receptive language skills before expressive language skills. Before the infant develops the ability to control her vocalizations and produce speech, she is learning the sounds, rules, and words of her language. The ability to acquire language is supported by the infant's rapid cognitive development. Within four years, the infant will have mastered the rules of her language.

Newborns can recognize stories that were read to them in the womb.

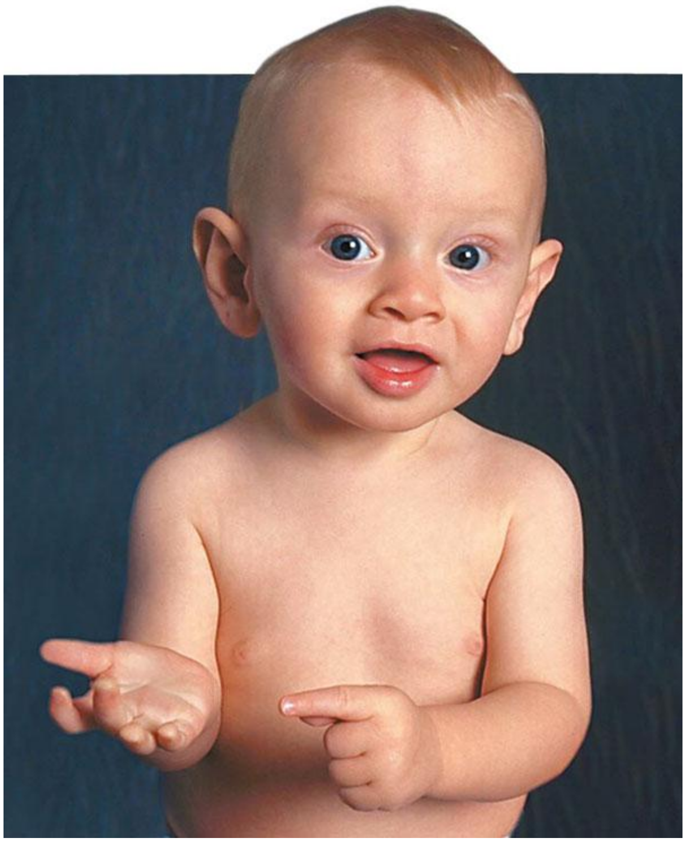
Language development follows a typical time course, with infants achieving major linguistic milestones in a predictable order. While there is a great deal of variability across different infants with regards to when they reach each milestone (Bates, Dale, & Thal, 1995), we can pinpoint the average age at which infants tend to reach these developmental milestones.

Timeline of milestones in language acquisition.

Average Age Range	Linguistic milestones
Birth-3 months	Learns to discriminate sounds of the language Produces nonlinguistic vocalizations
4-5 months	Begins to babble
6-9 months	Can segment speech into words Understands a few words and phrases
10-15 months	Enters one word stage Uses holophrases Understands over 50 words
18-23 months	Enters multiword stage Uses telegraphic speech Vocabulary of 50-200 words
24-35 months	Produces phrases and incomplete sentences Vocabulary of 1000 words
36-60 months	Produces full sentences Vocabulary of 10,000 words

Babble

For the first three months of life, infants produce various types of emotional vocalizations. Although these early vocalizations aren't considered linguistic, they often communicate vital information, such as whether the infant is distressed, happy, or content. During this time, the infant is learning about the language being used around her. She is becoming sensitive to the letter sounds, or **phonemes**, of the language. Around 4 months of age, infants begin to **babble**, producing single-syllable vocalizations that consist of a consonant followed by a vowel or vice versa (e.g., "ga"). Around 7 months of age, infants begin to produce repeated strings of syllables known as *reduplicated babble* (e.g., "dadadadadada"). The phonemes produced by infants during this stage generally match the sounds of the language spoken around them (de Boysson-Bardies, Sagart, & Durand, 1984). This period of sound exploration is sometimes thought of as a prelinguistic phase, but there is evidence that babbling is actually a linguistic activity. Babble appears to be supported by the left hemisphere of the brain—the hemisphere that plays a crucial role in processing and producing language (Holowka & Petitto, 2002). These vocalizations are more than mere products of early vocal experimentation; babbling is a form of *linguistic* experimentation. This point is only strengthened by observations of infants who are in the process of learning sign language. Deaf infants born to deaf parents actually babble with their hands, creating a small set of signs corresponding to syllabic units used in sign language (Petitto & Marentette, 1991). This type of manual babble has also been observed in hearing infants born to deaf parents (Petitto, Holowka, Sergio, Levy, & Ostry, 2004). Babble—whether produced by the mouth or the hands—is the first major milestone of language acquisition.



Infants born to deaf parents will babble with their hands, demonstrating that babbling is a linguistic activity.

Speech Segmentation

When you listen to speech, your knowledge of the language allows you to easily break the steam of sound into individual words. The word boundaries are so clear that you may think the stream of sound contains small breaks between words. Your brain, however, imposes the breaks; there are generally no pauses between words to help you figure out where one word ends and the next begins. The next time you hear someone speaking in a foreign language, try to pick out the individual words. You'll discover that this is a real challenge! Without prior knowledge of the language, the lack of clear physical breaks between words makes it very difficult to segregate a stream of speech into individual words. Infants are faced with the challenge of **speech segmentation**—determining where one word ends and the next begins. Infants may rely on statistical learning to segment speech into words. A study conducted by Saffran, Aslin, and Newport (1996) demonstrated that 8-month-old infants can quickly learn the statistical regularities of language. An infant listening to a stream of syllables can learn that certain syllables have a high probability of occurring together, whereas other syllables do not. This enables the infant to discriminate a word—a group of syllables that occur together—from the sounds around it, which belong to different words. Suppose a mother says to her baby, "Who's the pretty girl? You are! Yes, you're so pretty! You're mommy's pretty baby girl, yes you are!" What can the baby learn from this? The syllables in *pretty* always occur together, but the sounds surrounding *pretty* change each time the word is spoken, enabling the baby to learn that *pretty* is a word, as shown in the illustration.

How can an infant learn the word ***"pretty"*** from the following context?

"Who's ***the pret-ty girl***? You are! Yes, you're ***so pret-ty***!
You're mom-***my's pret-ty ba***-by girl. Yes you are!"

Syllables co-occuring	**Probability of each combination co-occuring.**	**Probability of each combination co-occuring.**
the pret- so pret- -my's pret-	.33 .33 .33	These sounds belong to different words.
pret-ty pret-ty pret-ty	1	These sounds belong together. "Pretty" is a word.
-ty girl -ty you're -ty ba-	.33 .33 .33	These sounds belong to different words.

An infant is able to segregate speech into individual words by learning how often certain sounds occur together. Syllables that usually co-occur belong to the same word, whereas syllables with a lower rate of co-occurrence belong to different words.

One Word Stage

For infants to begin learning how words are used for communication, they must first learn that sounds can be linked to meaning. Infants may begin to make this realization around 5 months of age when they begin to respond consistently to certain words, such as their own name (Mandel, Jusczyk, & Pisoni, 1995). Between 7 to 10 months of age, infants will look at an object when it is named and can understand short phrases, such as, "Come here" and "Give me a hug." By 11 months of age, the average infant understands 50 or more words (Fenson et al., 1994). At this age, however, many infants have not yet spoken their first word, showing that there is quite a divide between what an infant can say and what an infant understands.

Most infants speak their first words between 10 to 15 months of age, reaching an average expressive vocabulary of 40 words by 16 months (Fenson et al., 1994). Some infants, however, have been observed to have a vocabulary of over 160 words by this age. Why do some infants learn words more quickly than others? The size of an infant's vocabulary is related to phonological memory capacity—the infant's ability to remember sequences of sounds (Gathercole & Baddeley, 1989). These findings are consistent with the idea that cognitive development sets the pace for language development.

Many developmental psychologists refer to the period between the child's first and second birthday as the **one word stage**. Even though children learn many words during this time, they tend to say just one word at a time. Some of these words refer to the child's favorite objects and people (e.g., "doggie," "truck," "ball," "Dada," "Mama"), and other words may function as commentary on events and actions (e.g., "uh-oh" and "bye-bye"). Children also use single words to make requests and inquiries, using one word to convey the meaning of an entire sentence. For instance, "Juice?" is often used to express, "May I please have some juice?" A child may say, "Mama?" to express "Where is my mother?" or "I want my mother." In instances such as these, the child is using a **holophrase**, which is a single word that stands for a complete thought that, in adult speech, is typically expressed by a full sentence.

In the second year of life, a child's vocabulary grows rapidly. The average infant may say only a few words at 12 months, but may have an expressive vocabulary of 300 words by 24 months of age (Fenson et al., 1994). By the time the child has reached the age of 5, she may understand 10,000 words!

Multiword Stage

After a child has learned many of the words in her language, she must learn to combine the words. The **multiword stage**, in which the child begins to create phrases that are two to three words in length, is the child's first step towards producing sentences. Between the ages of 18 to 23 months, most children begin combining words into short phrases (Fenson et al., 1994). These phrases generally reflect the word order rules of the language (for instance, a child would say "find teddy," but not "teddy find").

Two-word combinations generally express a small number of relational meanings (Brown, 1973), such as between an agent and an action ("Mommy sit"), an action and an object ("eat cookie"), and a possessor and their possession ("my truck"). Three-word combinations tend to combine two relational meanings, resulting in combinations such as agent, action, and object ("Mommy eat cookie").

"My truck!" Children in the multiword stage communicate a small number of relationships, such as object possession.

During this stage, children produce combinations that include things like nouns, verbs, and adjectives, but their speech often lacks articles (such as *a* and *the*), prepositions (such as *at*, *by*, *in*, *on*, and *to*), auxiliary verbs (such as *am*, *are*, and *is*), and the types of suffixes that we use to communicate tense (such as *–ing* and *–ed*). Because these elements tend to be missing from these multiword combinations, this type of speech has been dubbed **telegraphic speech**, as it resembles the concise style that people used when writing telegrams. Since the sender was charged by the word, function words were omitted from telegrams. It has been suggested that function words are costly to children as well, requiring a working memory and other cognitive resources that may be unavailable to a child at this point in development.

Grammatical Development

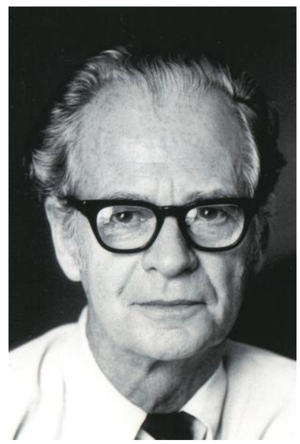
As children begin to master **grammar**, the system of rules governing the combination of linguistic units into meaningful phrases and sentences, their utterances become longer and more complex. They begin to fill in some of the words that were missing from their telegraphic speech, and they begin to create plurals and verbs of various tenses by applying suffixes in a rule-governed way. For instance, the telegraphic utterance, "Get blankie" may be transformed into, "I'm getting my blankie." However, the application of grammar rules may cause children to produce errors where none had previously existed. For instance, a child who previously produced, "I ate it," may now produce, "I eated it." It may seem that the child's speech has regressed, but errors such as this actually indicate that the child's linguistic skills have progressed. The child is now using a rule to create past tense words, whereas she previously had simply memorized the sounds of words. This new ability to apply a rule enables the child to create the past tense of new verbs, even when she has never heard the past tense of those words. The application of a rule sometimes leads to **overgeneralization**, an error produced when a rule is applied to an irregular word—a word to which the regular rule does not apply. Overgeneralizations, such as *goed*, *holded*, *bringed*, *bited*, *mouses*, *gooses*, and *mans*, eventually disappear from the child's vocabulary. The rule that produced those overgeneralizations supports our ability to pluralize words (singular noun + s) and create past tense verbs (verb + ed), even when confronted with novel words. What is the plural of *mib*? Mibs. What is the past tense of *tupp*? Tupped. A child who has mastered these rules can perform these transformations effortlessly. By the age of 4, children have acquired the grammatical rules of their language.

Theories of Language Acquisition

A typical three-year-old has a vocabulary of a few hundred words and can string together simple sentences and phrases, though they may not be the best conversational partners. And yet, while many animals display some noteworthy communicative abilities, no other creature on the planet even comes close to this level of linguistic sophistication. In fact, vocabulary growth proceeds so rapidly that by the age of five most children know about 10,000 words and can generate complex, novel sentences. Though there is a great deal of individual variability in language development, all across the world human children quickly become competent speakers of the language in their communities. What accounts for this remarkable ability to acquire language?

One possibility is that language acquisition is driven by our general capacity to learn from our experiences in the world. This viewpoint is commonly referred to as the **nurturist perspective** because it suggests that the child's environment (how they are nurtured) is the key to language learning. The nurturist perspective is famously associated with behaviorist psychologist **Burrhus Frederic (B. F.) Skinner** (1904-1990). Behaviorism was the dominant approach to psychology in the first half of the 20th century, and behaviorists believed that human psychology could be explained as a result of learning and environmental factors, with no need to posit mediating internal mental states. Skinner therefore suggested that children learn language just like they learn any other complex behavioral skill. Specifically, he highlighted the power of learning through environmental reinforcement (also known as operant or instrumental conditioning).

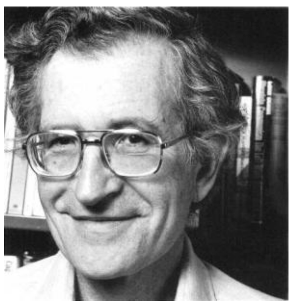
B. F. Skinner (1904-1990) supported a nurturist perspective on language acquisition, arguing that children learn language in the same way that all animals learn complex behavioral skills--through reinforcement.



To get a sense of how this type of learning works, consider how you might teach your pet dog to run over to you and lie down whenever you whistle at him. At first, he will only respond with random movements when you whistle because he has not yet been trained with this command. At some point, however, he might happen to move towards you after you whistle, at which point you can reward him with a tasty treat. This reward will *reinforce* this particular action and make it more likely that he will approach you again the next time you whistle. After he has mastered this first step, you can modify your reinforcement strategy so that you will only reward him if he comes a little closer to you. If you repeat this process over time, you can gradually shape his behavior until he has learned to execute the full sequence of desired actions.

Skinner spent most of his scientific career investigating variations of this type of learning in laboratory animals. In his well-known 1957 book, *Verbal Behavior,* he argued that these same principles could explain how human children acquired language. For example, if a baby is babbling and happens to randomly generate a sequence of syllables that sounds like "mama," the caregiver might react by smiling and exclaiming, "Yes, I am your mama!" In this way, social affection or attention can be seen as a reward that reinforces the desired verbal behavior of the child (making it more likely that they will say "mama" again in the future). Skinner's book is devoted to analyzing a variety of different linguistic behaviors and how they might be learned through extensions of this basic reinforcement process.

Not everyone was convinced that language acquisition could be accounted for by appealing to basic learning principles, however. The most influential critique was a 1959 review of *Verbal Behavior* written by the linguist **Noam Chomsky** (b. 1928), which many scholars believe helped contribute to the decline of Behaviorist (nurturist) views of psychology in the second half of the 20th century. Chomsky argued that linguistic phenomena were far too complex to be explained via reinforcement learning alone. For example, the children of immigrants become fluent in the language of their new homeland while their parents rarely do, which implies that children can pick up a language without direct caregiver reinforcement. Furthermore, children (and adults) can easily understand and construct sentences that they have never heard before, which suggests that we must possess some abstract knowledge of the grammatical rules that define how our language is structured and organized. Chomsky concluded that there is simply not enough information available in the experience of the child to be able to learn these grammatical rules, a line of reasoning that has become known as the **poverty of the stimulus** argument.



Noam Chomsky (b. 1928) supports a nativist perspective on language acquisition, arguing that the brain contains an innate, specialized system for acquiring language.

Chomsky devoted his linguistic career to articulating an alternative, **nativist perspective** on language acquisition (Chomsky 1965, 1986). He suggested that the human brain must contain an innate (or "native") language acquisition device that automatically tunes itself to the grammar of whatever language it is exposed to during the early stages of development. In effect, the brain must come pre-equipped with a sort of universal grammar that can accommodate any possible natural human language. The theory that we have evolved a specialized piece of neural machinery exclusively for language processing quickly became the dominant viewpoint in linguistics and psychology as researchers highlighted additional evidence in support of the nativist framework. For instance, the deaf children of parents with normal hearing would often automatically generate communicative gestures that appeared to be very much like a simple language ("home sign"), even though these children had never been exposed to any sign language before (Goldin-Meadow & Feldman, 1977). When home-signing children congregated together at a school in Nicaragua in the early 1980s, they ended up spontaneously creating their own more elaborate sign language that all of the students could use and which exhibited the core properties of natural language (Senghas, Kita, & Özyürek, 2004). Phenomena like these led the psychologist Steven Pinker to proclaim that humans must possess a special "language instinct" (Pinker, 1994).

In the past twenty years, however, many people have challenged this strict nativist perspective, arguing that we do not need to posit an innate language acquisition device to account for language development.

This updated version of the nurturist perspective has been driven in part by advances in our understanding of the power and nature of human learning abilities. Though Skinner focused on learning via reinforcement, humans (and certain other animals) also seem to be able to automatically learn the patterns or regularities in the information that is available in their experience. To understand how this works, think about a website that you frequent to buy clothing (or books or movies). When you decide to purchase a particular red shirt, the website probably gives you a recommendation for another item it thinks you might like, such a particular pair of brown shoes. But how can a website predict what you might want to buy? By tracking the patterns in people's shopping habits, the site has learned that people who purchase that red shirt also tend to purchase those brown shoes (and not, for example, a different pair of green shoes or another red shirt). In much the same way, children may be sensitive to the patterns or regularities in the linguistic information they encounter, such as which syllables are more likely to group together in a word, or which words are more likely to follow one another in a sentence. For example, if you hear the phrase "hit the nail on the _______," there's a good chance that the next word in the sentence is going to be "head." Computer simulations and experiments with babies support the idea that infants and children can learn these sorts of linguistic regularities, and also suggest that knowledge of more abstract grammatical rules may emerge from this same basic learning process (Elman et al., 1996; Saffran, Aslin, & Newport, 1996).

Other researchers have also highlighted the important role that human social processes play in language development. Caregivers automatically modulate the speech they use to talk to babies, speaking with an exaggerated, higher pitched intonation and a larger amount of acoustic space between the vowels (this is known as "motherese"). This makes it easier for infants to pay attention to and track regularities in the speech stream (Kemler-Nelson, Hirsh-Pasek, Jusczyk, & Wright-Cassidy, 1989). Furthermore, early word learning seems to depend on the infant's ability to understand the intentions of the caregiver who is speaking to them (Tomasello, 2003). That is, the child must be able to figure out what object or event in the world the caregiver is intending to communicate about in the first place before they can master symbolic language. By tracking these social cues, the task of learning what words mean and how they can be used may be greatly simplified, especially in conjunction with the powerful learning principles described above. Through this lens, then, language is thought to emerge from the interaction between basic learning mechanisms and sophisticated social exchanges as infants actively engage and interact with the people and world around them. For this reason, researchers sometimes refer to this new take on the nurturist viewpoint as the **emergentist perspective**.

Supporters of the emergentist perspective on language acquisition highlight the important role that human social processes and general learning mechanisms play in language development.

Today, psychologists and linguists are still debating which of these theories best captures our incredible ability to acquire language. Though there is not yet any consensus on the issue, this heated discussion has served to sharpen our understanding of the scope and limits of learning and the very nature of language itself.

Is Language Unique to Humans?

Linguist Noam Chomsky (1965) famously proposed that the ability to acquire language is innate in humans—that human genes contain blueprints for brain structures that enable us to acquire language effortlessly. He theorized that humans have a language acquisition device, a region or set of brain regions prewired to support language, and that other species lack a language acquisition device, rendering them incapable of developing language. Chomsky's nativist view has influenced many psychologists, including Steven Pinker, who has proposed that the ability to acquire language is a uniquely human biological adaptation (Pinker, 1994). He calls this adaptation the "language instinct." Many other psychologists have argued against this strongly nativist view, suggesting that we can't overlook the importance of the brain's powerful general-purpose learning mechanisms, which enable infants to learn about patterns that are present in the environment and support language acquisition (e.g., Elman et al., 1996). Still others have argued that behaviors are shaped by reinforcement (e.g., Skinner, 1957), suggesting that with the right reinforcement, nonhuman species may be able to acquire language. Thus, the study of animal communication can inform our understanding of the origin of human language.

Many species have systems of communication. Vervet monkeys warn each other about predators. Rhesus macaques can communicate about the quality of their food. Birds sing, as do whales. Are these communication systems the same as language? Are nonhuman species capable of learning language? If we were to raise a chimp as if it were a human child, would it naturally acquire language, just as children do?

To determine this, we must identify some of the fundamental components of language. **Language** is a communicative system in which arbitrary symbols (such as specific vocal sounds) are linked to specific meanings; these symbol-meaning constructs are more commonly known as **words**. Languages use a **generative grammar** so that individual units (such as words) can be combined in a generative manner to create an infinite number of meaningful sequences. Moreover, there are culturally-specific rules governing the creation of these sequences—or sentences. The words of a sentence are organized according to a formal system of rules called syntax. The rules of **syntax** enable us to understand the relationships between words in a sentence. Syntax governs word order, which allows us to determine who did what to whom. A small difference in word order may translate to a big difference in meaning. This is why two very different meanings emerge from the phrases, "the cat ate the mouse" and "the mouse ate the cat."

To determine whether nonhuman species have language, we can examine whether their systems of communication contain words, whether these words are combined in a generative manner, and whether the combinations are governed by formal rules.

Birds

Have you ever sat and listened to a chorus of birds? If you have, you've probably noticed that birds can produce a variety of different sounds. You've probably also noticed that birds often take turns vocalizing—almost as though they are taking turns in a conversation. Are the birds actually communicating with each other? Is birdsong a type of language?

Birdsong is used to advertise fitness to potential mates and foes.

There is a distinction between birdcalls and birdsong. The calls are shorter and tend to be produced with a specific purpose, such as advertising the presence of a predator. Therefore, birdcalls can communicate specific concepts. However, different calls aren't combined in a generative manner. So, birdcalls function like words, but the "words" aren't combined into meaningful sequences. These calls lack generativity and organizational rules.

The function and structure of birdsong is quite different from birdcalls. It is longer and is produced only by the males of most songbird species, and generally only during mating season. It is used to advertise the fitness of the male, and as such, it functions as both a courtship display and as a means of securing territory. The quality of bird vocalizations is influenced by parasites and disease (Garamszegi et al., 2004; Redpath, Appleby, & Petty, 2000), which allows females to identify healthy mates and enables male rivals to determine whether a bird is strong enough to defend his territory.

Birdsong is made of individual sound units that are organized in a generative manner to create new sequences. There even seems to be rules for organizing these units (Marcus, 2006). In this regard, birdsong has some properties of language—it is generative and has organizational rules. However, the individual units of sound don't seem to function as words—that is, they don't seem to communicate specific meanings. While birdsong does contain some of the building blocks of language, it doesn't match the human definition of language.

Whales

The song of humpback whales has been studied extensively, and it is remarkably similar to birdsong in form and function. The males sing during mating season, and their song is believed to function as a courtship display, signaling to females whether the male is healthy. It may also function as a means of establishing territory.

Male humpback whales sing during mating season. Their song is thought to function as a courtship display.

The structure of humpback whale song is similar to birdsong in that in contains units of sound that are organized in a generative manner. The structure of whalesong is systematic and rule-governed. The individual sound units, however, don't appear to have meaning. Like birdsong, whale song has some properties of language—generativity and organizational rules, but the units of sound are not analogous to words.

Nonhuman Primates

Many scientists have been particularly interested in the communicative systems of nonhuman primates, as humans and nonhuman primates share an evolutionary history and a taxonomic order. Certain species of monkeys have been observed to have a small set of vocalizations that function as words. Vervet monkeys, for instance, use different alarm calls to warn of the presence of eagles, leopards, and snakes. The monkeys respond in different ways when they hear each type of call, as evading a leopard requires different actions than evading an eagle. Vervets respond to these calls even in the absence of a visible predator. Rhesus macaques also have vocalizations that they use in specific circumstances to communicate with others. When a macaque encounters rare, high quality food, such as a mango or coconut, it will vocally alert others. Different types of vocalizations are produced in response to common, low quality food (Hauser & Marler, 1993). But both vervet monkeys and macaques lack generativity and organizational rules; they have a small number of "words," but they don't string them together to form meaningful sequences.

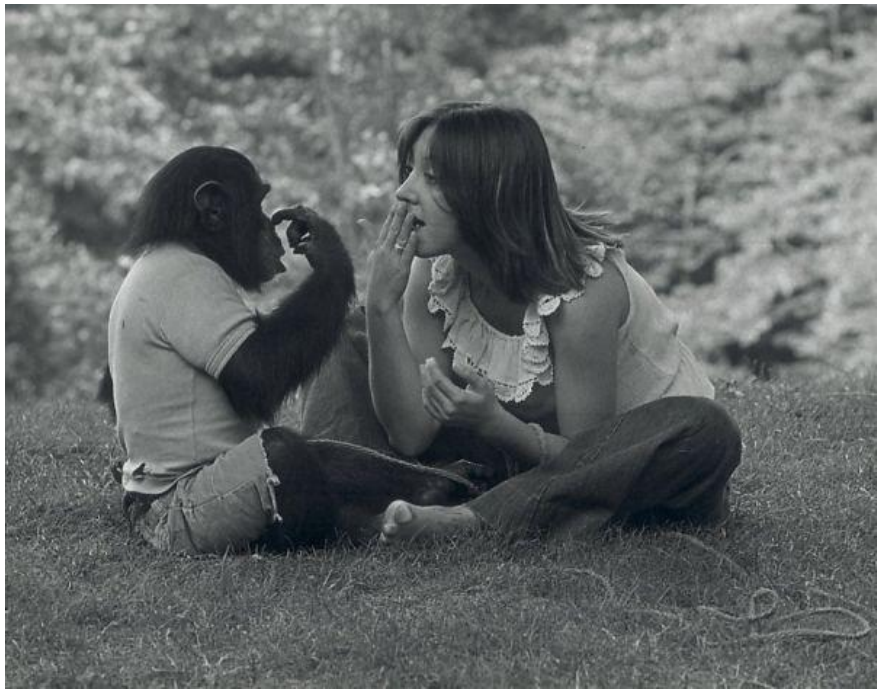
There have been a number of attempts to teach chimps language. Humans are more closely related to chimps than we are to any other primates, so it has been theorized that if any primates are capable of learning language, chimps are the best candidates. It was hypothesized that if language acquisition is merely a matter of environmental learning and behavioral reinforcement, a chimp raised in the same manner as a child should be able to learn language as easily as a child can. Since chimps lack the ability to pronounce the speech sounds used by humans, scientists have attempted to teach chimps sign language to test the aforementioned hypothesis.

The first attempt to teach a chimp American Sign Language (ASL) was made by Allen and Beatrix Gardner (Gardner & Gardner, 1969). They raised a female chimp named **Washoe** as if she were a child, incorporating her into their normal routine—chores, meals at the table, car rides, etc.—while teaching her ASL. Washoe is reported to have learned to use over 100 signs, which she arranged into combinations to which she'd never been exposed. For instance, she was reported to have once signed "water bird" upon seeing a duck and "dirty monkey" after fighting with another monkey—word combinations that her trainers had never used. Although Washoe did generate combinations of signs, there is only anecdotal evidence that her signs followed organizational rules resembling syntax. Washoe's trainers have been criticized for making claims about her abilities without publishing data to support those claims (e.g., Seidenberg & Petitto, 1981).

Washoe's trainers attempted to teach her American Sign Language.

A research group led by Herbert Terrace at Columbia University attempted to study chimp language using a more rigorous, scientific approach than that used by the Gardners in their study of Washoe. Terrace and colleagues attempted to teach ASL to a young male chimp. They dubbed their test subject **Nim Chimpsky**, a pun on Noam Chomsky, who argued that only humans could acquire language. Terrace and his team set out to prove Chomsky wrong. Through extensive training, Nim was able to learn 125 signs, which he combined into sequences such as, "Grape eat Nim," and "Banana me Nim me." Nim's longest sequence was reported as, "Give orange me give eat orange me eat orange give me eat orange give me you." Although he was able to create sequences by combining signs, Nim's sequences didn't follow any organizational rules. Terrace and colleagues eventually concluded that the project was a failure and that Nim's signed sequences could not be considered language (Terrace, Petitto, Sanders, & Bever, 1979).

Developmental psychologist Laura Ann Petitto was Nim's primary trainer. Nim was able to learn over 100 signs, but he failed to learn word order rules.



While many nonhuman species possess some of the building blocks of language, such as a small set or words or the ability to generate sequences according to organizational rules, humans seem to be the only species in possession of all of these components of language. However, we cannot conclude that these findings are consistent with Chomsky's strongly nativist view, as we don't know whether these animals are lacking a "language instinct" or whether they lack the general-purpose learning mechanisms needed for language acquisition. By examining the properties of the human brain that support the computations needed for language, we can begin to understand what separates man from beast.

The Influence of Language on Thought

We commonly use language to communicate our knowledge and beliefs to others, which can influence how they think and act. For example, if I tell you that your psychology professor is a harsh grader who loves cupcakes, you will probably think about running to the bakery before your next exam. However, the relationship between language and thought is often more subtle than this overt exchange of ideas; at times, very slight differences in word choice or grammar can significantly impact our behavior. When prunes were rebranded as "dried plums" in California in the early 2000s, sales increased by more than 5% in the first year alone ("Dried Plums," 2001). Advertisers rely on the fact that when we process language we automatically associate the words we encounter with other words and concepts, which can then influence what we think about (and whether we decide to buy the product). In this case, although *prunes* and *dried plums* are just different labels for the same thing, prunes are typically associated with old age and digestive problems, while dried plums are not.

Which would you rather eat? Even though these packages contain the same fruit, prunes are associated with things like digestive problems and old age, making dried plums the more tempting treat for many consumers.

These effects are not limited to consumer shopping habits. In a study that was conducted just prior to the 2008 presidential election, a brief questionnaire was administered to a group of Californians to probe their feelings about voting in the upcoming election. For half of the participants, the questions included a verb to refer to the act of voting (e.g. “How important is it to you *to vote* in tomorrow’s election?”). For the remaining participants, the questions included a noun phrase instead (e.g. “How important is it to you *to be a voter* in tomorrow’s election”). Voting records showed that participants who filled out the noun phrase questionnaire were about 15% more likely to vote in the presidential election than participants who filled out the verb phrase questionnaire. How could such a small difference in wording create such an incredible difference in behavior? The researchers argued that the noun phrase (implicitly) led participants to consider the value in being the type of person who could be labeled a voter. Since people are generally motivated to maintain a positive sense of self, they are more likely to cast a vote when they are thinking about how it might enhance their self-image (Bryan, Walton, Rogers, & Dweck, 2011).

What about people who speak different languages? There are roughly 7000 languages spoken on earth, and they differ from one another in a variety of ways – from their vocabulary and writing direction to more subtle variations in grammatical structure. Does speaking a particular language shape the way you think? This question has a long intellectual history, but it is commonly associated with the work of the linguist **Benjamin Lee Whorf** (1897-1941). Born in Massachusetts and trained as a chemical engineer, Whorf developed a keen interest in linguistics while working as a fire prevention consultant, studying and writing about several different languages in his spare time. He eventually attended classes and lectured at Yale University, where he worked closely with the noted anthropologist and linguist Edward Sapir.

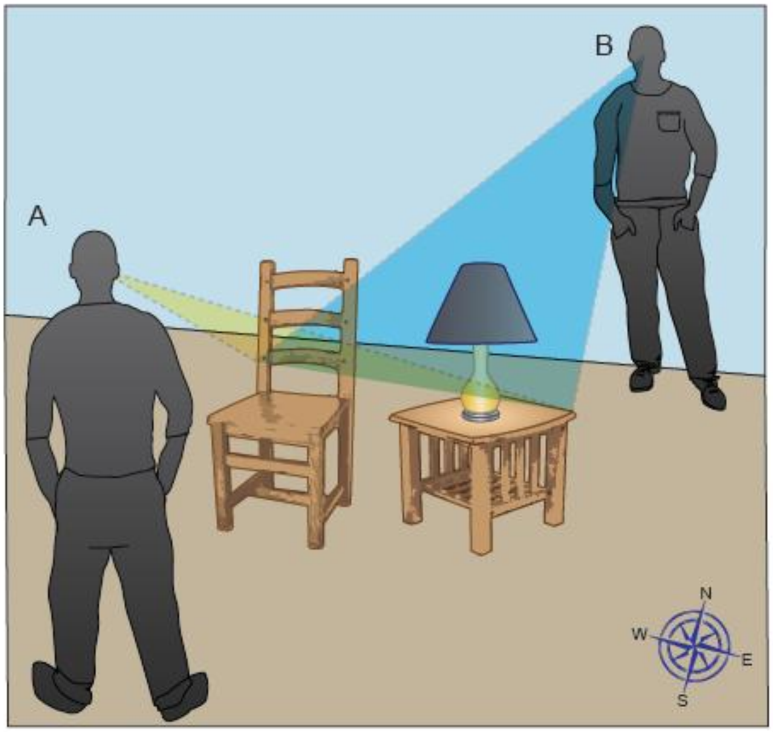
Benjamin Lee Whorf (1897-1941) was an American linguist, best known for his work on linguistic relativity, the idea that the language you speak shapes the way you think about and experience reality.

Both Whorf and Sapir believed that language plays a critical role in how we think about the world. According to Whorf (1956), “We dissect nature along lines laid down by our native languages… the world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds—and this means largely by the linguistic systems in our minds.” In other words, we perceive and understand reality through the lens of our language, which classifies our experiences into coherent categories. Since different languages have distinct ways of partitioning experience, speakers of these languages should come to think very differently about the world, an idea Whorf referred to as the principle of **linguistic relativity** (though it has become popularly known as the **Sapir-Whorf Hypothesis**, or just the Whorfian Hypothesis).

To take one example, Whorf argued that the Hopi Native American language does not have any means of referring to the concept of *time* in the way that English does, as a substance that flows in a linear fashion and can be divided into past, present, and future. He therefore proposed that Hopi speakers do not think about or experience time in the same way that English speakers do. In the extreme, linguistic relativity amounts to a form of **linguistic determinism;** the idea that the language we speak exclusively determines the contents of our thoughts. However, in some of his writings Whorf expressed a more moderate position, suggesting that patterns in language influence patterns in thinking, but that language is not the sole determiner of thought.

While Whorf’s views initially attracted a great deal of attention, support for linguistic relativity waned in the second half of the 20th century in the face of scholarly criticism and a lack of convincing empirical evidence (Bloom & Keil, 2001; Pinker, 1994; Pullum, 1991). At the time, most psychologists believed that basic cognitive processes were largely universal and independent of language and that most linguistic differences were largely superficial. Some scholars questioned Whorf’s linguistic analyses, arguing, for example, that the Hopi language does in fact have a means of discussing time (Malotki, 1983). Moreover, Whorf’s reasoning was attacked as circular because his primary evidence that language influenced thought was his analysis of language itself. In spite of these criticisms, in the past twenty years there has been a resurgence of interest in the Sapir-Whorf Hypothesis, driven by a greater appreciation for the role that individual experience plays in cognitive development and an array of novel and creative cross-linguistic studies.

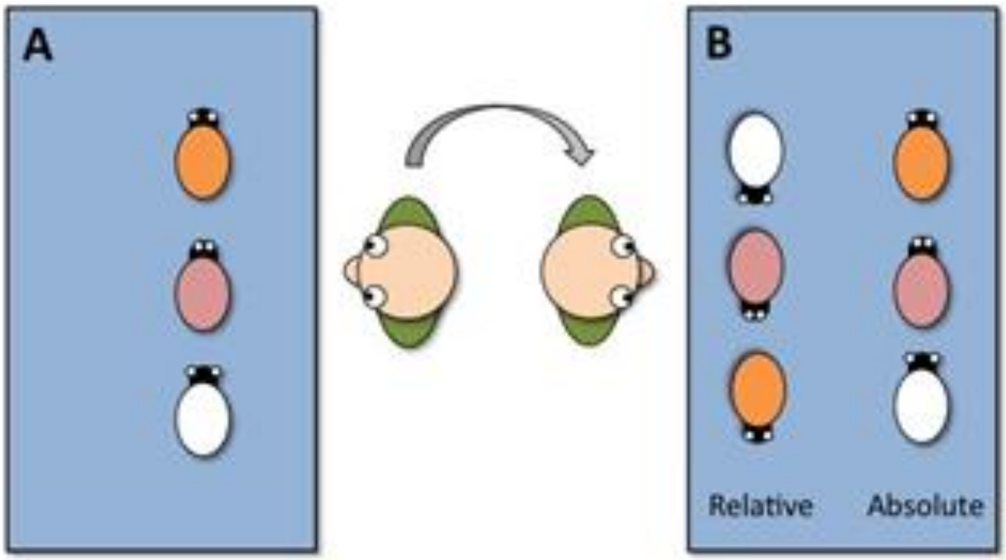
For example, consider the domain of space. In order to talk about where something is located, you must specify a particular frame of reference. If you say, “the chair is to the *left* of the cabinet” you are relying on the *relative* frame of reference because you are locating the chair relative to your current viewpoint. If you moved to the opposite side of the room, the chair would now be to the *right* of the cabinet relative to your position. But you might also say, “the chair is to the *west* of the cabinet,” which would be true no matter where you were standing in the room. This expression therefore specifies an *absolute* frame of reference.



Where is the chair? You could respond using the *relative* frame of reference and say, “the chair is to the left of the cabinet,” but only if you were standing in location A. If you were in location B, you would have to say, “the chair is to the right of the cabinet. You could also respond using the *absolute* frame of reference and say, “the chair to the west of the cabinet” (no matter where you were standing).

English and Dutch include terms for both the relative and absolute reference frames, but speakers of these languages mostly rely on relative terms in everyday life (would you ever say you left your keys to the northeast of the television?). However, some languages – like the Mayan Tzeltal language spoken in parts of Mexico, and the Australian aboriginal language Kuuk Thaayorre – lack relative words like left and right. Instead, speakers of these languages talk about spatial locations with absolute coordinates, using terms that roughly align with the cardinal directions (north, south, east, and west).

Do these linguistic differences have any cognitive consequences? In one experiment, participants were seated at a table and three plastic toy animals were lined up in a row in front of them. Participants were then rotated 180° and, after a brief delay, were instructed to recreate the array of toys on a testing table. Dutch speakers always recreated the array in accordance with the relative frame of reference, so that if the toys were facing to the right on the original table, they would line them up facing right on the testing table. Speakers of Tzeltal did the exact opposite, lining the toys up in accordance with the absolute reference frame, even though this meant the toys would now be arranged in the opposite direction relative to the participant. The same pattern was observed in several variations of this study, suggesting that the way we talk about spatial locations influences how we perceive, remember, and think about how objects are arranged in the environment (Pederson et al., 1998). Researchers have documented similar effects in other domains such as color, time, motion, and shape (Boroditsky, 2003; Winawer et al., 2007).



Does the way you talk about space influence the way you perceive and remember objects? In one experiment: (A) participants watched as three plastic toy animals were lined up in front of them on the table, then (B) they rotated 180° and had to recreate the array of animals on a new table. Dutch speakers did so according to the relative frame of reference, while Tzeltal speakers did so according to the absolute frame of reference.

Language can also serve as a tool for thinking about the world, enhancing our general cognitive abilities in a variety of ways (Gentner & Goldin-Meadow, 2003). For example, number words make it a lot easier to think about, remember, and manipulate exact quantities. If you want to know whether you have enough gum to share with everyone in your class, you simply count how many pieces you have and compare that number with the number of students in the class (which you could also count quite easily). Would you be able to do this if your language did not have any way of referring to individual numbers? This is precisely the situation facing the Pirahã people of Brazil, who live in a remote corner of the Amazon rainforest and whose language does not include exact number words. In one experiment, spools of yarn were placed into an opaque container one at a time while a member of the Pirahã watched. They were then instructed to place the same number of balloons in a line in front of them, a task that would be trivial for a middle school student in United States. The Pirahã were able to succeed at this task when there were only a couple of spools placed in the container, but any more than one or two caused their performance to drop rapidly (Frank, Everett, Fedorenko, & Gibson, 2008).

In sum, language and thought are intimately related in several important ways. First, small differences in the specific words or labels we use can subtly influence our behavior because different words bring to mind distinct concepts and ideas. Second, while Whorf's principle of linguistic relativity remains controversial, there is now evidence suggesting that the language we speak can influence how we think about and remember certain aspects of our experience. Finally, in some respects language can be thought of as a tool that augments our ability to think in various ways.

DECISION MAKING

Making Decisions

Most of the things that you do each day involve making a **decision**, which is choosing an option from a number of alternatives. Decisions fall into two main categories: those that we make instantly without any real thought and those that we make slowly through a process of deliberation. These types of decisions rely on different processes.

Fast, Automatic Decisions

Fast decisions rely on processes that are largely automatic. Some are reflexive, such as jumping out of the way when a car comes barreling down the street while you're in a crosswalk. You don't have to deliberate about whether you should stay where you are or move. Emotions, such as fear of being hit by a car, can compel you to make spontaneous decisions that don't require you to weigh various possible outcomes.

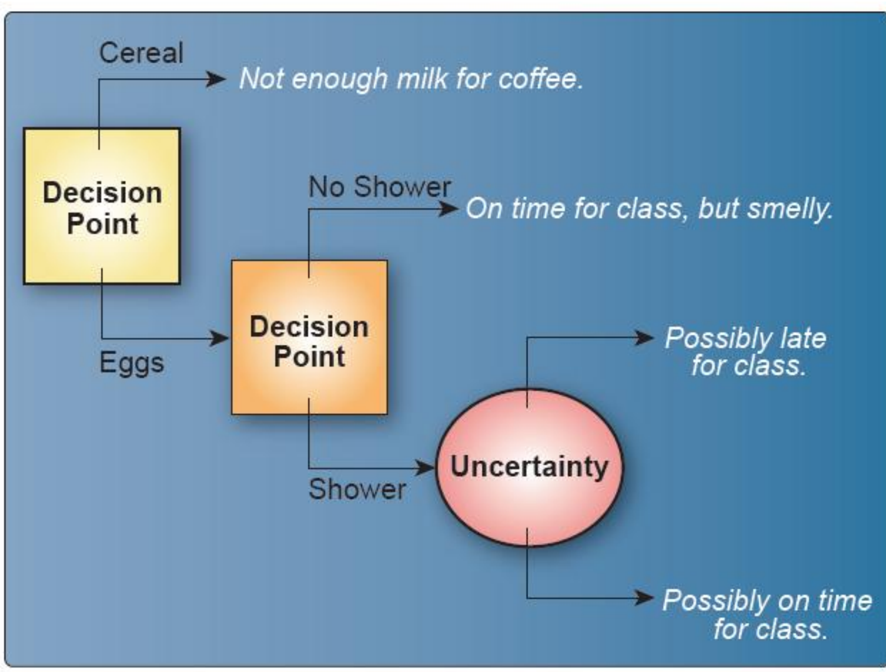
We can use our prior knowledge of the world and our interactions with it to make snap decisions. Some decisions are not reflexive, but require no deliberation. Imagine you're buying an ice cream cone, and the flavor options are chocolate, strawberry, or vanilla. Most people will decide on a flavor without putting any real thought into it. They make a snap decision: chocolate. A judgment like this is usually based on past experiences—a person who has always enjoyed chocolate ice cream more than the two other flavors will not have to think about the choices; their past experiences can drive this decision automatically.

Experts are often able to make snap judgments within their area of expertise. For instance, Malcolm Gladwell (2005) tells of snap judgments made by art experts who were consulted about a sculpture that was of questionable authenticity. Although scientific analysis of the sculpture did not reveal any evidence of forgery, the reactions of art experts told a different story. Numerous art experts had an immediate negative reaction to the sculpture. Within just a few seconds of viewing it, the experts knew that there was something "off" about the sculpture, even though they were unable to pinpoint what it was. Eventually, new evidence began to amass, suggesting that the art experts were right and the sculpture was a forgery.

Emotion can influence our judgments and behavior—sometimes without our realization. This was demonstrated in a famous gambling experiment conducted at the University of Iowa (Bechara, Damasio, Tranel, & Damasio, 1997). Participants were instructed to try to win as much money as possible by choosing cards from four different decks. Each card resulted in a monetary gain or loss. Decks A and B appeared attractive at first; winning cards were worth twice as much as those from decks C and D. However, the losing cards from decks A and B were five times more costly than the losing cards from decks C and D. Over the course of the experiment, the participants came to realize that Decks A and B were a bad bet (resulting in a net loss of $250 for every 10 cards drawn), whereas decks C and D were a good bet (resulting in a net gain of $250 for every 10 cards drawn). Participants drew an average of 50 cards before reporting that they liked certain decks and disliked others. But the interesting findings come from the initial stage of the experiment—before the participants could consciously report that any of the decks were a bad bet. The participants' palms began to sweat before taking a card from the bad decks. This sweating, measured by electrodes that were attached to the tips of the fingers, indicated that the subjects experienced anxiety each time they reached for a card from the bad deck. Along with this anxiety response, participants began to take fewer cards from the bad decks. However, this all happened before the participants had a conscious hunch about the decks. This study is just one demonstration of how emotions can influence decisions and behaviors without our conscious awareness.

Slow, Deliberate Decisions

Many decisions involve a process of deliberation, requiring us to consider a number of alternatives and choose the best one. The consequences of decisions are often uncertain, which introduces an element of risk. How do you decide which course of action is best? For instance, how do you choose what to have for breakfast? This seemingly simple decision involves weighing the immediate consequences of each choice. Suppose you have to choose between cereal and eggs, two foods that you like equally. These alternatives, along with their potential consequences, are shown in a decision tree. Both alternatives are associated with pros and cons. Eggs take longer to prepare, which could be a problem because you're in a rush—your morning class starts in 20 minutes. Cereal is a time-friendly option, but it requires milk, and you're almost out of milk. If you have cereal, you won't have enough milk left for your morning cup of coffee. You breakfast decision now involves uncertainty. If you choose eggs, you'll risk being late for class. If you choose cereal, you'll have to go without your coffee and will be less alert in class. To make this decision, you may have to consider additional information, such as the consequences of being late to class. You may even consider skipping your morning shower to save a few minutes of time—a decision that has its own set of possible consequences. When we make a decision, we must weigh the *probable outcome of each choice*, as well as the *personal value of each option*. In this scenario, you may need to decide which outcome you value the most: getting to class on time, showering before going out in public, or savoring your morning cup of coffee.



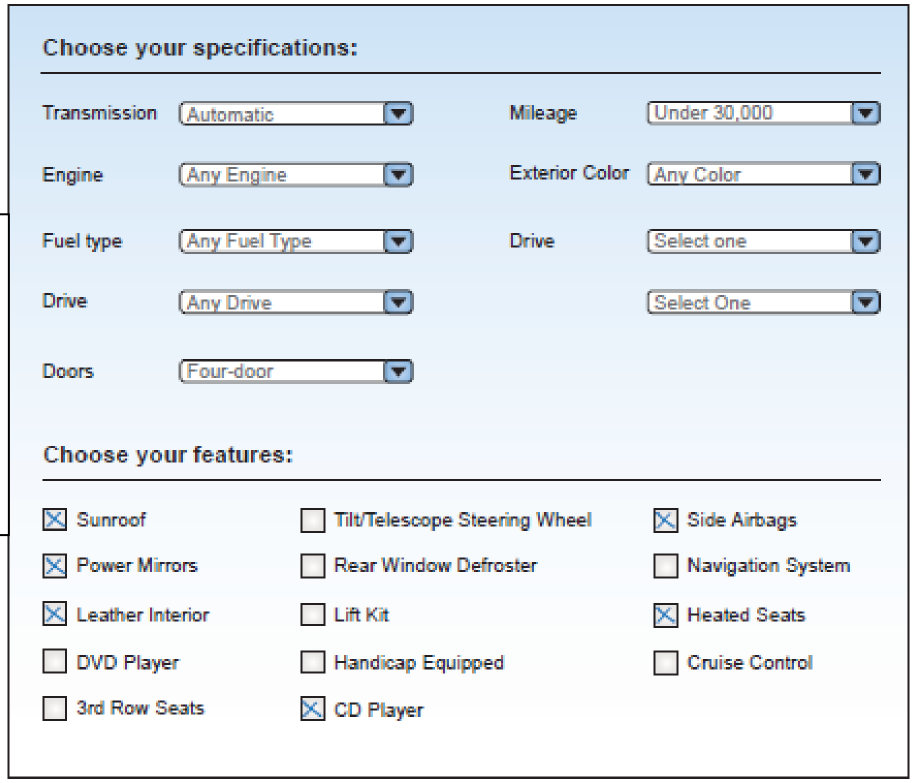
This decision tree shows the consequences of a fairly simple decision: what to eat for breakfast.

When making a decision, one needs to decide between **alternatives**, the various possible choices or courses of action available. The decision incorporates one's **beliefs** about the most probable consequences of each alternative—our estimates that certain outcomes will result from each possible choice. In the aforementioned scenario, you believe that taking the time to make eggs for breakfast may result in being late for class. Your belief may range from a weak estimate—a small possibility of being late—to a strong estimate—utter certainty that you will be late. Each decision has **consequences**, the chain of events triggered by the decision, as well as the benefits and losses associated with the outcome. When weighing possible alternatives, one considers the **utility** of possible outcomes—how much one personally values each outcome. For instance, a person who values academic success and personal hygiene may have an easy time making the aforementioned breakfast decision, as coffee may have less subjective utility than being freshly showered or getting to class on time. Coffee lovers, on the other hand, may be unwilling to sacrifice their morning brew and would have to decide which they value more: cleanliness or getting to class on time.

Decision Making Strategies

Suppose you want to buy a car. This decision is obviously far more complicated than deciding what to eat for breakfast. The sheer number of cars available for purchase is staggering, and you can't possibly evaluate all of them. You need to eliminate the majority of the alternatives so that you may evaluate only the cars that will best fit your needs. This strategy, known as **elimination by aspects**, involves excluding alternatives according to specific criteria. You may begin by eliminating cars that are outside of your price range and that are located more than 50 miles away from you. If you need an automatic transmission, you'll eliminate cars with a manual transmission. You may further narrow the field of alternatives by eliminating all cars that have more than 30,000 miles. Maybe you only want a car that has heated seats and a moon roof; you eliminate all cars that don't. Your elimination strategy may have left you with a small, manageable number of alternatives so that you can reasonably evaluate whether each alternative will meet your needs. When choosing between these alternatives, you may adopt an **additive strategy**, noting all of the desirable attributes of each alternative, perhaps weighting them according to how important each attribute is, and adding up the attributes for each possible choice to arrive at the alternative that best matches your needs. For instance, when choosing between three cars, you may create an additive score for each car based on safety ratings, miles per gallon, attractiveness, color, cost, and reliability ratings for that model. This additive strategy may help you decide which car is optimal for you. One the other hand, you may not want to spend so much time researching each car. You may be more concerned about finding a satisfactory solution than an optimal solution. You may opt to **satisfice**, choosing the first option that meets your criteria—the first satisfactory alternative (Simon, 1955).

The websites of car dealers sometimes utilize the elimination by aspects search strategy to help you find a car that will meet your needs.



When making decisions in the face of uncertainty, we often rely on **heuristics**, which are rules of thumb that help us judge information and arrive at decisions. For instance, when judging which car companies build unreliable cars, you may think about the cars that you, your family, or your friends have had trouble with in the past. You may rule out a company if you can easily think of people who have had problems with that company's cars. This is an example of an **availability heuristic**, which involves searching your memory for relevant events and information and basing your judgments on the ease of recall (Tversky & Kahneman, 1973). When we can remember an instance of an event quickly and easily, we may estimate that the event is likely to occur again. Thus, if you had a number of problems with your old car, you will avoid that car company in the future, as you'll likely think that company makes unreliable cars.

If you go to a dealership to test drive new cars, the dealer may use heuristics to calculate whether you're likely to actually buy a car. For instance, if you show up at a BMW dealership wearing old jeans, a sweatshirt, and sneakers, the dealer will probably think that you have no plans to buy a BMW, as people who have money to buy expensive cars tend to wear nicer clothing. The dealer is relying on the **representativeness heuristic**, in which one uses the typicality of a target—such as an item or event—to estimate the probability that the target belongs to a particular category (Tversky & Kahneman, 1974). When a target displays characteristics that are typical of a category, one can make inferences about the target. Car dealers are primarily concerned with two categories of people: those who buy cars and those who don't. The dealer may use surface features, such as your clothing, to categorize you. People who buy expensive cars don't typically come to the dealership in jeans and a sweatshirt, whereas people who have come to simply test drive a car that they can't afford may come to the dealership in such casual clothing on a fairly regular basis. In this instance, the target—you—would be representative of someone who has no intention of buying a car. If you were wearing a suit, however, the dealer may use the representative heuristic to determine that you have enough money to buy an expensive car. While this strategy may backfire now and then, as clothing does not always reflect one's financial resources, it probably leads to an accurate assessment more often than not. Use of heuristics can reduce the cognitive resources required for decision making.

Models of Decision Making

Suppose you're on a game show and you're given the choice of playing one of two games. In Game A, you would be presented with two briefcases; one contains $100, and the other is empty. You can open one briefcase, so you have a 50% chance of walking away with the prize. In Game B, you would be presented with four briefcases; one contains $250, and the other three are empty. You can only open one briefcase. Would you choose to play Game A or Game B?

According to the **expected value** model, the best decision is the one that results in the largest gain after taking probability into account. To determine the expected value of each game, simply multiply the odds of winning by the amount of the prize money. The expected value of Game A is $50, and the expected value of Game B is $62.50. According to the expected value model, you should choose Game B.

But what if instead of wanting to win the largest possible prize, you'd rather walk away with *any* prize, regardless of the size? This choice is best accounted for by the **expected utility** model, which reflects the personal values that we apply to specific outcomes, weighted by the probability of the outcome. The expected utility model can often account for choices that cannot be explained by the expected value model. The expected value model predicts that you should choose Game B in the scenario above, not acknowledging that the expected value is perhaps not the indicator that is most relevant to the decision maker. If you're struggling to make ends meet, you may place a higher value on winning a monetary prize of any size than on winning the largest possible prize. The expected utility model accounts for personal values; it would predict that you should choose Game A, so as to maximize your odds of winning a prize.

To a certain extent, the expected value model can explain consumer behavior, but there are situations in which the expected utility model can better account for spending decisions. For instance, suppose that a single roll of toilet paper costs $1. A package of 12 rolls costs $10. Which would you buy? According to the expected value model, you should buy the package of 12, since each roll will only cost 83 cents. What if someone offered you 1,000 rolls of toilet paper for $400? At 40 cents per roll, the expected value model dictates that you should take this deal. But you would probably rather buy the package containing 12 rolls, even though it'll cost you more than twice as much per roll. While the expected value model explains why you would buy 12 rolls rather than only 1 roll, it can't explain why you would buy 12 rolls instead of 1,000. The expected utility model, on the other hand, accounts for the personal value that you attach to massive quantities of toilet paper. The challenge of finding a place to store such a quantity makes this option of little value to you (not to mention the potential social ramifications of being known as the guy who hoards toilet paper). If you ran a hotel, however, the personal value that you attach to bulk purchases is likely very high. The expected utility model explains why this deal would be attractive to a hotel owner but not to a college student.

Even at a bargain rate, you'd probably find very little utility in purchasing 1,000 rolls of toilet paper!

The expected utility model specifies that rational principles should govern decisions. One of these principles is **transitivity**, which specifies that when there is a relationship between pairs of items, such that A is greater than B, and B is greater than C, the relationship will hold across all items, such that A is greater than C. For instance, if Alex is older than Billy, and Billy is older than Carlos, Alex is older than Carlos. This logic doesn't always apply to our decisions. For instance, you may like ice cream more than you like cookies, and you may like cookies more than you like cupcakes. When presented with a choice between ice cream and a cupcake, transitivity dictates that you should invariably choose ice cream. However, every so often, you might choose a cupcake over ice cream, violating the rule of transitivity.

Psychologist Amos Tversky (1937-1996) noted that participants in a gambling experiment made decisions that violated transitivity (Tversky, 1969). He presented participants with a choice between pairs of gambles shown in the table. When asked to choose between any two adjacent gambles (i.e., A or B? B or C? C or D? D or E?), participants chose the gamble with the higher payoff. However, when asked to choose between A and E, participants chose E, the gamble with the lower payoff but higher probability of winning. These findings demonstrate intransitivity in decision making.

Gamble	Probability of winning	Payoff
A	7/24	$5.00
B	8/24	$4.75
C	9/24	$4.50
D	10/24	$4.25
E	11/24	$4.00

When choosing between adjacent gambles, higher payoffs were preferred. When choosing between A and E, participants preferred E—a lower payoff, but a higher probability of winning (Tversky, 1969).

Tversky worked with psychologist Daniel Kahneman (b. 1934) to develop **prospect theory**, a model of decision making that improved on the expected utility model. Prospect theory reflects a pattern that Kahneman and Tversky noted repeatedly in their experiments; people exhibit risk aversion when making decisions about potential gains and exhibit risk seeking behavior when making decisions about potential losses. For instance, consider the following choice:

Gamble A: 80% chance of winning $4,000, 20% chance of winning nothing

Gamble B: 100% chance of winning $3000

When faced with the choice between Gamble A and B, 80% of participants chose Gamble B, exhibiting risk aversion (Kahneman & Tversky, 1979). When faced with the possibility of a sure gain, most participants were unwilling to wager it to possibly gain more.

Participants were also asked to consider the following choice:

Gamble C: 80% chance of losing $4,000, 20% chance of losing nothing

Gamble D: 100% chance of losing $3,000

When faced with this choice, 92% of participants chose Gamble C. Kahneman and Tversky noted this risk seeking behavior in many experiments.

Prospect theory has become one of the most influential theories in behavioral economics, and Kahneman was awarded the 2002 Nobel Prize in Economics for his work (the prize is not awarded posthumously, so Tversky was not included in this award). Prospect theory helps us understand how people make decisions when there is an element of risk.

Barriers in Decision Making

Hooked on Heuristics

We often have to make decisions without knowing all of the relevant facts. In the face of uncertainty, we rely on **heuristics**, rules of thumb that help us judge information and arrive at decisions. We apply our prior knowledge and beliefs to form best guess judgments. For instance, what do you think is currently the top selling smartphone? Without looking up any sales reports, you can probably come up with an accurate answer. How did you arrive at your decision? You probably relied on an **availability heuristic**, which involves searching your memory for relevant events and information and basing your judgments on the ease of recall (Tversky & Kahneman, 1973). In this instance, you probably searched your memory for references to smartphones, such as commercials, print ads, conversations with friends, and product reviews. Commercials keep products available in our minds so that when we go to retrieve information about specific types of products, we think of the products that we have seen advertised recently (which is why advertising leads to increased sales).

Psychologists Amos Tversky (1937-1996) and Daniel Kahneman (b. 1934) were the first to identify many of the heuristics that we use when making decisions in the face of uncertainty (Tversky & Kahneman, 1974). We use heuristics because they generally lead us to in the right direction. However, heuristics sometimes lead us astray. Tversky and Kahneman identified ways in which heuristics can **bias** our decisions, introducing systematic errors.

Who do you think is more likely to have an extramarital affair--a politician or a dentist? You can probably think of several political scandals involving some sort of indiscretion, while you may not know of any dentists who have had affairs. Does this mean that politicians cheat more often than dentists? Not necessarily. It simply means that we're more likely to hear about it when a politician has an affair. The love life of a dentist isn't exactly front-page news. In this instance, the availability heuristic may bias us to overestimate the number of politicians and underestimate the number of dentists having extramarital affairs.

When making decisions, we often need to quickly categorize items so that we can make inferences about how we should interact with those items. For instance, imagine coming across a large dog while hiking in the woods. You need to figure out whether this dog poses a threat to you so you will quickly look for features that will tell you whether this dog is wild (and potentially very dangerous) or is someone's pet. If the dog looks well groomed and has a collar, you will infer that it is a pet and is unlikely to be hostile. If the dog looks malnourished and unkempt, you would infer that the dog is wild and will behave unpredictably. When we categorize an item, we're able to make quick inferences about that item by drawing on our knowledge of other items in that category. These inferences can guide our behavior.

The representativeness heuristic can help us determine whether this is a wild dog or someone's pet.

We place items into conceptual categories according to whether the items have sets of similar features and characteristics. To do this, we may apply the **representativeness heuristic**, in which we use the typicality of an item to estimate the probability that it belongs to a certain category (Tversky & Kahneman, 1974). Although this heuristic is generally useful, it can also bias our judgments. Consider the following description: "Steve is very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail" (Tversky & Kahneman, 1974, p. 1124). Is Steve more likely to be a librarian or a farmer?

You probably think that Steve resembles a stereotypical librarian more than he resembles a farmer. The representativeness heuristic leads us to think he has a higher probability of being a librarian, but in this instance, this heuristic is leading us astray because it causes us to overlook an important piece of information: there are a lot more farmers than there are librarians. However, we're so swayed by representativeness that we ignore **base rates**, which in this instance is the probability that an individual is employed as a farmer or librarian. Base rates should factor into our judgment of Steve's occupation, but people often ignore base rates and instead use representativeness to judge probability. Kahneman and Tversky (1973) found that when people were provided with base rates and no other information, judgments of the person's probable profession matched the base rates. For instance, when participants were told that 30% of men in a sample were lawyers and 70% were engineers and they were given no information about a person's personality, they judged the person as having a 30% probability of being a lawyer. However, when the same participants were provided with a description of a stereotypical lawyer along with the previous base rates, the participants practically ignored the base rates and judged the person to have a higher probability of being a lawyer. Surprisingly, Kahneman and Tversky also found that providing participants with *any* description, even one that was completely uninformative (for instance, "A man of high ability and high motivation, he promises to be quite successful in his field."), also caused participants to ignore base rates! When provided with this useless description, participants judged the person to have a 50% probability of being a lawyer—even though they knew that only 30% of the men in the sample were lawyers. Descriptions—even meaningless ones—can cause us to ignore base rates.

Here are the results of six coin tosses.
Is the outcome of the next toss more likely to be heads or tails?

Not only does our use of base rates leave much to be desired, but most of us also have a poor understanding of chance events. Consider what happens when you flip a coin several times in a row. If the results of your first six tosses were heads, tails, heads, heads, heads, and heads (as shown in the photo), which outcome are you more likely to get on the next toss–heads or tails? After landing on heads five times and tails only once, you may think that you're due to hit tails. But each coin toss is independent, so the previous coin tosses don't influence whether you will hit heads or tails on the next toss. The belief that tails is "due" reflects a common error called the **gambler's fallacy**. The representativeness heuristic leads us to think that the outcomes of 10 coin tosses should resemble the outcomes of 1,000 coin tosses; that is, we expect the results of our coin tosses to reflect the 50/50 odds of the coin. However, the results we get in a small number of tosses are not necessarily representative of what we'd get if we were to toss the coin 1,000 times. You may want to keep this in mind if you ever decide to spend some time in a casino.

How much is this car worth? The dealer's list price will influence your estimate.

Take a look at the car in the photo. How much do you think it is worth? Based on this photo and nothing more, what would you estimate as a fair price? What if I told you that this car typically sells for $199,900? Does that change your estimate of how much this car is worth? If you found yourself raising your estimate, you're not alone. But if I told you that this car generally retails for $49,900, your estimate would be quite different. Our judgments are often influenced by **anchoring**, in which we use starting values—anchors—to determine the range of our subsequent estimates (Tversky & Kahneman, 1974).

Retailers use anchoring all the time. Whenever you enter a store and see a price tag that has a “Retail Value” crossed out and then a much lower price listed as the sale price, your estimate of how much the object is worth is influenced by an anchor—the retail value. If the sale price is considerably lower than the anchor, you might feel like you’re getting a real bargain. Infomercials use this tactic as well. “This juicer retails for $150! But you won’t believe the price we’re offering today. Not $125. Not even $100! It would be a steal at $90! But today, you can buy this juicer for the rock bottom price of $79.99!”

Biased by Beliefs

What kinds of articles did you read about the candidates of the last presidential election? If you strongly favored one candidate, you probably gravitated towards articles that cast your candidate in a positive light or his rival in a negative one. When seeking out new information, people are drawn to things that are consistent with their personal beliefs. This is known as **confirmation bias**, and it reveals that people tend to seek evidence that is consistent with their own beliefs.

When people inadvertently come across information that contradicts their beliefs, they often reject the information. This is known as **belief bias**. You can probably think of a few instances in which you experienced belief bias during the presidential election. If you came across any information that made the opposing candidate look good (or made your candidate look bad), you probably dismissed it. Beliefs shape the type of information we seek out as well as our ability to modify our preexisting beliefs to accommodate new information.

Before the election, who did you think was going to win? Right now, you would probably say you were fairly confident that President Obama would be reelected. But if you had been asked this question the day before the election, you probably wouldn’t have been quite as confident. We’re not very accurate when it comes to remembering our past beliefs. When we try to remember how we felt about something before it happened, we exhibit **hindsight bias**, an overestimation of how certain we were about the ultimate outcome. Today, you may think that you knew all along that Obama would be reelected, but before the election, your level of certainty was probably not quite as high as you think it was.

PROBLEM SOLVING

The Process of Solving Problems

No matter who you are or where you come from, your life is probably filled with problems. Whether you are working on the Sunday crossword puzzle, trying to finish your math homework, or figuring out how to find true love, whenever your current situation does not match your desired goal state you are faced with a **problem** in need of a solution. Is it possible to characterize the general process someone goes through when they make an effort to solve a problem? Are there different types of problems that call for different problem-solving approaches? Will any of us ever find true love?

One way of addressing these issues (except maybe the last one), is to think about the steps that people take when they are confronted with a problem. A colleague of the Nobel Prize-winning physicist Richard Feynman once remarked that Feynman's problem-solving method involved writing the problem down, thinking very hard, and then writing down the solution. Though this wry commentary on Feynman's genius offers little in the way of clarification, it does capture something about the typical series of steps people take when they try to solve a problem.

First, you have to accurately represent both the problem you are trying to solve and your desired goal or outcome. For example, if you are working on a crossword puzzle, your goal is to fill up all of the blank squares with the appropriate words, and the problem you face is determining what those words are based on the numbered clues with which you are provided. It would be difficult to make any progress on the puzzle if you did not clearly represent the nature of the problem itself. Just imagine how much harder it would be to figure out the words that go "across" if you thought you could only use the "down" clues!

The second step in the problem-solving process is to form a strategy for working towards your goal or solution. This may involve figuring out what resources you have at your disposal and what rules or limitations are imposed by the particular problem on which you are working. For instance, a professional crossword puzzler (assuming such a person exists), may be barred from using the Internet to help them crack the clues. At the same time, they may decide that a good strategy would be to work on one specific corner of the puzzle first instead of randomly picking clues from all over the place. In other words, they may define a small section of their larger goal, a **subgoal**, to accomplish first. This overall process of defining a desired goal and then figuring out the appropriate actions to take to minimize the difference between your current state and the solution state is known as a **means-ends analysis**. We will have a lot more to say about problem solving-strategies in the next section!

As a third step, you should implement the strategy you devised in the second step and start working towards your goal. As you proceed, though, you will need to monitor your performance to determine whether or not you have made any progress on solving the problem. If you have been working on a specific math problem for two hours and have not yet solved for X, you may want to rethink the particular strategy you are using.

Finally, when you think you have solved the problem, the fourth and final step is to evaluate your work to make sure that you have come up with the optimal or proper solution. If you believe you have solved a complex algebra problem, for example, you should plug the value you got for X back into the equation to make sure that the math adds up.

Algebra problems and games like tic-tac-toe or checkers are considered **well-defined problems** because the nature of the problem, the desired goal or outcome, and the particular operations or actions you can take to solve the problem are clearly specified. In playing checkers, for example, the goal is to capture all of your opponent's pieces and you can only move your pieces in a particular way based on the rules of the game. For a well-defined problem, monitoring your progress and evaluating your final solution is generally straightforward, though the problem can still be quite difficult to solve (students enrolled in advanced calculus are well aware of this fact).

Many of the problems we face in our daily lives, however, are not so clear-cut. When your English professor asks you to write a beautiful poem about autumn leaves, what are the criteria for succeeding at this task, and how can you be sure when you have achieved your goal? Even professional literary critics sometimes disagree about what defines a beautiful poem. And what about the problem of finding true love? How would you go about working on this problem? These are **ill-defined problems** because the goals are not clearly defined—it is not obvious what a "correct" solution to these problems should look like—and the actions you are allowed to take are not specified in advance.

While there is clearly a difference between solving a well-defined algebra problem and an ill-defined poetry problem, both of these problems can be worked on gradually by implementing a particular strategy. There are some ill-defined problems that seem to resist any such incremental progress, however. Consider the following riddle:

> A man has married dozens of women but has never been divorced, none of the women have died, and he is not a polygamist. How is this possible?

Have you figured it out? Solving this riddle requires that you recognize that the word "married" has at least two different meanings, one of which refers to the act of presiding over the marriage of others. In other words, the man in the riddle must be a priest, rabbi, or court justice—someone who is licensed to marry other couples in this sense. Problems like these are known as **insight problems** because the solution simply seems to "appear" to the problem solver in a flash of insight (the "aha!" moment). Often, this will entail spontaneously restructuring how you interpret the problem itself, like noticing that a specific word may have multiple interpretations. In the following two sections, we will explore different strategies people can take when they attempt to solve a problem, and what barriers exist that impair the problem-solving process.

Problem-Solving Strategies

Take a few moments to consider the following problems and how you might go about solving them:

1. If 3X + 5 = 17, then what does X equal?

2. Who is the tallest person in your hometown?

3. Imagine you are a doctor and you have a patient with a malignant tumor in his stomach. You cannot operate on him, but if the tumor is not destroyed the patient will die. There is a special laser that can be used to destroy the tumor as long as it hits the tumor all at once at a sufficiently high intensity. Unfortunately, at this intensity the healthy tissue that the laser passes through on the

way to the tumor will also be destroyed. At lower intensities the laser is harmless to healthy tissue, but it will not affect the tumor either. What type of procedure could you use to destroy the tumor with the laser, and at the same time avoid destroying the healthy tissue? (Adapted from Duncker, 1945 and Gick & Holyoak, 1980).

Let's start with Problem 1, a well-defined math problem. How did you solve it? One strategy would be to carry out the algebraic operations you learned in middle school to solve for X (i.e., subtract 5 from 17, then divide by 3). I will forgive you if your algebra is a bit rusty, however. Another effective strategy would be to use **trial and error** and just try different possible values for X until you happen to choose the right number (while discarding the wrong values along the way). For a relatively simple math problem like this one, that strategy actually works pretty well; assuming you start with the possibility that X=1 and move up by single integers, it will not take you long to figure out that X must be equal to 4.

Trial and error is often an effective strategy to use when you simply do not have any other idea about how to approach a problem. It can also be extremely time consuming, however, especially as the complexity of the problem increases; imagine using trial and error to figure out a multipart calculus equation where you have to solve for two different unknowns, X and Y! Additionally, trial and error really only works if there is a straightforward way of instantaneously evaluating whether you have solved the problem or not (as is the case with algebra problems).

Indeed, trial and error does not seem like it would really work for Problem 2 because you have no way of assessing which person really is the tallest unless you compare each person to everyone else in the town. So how would you solve this problem? One approach would be to go to every house and apartment in town and measure each person's height individually, and then simply check to see who is the tallest once you have measured everyone. This strategy relies on an **algorithm**, which is a step-by-step formula or procedure that guarantees you will find the correct solution as long as you follow it precisely. The algorithm here involves locating each resident of the town, measuring and recording their height, and then identifying the tallest person at the end.

Because you will always discover the correct solution, algorithms play an important role in problem solving. In fact, the algebraic operations you (could have) used to solve Problem 1 are a perfect example of algorithmic problem solving in action. Like trial and error, however, using algorithms can be very time consuming. Furthermore, algorithms really only work for well-defined problems; it is much harder to generate an algorithm for writing a Pulitzer Prize-winning novel or finding true love (though certain internet dating sites might claim otherwise).

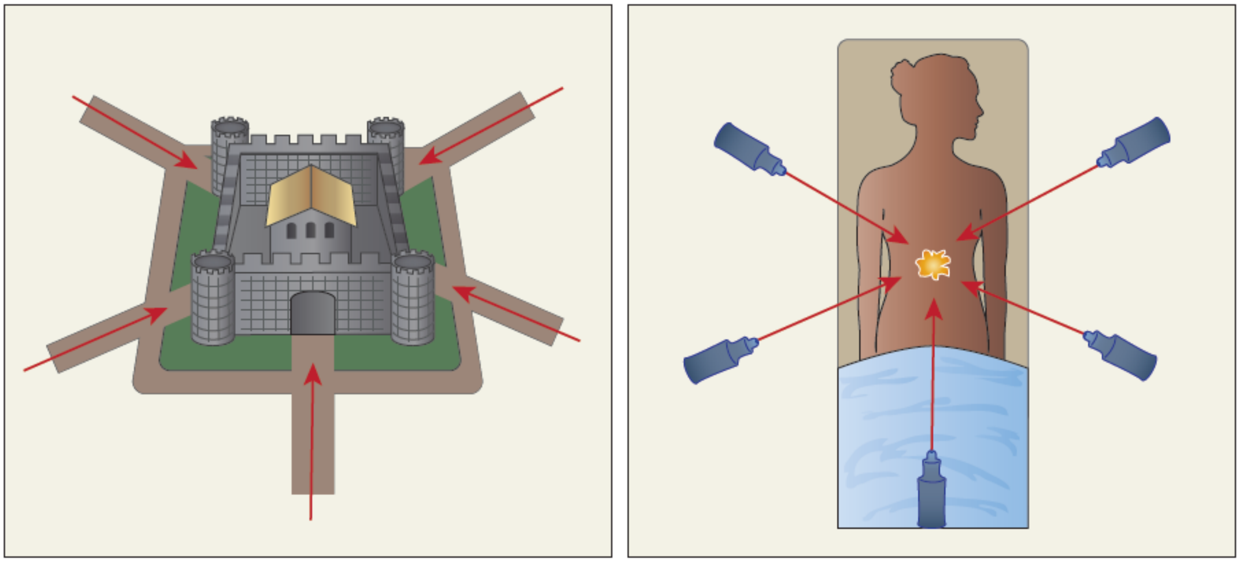
One way of saving time when you are working on a problem is to rely on a **heuristic**, which is a shortcut or rule-of-thumb strategy designed to quickly and efficiently produce a satisfactory solution (see also the section on decision making). Often, coming up with a workable heuristic depends on past experience in the problem domain on which you are working. For example, one heuristic you might use to solve Problem 2 would be to only measure the height of men who play on a basketball team, since you can make the reasonable assumption that they are likely to be the tallest people in town. Of course, while this speeds up the problem-solving process immensely, it does not guarantee that you will find the right solution like an algorithm would; there could always be a person who is seven feet tall but prefers bowling to basketball.

Now, what about Problem 3, an insight problem that does not seem readily amenable to any of the strategies discussed above? If you are struggling to come up with a way of destroying that tumor without killing your patient, do not worry, you are not alone: only about 10 percent of people come up with a viable solution to this problem when they first hear it (Gick & Holyoak, 1980). Maybe the following story will help you figure it out:

> An army general wanted to capture a fortress that was located at the center of his enemy's territory. There were multiple roads radiating outward from the fortress. Unfortunately, landmines had been planted on each road so that while small groups of soldiers could pass over the roads safely, any large force would detonate the mines. A full-scale, direct attack was therefore impossible. The general was very clever, however, and decided to divide his army into small groups and send each group to the head of a different road so that they would all converge on the fortress simultaneously (adapted from Gick & Holyoak, 1980).

At this point you may have noticed that the general's strategy for capturing the fortress can be applied in an analogous way to solve the tumor problem. If you position a bunch of lasers around the body of the patient and simultaneously fire weaker laser rays that converge on the tumor, you can hit the tumor with enough force to destroy it, while at the same time the weaker rays will not damage the healthy tissue they must pass through.

When people read the fortress story before they received the tumor problem, they were three times more likely to solve the tumor problem correctly. In fact, when they were explicitly given the hint that the fortress story might help them solve the tumor problem, the success rate rose to 75 percent (Gick & Holyoak, 1980). People solved the problem by drawing an analogy between the current problem they were faced with and another similar problem they had encountered before that had an identifiable solution—a strategy known as **analogical problem solving**.



In the Fortress and Tumor problems, a central target must be reached by surrounding the target with weaker forces that converge on the target simultaneously.

We frequently draw analogies between domains that are not similar in any obvious way; doctors healing tumors and generals attacking fortresses do not have many surface features in common. Rather, analogies often work because the domains share certain key abstract relationships: both the tumor and fortress stories involve a central target that cannot be reached by a large force applied at one location, and therefore the force must be divided up around the target and converge on it simultaneously. The ability to notice these abstract relationships and draw analogies between domains to come up with workable solutions plays an important and powerful role in problem solving, as well as reasoning in general (Gentner, 1983; Gick & Holyoak, 1980).

Unfortunately, it is not always easy to retrieve the appropriate prior experience from memory in the service of analogical problem solving. In the study mentioned above, many participants required an explicit hint from the experimenters in order to draw an analogy between the fortress and tumor stories. Sadly, life does not always provide us with such hints when we are working on a problem that might benefit from drawing a specific analogy. Luckily, life can provide us with multiple different analogous experiences, which may be just as good: when participants first read two stories that were analogous to the tumor problem, about 75 percent of them drew the appropriate analogy and solved the tumor problem, even without a hint (Gick & Holyoak, 1980)!

Problem-Solving Barriers

Even skilled problem solvers sometimes get stuck and are unable to make any progress on a challenging problem. Similarly, we occasionally come up with a solution that is off the mark or suboptimal, even when we feel like we are making real headway. Psychologists have documented a number of common factors that can act as barriers to successful problem solving, and by examining these factors we can potentially steer clear of them in the future in our own problem-solving endeavors.

As you read about in the previous section on problem-solving strategies, we often rely on our past experiences and prior knowledge as we work towards a solution to a given problem. The tendency to approach or represent a problem in a particular way because that approach has been effective in the past is known as a **mental set**. Though mental sets can help you when the problem you are working on can be solved in exactly the same way as an earlier one, sometimes relying too much on past experience can actually hinder your ability to solve a novel problem.

Consider the water jug problem depicted in the illustration below (adapted from Luchins, 1942). On every trial you are given three (virtual) jugs that each hold a specific amount of water. Your job is to figure out how to produce the desired amount of water by using these three jugs. For example, if you need exactly 100 gallons of water and jug A holds 21 gallons, jug B holds 127 gallons, and jug C holds 3 gallons, what should you do? Take your time!

PROBLEM	DESIRED AMOUNT	JUG A	JUG B	JUG C
1	100	21	127	3
2	99	14	163	25
3	5	18	43	10
4	21	9	42	6
5	31	20	59	4
6	18	15	39	3

For each problem, come up with the desired amount of water by using the jugs you have available. Be mindful of developing a mental set!

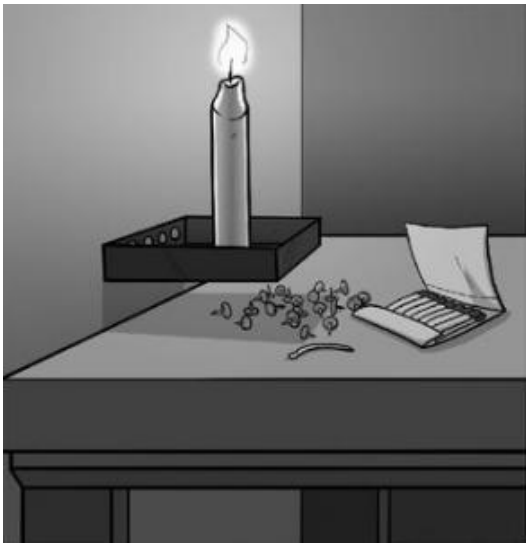
Did you figure it out? If not, try this: first, fill jug B to the brim (127 gallons). Next, pour out enough water from the now-filled jug B to fill up jug A (21 gallons), which will leave 106 gallons in jug B. Finally, use jug B to fill jug C up twice, leaving exactly 100 gallons in jug B. If you represent this as an algebra problem, the solution comes out to B - A - 2C. Now try your hand at the rest of the problems listed in the water jug illustration.

How did you do? What may have become apparent is that you could apply the same B - A - 2C algorithm that worked so well on Problem 1 to solve Problems 2-6 as well. What may not have been apparent is that you can also solve Problem 6 by using the much simpler A + C formula. People who work on this task often miss this simpler solution to the last problem because they have gotten used to solving these problems in a particular way (Luchins, 1942). In other words, their mental set has prevented them from discovering an easier solution to the well-defined problem at hand.

Similar issues can crop up for ill-defined problems as well. For example, imagine you walk into a room and are presented with the items depicted below (a candle, a box of thumbtacks, and a matchbook). Your task is to use these items to attach the candle to the wall (adapted from Duncker, 1945). Take a moment to think about what you might do to solve this problem.

Can you figure out how to attach the candle to the wall using only the items present on the table?

If your first instinct was to somehow melt the candle and use the hot wax to stick it to the wall, I am afraid that just will not work. The correct answer is depicted below in the illustration on the next page: use the tacks to mount the box to the wall, and then simply place the candle into the box. This particular insight problem is difficult for people to solve because they typically view the box merely as a container for the tacks rather than as an item that can be used in a novel way as part of the solution to the problem. The tendency to view objects as having a specific, normal, fixed function is known as **functional fixedness**.



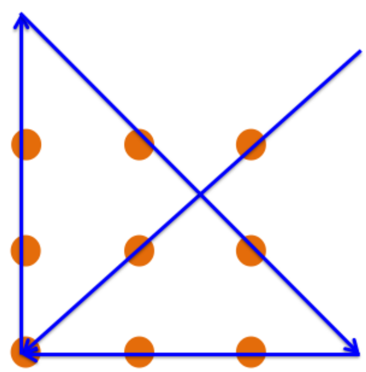
To solve this problem you must overcome your functional fixedness and realize that the box holding the matches can be used to hold the candle!

Often, the function you associate with a particular object will be based on your past experiences with that object, making functional fixedness analogous to a mental set effect. The way in which the objects are presented, however, is important as well, and can actually help free you from these constraints imposed by your past experience. For instance, when participants were faced with the same candle problem but the tacks were in a pile on the table and the box was empty, more than twice as many people came up with the correct solution (Adamson, 1952).

Studies of functional fixedness reveal that the way we interpret a problem (or the items we have to manipulate to solve a problem), can have a powerful impact on our ability to come up with a viable solution. Another way of thinking about this barrier to successful problem solving is that we sometimes **impose additional constraints** on the problem itself and erroneously assume that certain strategies or actions are not permissible. Consider the "9-Dots" problem depicted below. Using a pen or pencil, your task is to connect all nine dots using four straight lines without lifting your writing utensil up from the page (note: if you are reading this on a digital device, you may want to copy the dot pattern down onto paper before attempting to solve this problem!).

Can you connect all 9 dots using 4 straight lines without lifting your pencil up from the page?

How did you do on this one? If you are like most people, you started by putting your pencil down on one of the corner dots and drawing lines inside the square figure defined by the entire dot matrix. If that was your strategy, you were unfortunately doomed to fail. One possible solution to this problem is given below. As you can see, to solve the 9-Dots problem you have to think (well, draw), outside the box. Most people assume, however, that the lines must remain inside the square of dots, even though this is never stated in the problem instructions. By imposing this additional constraint, the problem becomes impossible.



Solution to the 9-Dots Problem

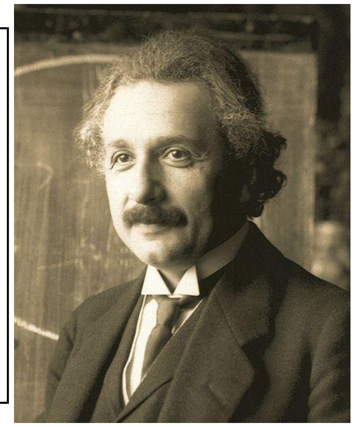
These examples highlight the fact that when we approach a new problem we often make quick decisions regarding which strategies to try out, and that problem solving can be hindered by making the wrong decision, imposing too many constraints, or relying too heavily on past experiences.

CREATIVITY

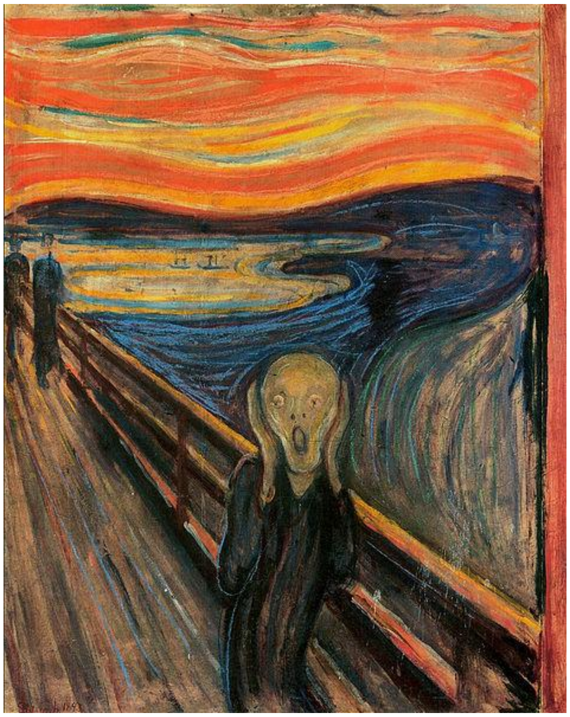
Characteristics of Creativity

Steve Jobs. Albert Einstein. Henry Ford. Michael Jackson. What do these people have in common? They are all celebrated for their creativity. Each of these individuals has made contributions of immeasurable value to our culture. The products of their imaginations have shaped the way we interact with technology, the way we think about the universe, the way we travel, and the music we create (not to mention the way we dance). Although their creative contributions had a global impact, achievements do not need to be so monumental to be considered creative. We engage in creative thought whenever we create an original drawing, improvise a joke, or find a new use for a familiar object.

Creativity comes in many forms. Steve Jobs, founder of Apple, was one of the leaders in the development of personal computers and many other devices. Albert Einstein's theory of relativity revolutionized physics.



Creativity is the ability to generate original, valuable ideas. This definition allows for multiple interpretations of "original" and "valuable." An individual may independently generate an idea that is novel to that individual, but the idea may not be original on a global scale. For instance, countless individuals undoubtedly imagined the concept of video on demand years before this mode of entertainment became a reality. (Imagine living in a world where if you missed an episode of *Breaking Bad*, *Dexter*, or *Mad Men*, you would have no option other than to wait months or years to catch the episode as a rerun! No wonder so many people dreamed of a system that would deliver any episode to their television with just the click of a button!) On the other hand, ideas may be original on a global scale, such as Einstein's theory of relativity or J. K. Rowling's Harry Potter books. Similarly, there are many ways in which something may be valued. A contribution may be universally valued or valued by a small number of people; parents may value the artistic creations of their children even more than they value the work of a famous artist, but the number of people who value each creation obviously differs. A creation may be valued because it is useful or simply because it is beautiful. The iPhone and Edvard Munch's painting *The Scream* are both highly valued, but for different reasons; the iPhone can be used to achieve many different goals, whereas the painting's utility lies primarily in its aesthetic appeal. These differences, however, should not lead us to conclude that one is more creative than the other. The fact that creative achievements span so many different disciplines and serve many different purposes makes it difficult to propose a more precise definition of creativity.

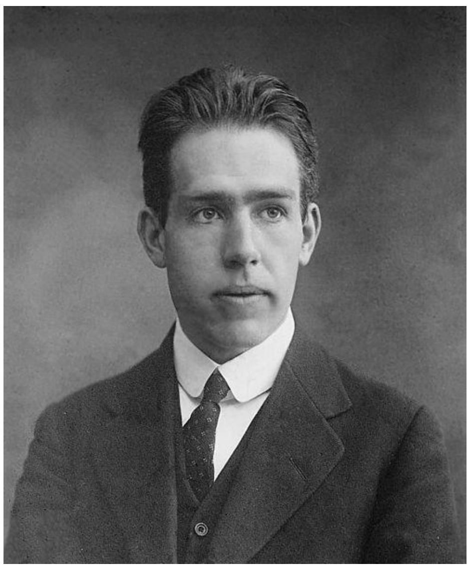


The Scream is valued for its aesthetic appeal.

The creative thought process is generally directed at solving a problem—often one with countless potential solutions. Creative thought is characterized not only by **originality**, but also by **fluency (**the ability to generate many possible solutions), and **flexibility** (the ability to shift between different perspectives and problem-solving strategies). Finding a creative solution to a problem often requires an individual to reorganize their knowledge. This reorganization may range from modifying something that already exists (such as innovating an existing technological device—just think of the number of modifications that have been made to devices for playing recorded music), to establishing an entirely new set of principles (such as identifying the principles of evolution or relativity).

Consider how the following anecdote (reported by Lubart & Mouchiroud, 2003) demonstrates originality, fluency, and flexibility of thought. A physics exam required students to describe how a barometer could be used to measure the height of a building. One student wrote that a person could tie a string to the barometer, take it to the top of the building, and lower the barometer over the side of the building until it reached the ground. One could determine the height of the building by measuring the length of the string. The student's answer was marked incorrect, as he had not used the principles of barometric pressure that he had learned in class. The student protested his grade, and a professor was asked to serve as an impartial judge. The professor asked the student to provide an answer that would demonstrate his knowledge of physics. The student then offered not one, but several alternative answers. He suggested dropping the barometer from the roof, measuring the time it took to reach the ground, and using a formula involving the gravitational constant to determine the height of the building. Additionally, one could put the barometer in the sun, measure the length of its shadow and the building's shadow, and use a simple proportion to find the height of the building. He offered another answer that involved using the barometer as part of a pendulum and taking measures at the top and bottom of the building. The student even suggested asking the building's superintendent to tell him the height of the building in exchange for the barometer! After providing several viable solutions, none of which involved the principles of barometric pressure, the student was asked whether he actually knew the answer the professor was seeking. He did, of course, but was sick of having to simply regurgitate information to get a good grade; he was clearly itching for opportunities to exercise his creativity.

This student's answers were certainly original, and he provided several possible solutions—a demonstration of fluency. Each answer used a different approach to solve the problem, showing flexibility of thought. This student was a man named Niels Bohr, and his creativity served him well in the future; he went on to win the Nobel Prize in Physics!



As a young man frustrated by his academic climate, Niels Bohr stunned his professors by suggesting several creative things they could do with a barometer.

The type of flexible thinking displayed by Niels Bohr is often referred to as **divergent thinking**, which involves considering a problem from multiple perspectives and generating a variety of answers that branch off (or diverge), in different directions. Divergent thinking is often open-ended and leads to a number of possibilities. We generally use divergent thinking when there is not a single "correct" answer. Niels Bohr's answers were surprising to his professors because they were looking for a single correct answer without considering the possibility that there are many ways that a barometer can be used to judge the height of a building. People generally use convergent thinking to answer questions such as this and, in fact, most questions on standard academic tests. **Convergent thinking** is an approach by which one narrows down the possibilities to arrive at a single correct answer. For instance, multiple-choice exams involve convergent thinking; you eliminate alternatives until you converge on the correct answer.

Given that most academic assessments focus on convergent thinking, one might think that divergent thinking is less valued; this is not the case, however. Divergent thinking is necessary for creative professions such as writing, product design and development, marketing, and the entertainment industry. It is also used constantly by people in professions that are not traditionally thought of as creative, such by scientists, military strategists, politicians, and law-enforcement agents. Early and repeated engagement in the arts and other activities that foster divergent thinking skills may contribute to future success in professions that require divergent thinking.

Measuring Creativity

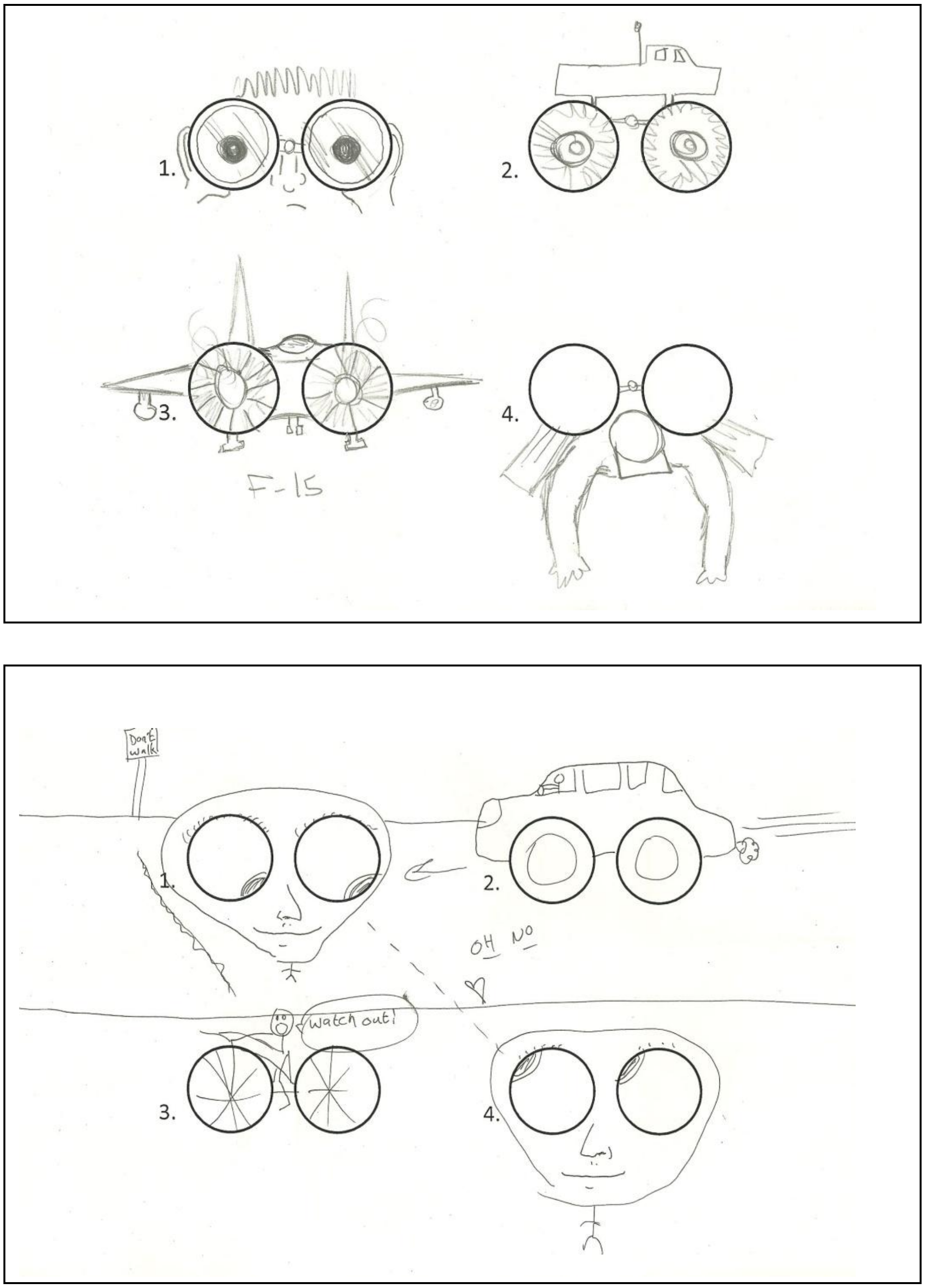
Can we objectively measure creativity? Does it have anything to do with intelligence? A psychologist named Lewis Terman was interested in the relationship between intelligence and achievement, and in 1921, he embarked on a longitudinal study to determine whether children who were identified as “gifted” would go on to be the best and brightest minds in the country (making the most important contributions to science, medicine, literature, and so on). He measured the intelligence quotient (IQ) of thousands of children and identified approximately 1,500 children of exceptional intelligence. The average IQ score of this group was 151. Considering that the average IQ of the general population is 100, and anything above 140 is considered genius-level intellect, Terman’s group of children was truly exceptional. He followed these children (who became known as the “Termites”), over the course of their lives, reporting about their activities and achievements at regular intervals. The report from the thirty-fifth year of the study (Terman & Oden, 1959) indicated that many of the Termites went on to be very productive and successful; the group as a whole had produced over 2,000 scientific articles, 90 books, and had secured over 200 patents. However, only a small number of the Termites made these notable creative contributions to society; the majority of the Termites ended up working as policemen, typists, filing clerks, fishermen, and in other common careers. It is worth noting that none of the Termites ever received the Nobel Prize, an award that may be considered the ultimate recognition of one’s creative contributions. (Incidentally, two children who had been among those screened for inclusion in Terman’s study did go on to receive the Nobel Prize, but these children had been passed over by Terman—they weren’t smart enough to be included in his group of Termites!)The results of Terman’s study suggest that there is not a clear relationship between IQ and creative achievement. Although those who make important creative contributions tend to be smart, they do not need to have a genius-level IQ; there is more to creativity than IQ.

The questions on standard IQ tests require **convergent thinking**, which involves narrowing down the possibilities to arrive at a single correct answer. Creative solutions often involve an entirely different mode of thought called **divergent thinking**, in which one starts with a problem (or a goal), and considers it from multiple perspectives or approaches, generating a number of possible solutions. Divergent thinking is generally used when a problem is not clearly defined, such as when one is attempting to compose a song or story, create visual art, or develop an invention. In these instances, there is not a single “correct” answer. Since IQ tests focus on convergent thinking, IQ scores do not reflect one’s ability to think divergently—an important component of creative thought. This may be one of the reasons why Terman’s group of highly intelligent children did not become the creative leaders of their time; their high IQ scores did not reflect their divergent thinking skills. There are countless cases of individuals with average or below average IQ scores who produce works that are considered highly creative; there are also many highly intelligent people who do not produce creative content. Although there have been attempts to devise a creativity quotient (analogous to IQ), creativity comes in so many different forms that it is difficult to devise a test that captures the essence of creative thought. Nonetheless, tests have been developed to measure various components of creative thought.

How many uses can you think of for a brick? Try to think of interesting and unusual uses. Take a few minutes to write down some ideas. You have just performed the Alternative Uses task, which was developed by Guilford (1967). This task requires one to generate as many potential solutions as possible—a process known as **brainstorming**. Although this example used a brick, many different objects are used in the Alternative Uses task, such as a blanket, paper clip, pen, or shoe box.

The Alternative Uses task is a measure of divergent thinking. This and other divergent thinking tasks are usually scored on originality, fluency, flexibility, and elaboration of the responses. When one comes up with a response that differs from the responses of most other individuals, the unique response is given points for **originality**. Take a look at your responses to the brick task. Did you suggest that it could be used as a paperweight? Given the frequency with which this use is mentioned, you probably did; this response is not considered original. Did you suggest drawing a face on the brick and using it as a character in a stop-motion animation film? Probably not; this answer scores high for originality. How many responses did you generate? You may have spent more time coming up with different answers than you did making sure that each response was original, so the number of responses is taken into account when measuring performance on this task—**fluency** refers to the number of responses generated by an individual. Sometimes people come up with multiple responses that are very similar, such as the many different ways that a brick can be used for destruction. Other people may be a little less fixated on how many different objects they can smash and are able to consider the problem from multiple perspectives, enabling them to think of uses from many different general categories. **Flexibility** captures the extent to which one has viewed the problem from multiple perspectives, measuring the degree of difference between responses. For instance, there are a number of general categories that responses may fall into, such as using the brick as a weapon, for destruction, to place underneath objects or people, to weigh things down, as a writing utensil, or for games (brick ball, anyone?). When responses span multiple categories, flexibility scores are higher. Finally, some responses contain a great deal of detail, which is reflected in the **elaboration** score. For example, one might write that the brick could be used as "a gift," or one could elaborate and write that the brick could be used as "a gift for my friend Clyde, who has been thinking about getting a pet. He should start with a brick and see how it goes."

The Torrance Tests of Creative Thinking (TTCT) is the most widely used creativity test (Davis, 1997). It uses a variety of divergent thinking exercises, including verbal and drawing exercises (Torrance, 1966). For example, in the product improvement task, an individual is shown a picture of a common object and asked to think of as many ways to improve the object as they can. The Usual Uses task, which is essentially the same as Guilford's Alternative Uses task (described above), is also used in the TTCT. In a figural drawing task, the individual is given three pages containing circles or lines and they are asked to draw pictures that incorporate the circles or lines.



The performance of two individuals on the figural drawing task with circles (modified from the TTCT).

Although most creativity tasks focus on divergent thinking, there are also some convergent tasks that tap into the type of “outside of the box” thinking that underlies creativity. For instance, insight problems often have only one correct solution, but they require one to use a novel approach to find the solution. When mulling over this type of problem, one usually has a sudden flash of insight. Try to solve the following insight problem (the solution can be found at the end of the chapter):

> There are six bowls lined up in a row on top of a bar. The first three are full of peanuts, and the last three are empty. By handling and moving only one bowl, change the arrangement so that the full and empty bowls alternate. No two full bowls can be next to each other, and no two empty bowls can be next to each other.

The Remote Associations task (Mednick, 1962), is also a convergent thinking task that taps into creativity. It requires one to find a word that is associated with all other words in a short list. For instance, which single word is associated with blue, mouse, and cottage? Here is one that may be more difficult. Which single word is associated with shopping, washer, and broken?

It should be noted that the psychologists who developed these tests do not claim that these tests can measure every component of creativity, and each of these tests has been criticized by others in the field. While there may be some components of creative thought that can be captured by these tests, one's ability to be creative may be much more apparent when being assessed within one's own area of expertise. Having a solid foundation of knowledge in that area and past experience creating in that area may yield a high level of creativity that does not translate well to standardized tests outside of that specialized area.

Enhancing Creativity

The last two centuries have been a time of dazzling innovation, redefining the landscape of human culture to an extent that is unparalleled by any other period in history. The industrial age has been fueled not only by steam and electricity, but by creative thought. The products of man's creative genius have enabled us to rapidly travel around the earth and explore far beyond our solar system; to save lives with innovations such as penicillin, vaccinations, and pacemakers; to record sounds and moving images; to converse in real time with people on the other side of the globe; and to instantly access information about any topic imaginable. Creative thought has provided children with countless forms of entertainment, such Play-Doh, crayons, teddy bears, and roller coasters; adults may be more appreciative of inventions such as electric guitars, beer, bikinis, condoms, and Viagra.

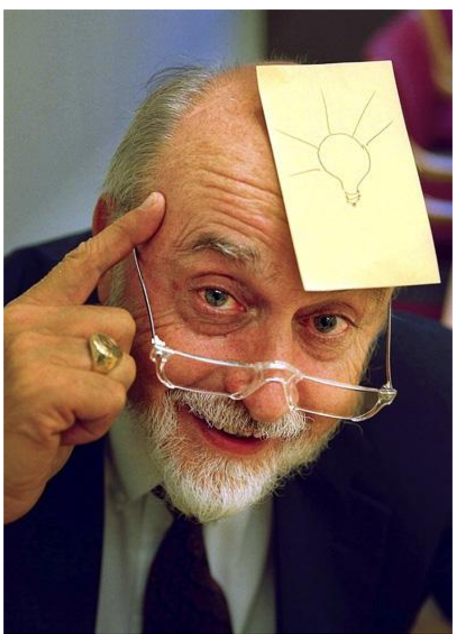
Creativity fuels innovation and propels scientific and medical advances—without it, none of these inventions would exist! However, many people fail to recognize their own creative potential. Creativity is not something that you are born with or without; generally, everyone is born with the cognitive skill sets and intelligence required for creative thought (Weisberg, 1988). But like all other skills, creativity must be developed through practice. This requires one to actively attempt to be creative. Although there is not an exact recipe for becoming the next Steve Jobs, Stephen Spielberg, or Lady Gaga, the following suggestions can help you enhance your creativity.

- Look for problems that need to be solved.

Make note of things that frustrate or annoy you; these often present opportunities for creative solutions. **Problem finding** is often the first step in the creative process. Instead of simply dismissing minor annoyances, actively search for possible solutions. Problems that do not have well-defined answers encourage **divergent thinking**, a creative thought process in which one considers a problem from multiple perspectives and generates a variety of possible solutions. Divergent thinking enables us to redefine problems and explore loose associations, allowing us to draw on knowledge that at first glance may have no obvious connection to the problem (Nickerson, 1999).

Problem finding often leads to new inventions. In the 1930s, a newspaper editor named László Bíró grew sick and tired of fountain pens; refilling them with ink was a messy, time-consuming process, and writing with them was no picnic—the ink smudged easily and the sharp tip of the pen often tore through paper. This prompted him to invent the ballpoint pen, revolutionizing the pen industry (and ensuring that no one from that point forward would ever have to cry over spilled ink).

Arthur Fry, who worked in product development at the 3M Corporation, invented the Post-it note in response to a minor annoyance. Fry sang in his church choir, and he inserted scraps of paper into his songbook to mark the pages of the songs that the choir sang each week. His markers often fell out when he opened the songbook. He wanted to find a way to make his scraps of paper stick to the page, but he also wanted the ability to easily pull them off the page without damaging the page. Fry recalled that a colleague at 3M had developed a mild adhesive that could create a temporary bond—and so the Post-it note was born.



Arthur Fry, inventor of the Post-it note.

- Be imaginative, flexible, and open to new experiences.
  You probably engage in imaginative thinking on a regular basis. Whenever you imagine future scenarios or alternate realities or scenarios where you think “if only” and “what if,” you are engaging in **counterfactual thinking**, which is a creative process (Byrne, 2005; Roese & Olson,

1995). Imaginative thinking can help you make new associations and see things from a new perspective.

Flexibility of thought is essential to the creative process, as it enables you to shift between different perspectives and problem-solving strategies. Spend time exploring other cultures and ways of viewing the world; it will enhance your ability to view a problem from different perspectives. Spending time abroad has been shown to improve creative problem-solving skills (Leung, Maddux, Galinsky, & Chu, 2008; Maddux & Galinsky, 2009; Maddux, Adam, & Galinsky, 2010).

- Think and act independently.
  Creative people tend to be nonconformists; they are not easily swayed by public opinion or how others view them. This helps one view problems from unique perspectives. It also prevents one from overlooking promising ideas that others have dismissed. Many creative people have been persecuted for questioning popular beliefs, but without such nonconformists, we might still be in the Dark Ages, believing that the sun revolves around a flat Earth.

- Do what you love.
  Creativity is driven more by **intrinsic motivation**—one's personal desire to learn, explore, and accomplish goals for the sake of satisfying one's own curiosity—than by **extrinsic motivation**, such as one's desire to make money or please others (Hennessey & Amabile, 1998). Creative exploration needs to be a goal in itself; that is, you need to enjoy the process, not just focus on the ultimate reward. People are more creative when the process of exploration is intrinsically rewarding or satisfying. However, people who have some training in creative thinking have been shown to exhibit increased creativity when they are told that they will be given an external reward for creative behavior (Eisenberger, Armeli, & Pretz, 1998; Eisenberger & Cameron, 1996). This suggests that by establishing creativity as the goal (and emphasizing the process, not the reward), adding an external incentive can enhance the creative process, so long as the reward itself is not the only goal.

- Gain expertise.
  People who make creative contributions generally have years of training in their field. Expert knowledge forms the foundation on which to build new ideas. Once this knowledge has been obtained, one can practice applying it in new ways. Even people regarded as creative geniuses needed to develop considerable expertise before making major contributions to their fields. Mozart, for instance, began composing at the age of five, but his early compositions were simplistic (and are thought to have been embellished by his father, who was also a composer). Mozart did not pen a critically-acclaimed composition until the age of twenty-one, at which point he had been actively composing for sixteen years.

  Have you ever been astounded by the improvisation skills of jazz musicians or comedians? While it is tempting to conclude that these people are simply gifted with creativity, their impressive skills are actually obtained through years of practice and dedication to their craft. Although improvisations are, by their very definition, produced spontaneously and have not been rehearsed, good jazz musicians and comedians have to practice improvising on a regular basis in order to produce creative content on the spur of the moment. Not only have these performers become experts in their respective crafts, but they have also—through extensive and rigorous practice of the creative process—become experts in creative thinking.

- Step away from the problem.
  After familiarizing yourself with a problem, it is often helpful to step away from it for awhile and do something else. While the steps of the creative process are not well understood, it is thought that **incubation** is an important component of creative insight (Wallas, 1926). When we actively attempt to solve a problem, we sometimes become fixated on inappropriate strategies, assumptions, or misleading ideas. It is thought that when we step away from the problem and let it incubate, the mind is able to "forget" about these inappropriate fixations (Smith, 1995; Ward, 2004), and unconsciously form new associations (Zhong, Dijksterhuis, & Galinsky, 2008).

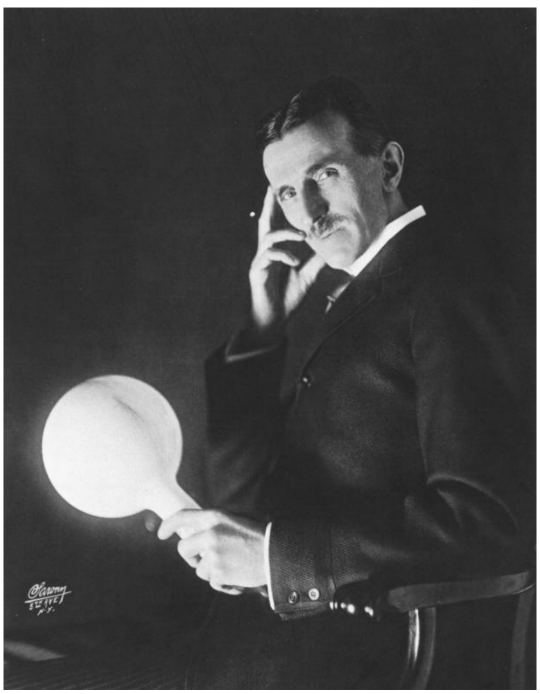
  Incubation happens most readily when the mind is allowed to wander (Baird et al., 2012). You may be able to gain new insight on a problem by setting it aside and taking a long walk—or even by going to bed! The rapid-eye movement stage of sleep has been associated with creative insight (Cai et al., 2009; Wagner et al., 2004).

- Immerse yourself in an environment where creativity is valued.
  A supportive and intellectually stimulating environment can spark creativity and help shape ideas. A study of the most eminent scientists and inventors revealed that they were generally supported, mentored, and intellectually challenged by their colleagues (Simonton, 1992). Environments that are conducive to creativity tend to value communication, teamwork, and innovation (Hülsheger, Anderson, & Salgado, 2009).

  Jonas Salk, the developer of the polio vaccine, made his discovery while spending time in a monastery, where he was able to work and contemplate without external pressures. This led him to recognize the importance of having an environment conducive to creative thought. He established the Salk Institute to provide such a place for scientists. The isolated compound was designed to be an intellectual retreat, providing scientists with the time and space to contemplate, work collaboratively, and above all, to think creatively. Since it opened in 1963, the Salk Institute has housed five Nobel laureates and trained six future laureates. This creative powerhouse is generally considered to be the top biomedical institute in the world.

- Be persistent.
  The core component of success in any field is **persistence**. Creative insight is generally the result of hard work, and after one has an idea, it may take years of effort to bring that idea to fruition. The road to creative success is filled with obstacles; effort and perseverance are required to overcome those obstacles. For instance, J. K. Rowling conceived of the idea for her Harry Potter series seven years before the completion of the first Potter novel. During that time, she persevered through poverty, personal loss, and depression. The manuscript was rejected by twelve publishing houses before a London publishing company agreed to publish the book in 1997. The critically acclaimed novel was the first in a series of seven that went on to be the best-selling series in history! Rowling's persistence clearly paid off.

  Nikola Tesla was an inventor who, like Rowling, persisted through adversity to produce some of the most important inventions in history. Tesla, who reportedly worked at least fourteen hours every day, was so far ahead of his time that the importance of many of his inventions was overlooked by his contemporaries. (Since the blueprints for many of Tesla's inventions were stored in his brain, scientists are still struggling to reinvent some of Tesla's devices!) Tesla worked for Thomas Edison, and it is thought that some of Edison's greatest contributions were actually Tesla's work. Tesla persevered through numerous challenges, including purported intellectual property theft (at the hands of Edison and others), a laboratory fire that destroyed years of his work, the destruction of his wireless transmission tower at the hands of the U.S. military during World War I (it was feared that German spies were using the tower against the U.S.), and perpetual economic struggles. Tesla persisted through all of these setbacks and hardships and, as a result, is credited with the development of alternating-current power transmission, the induction motor, the X-ray, fluorescent lights, vertical take-off aircraft (a precursor to the helicopter), wireless radio communication, wireless energy transmission, and the discovery of the resonance frequency of the earth. He even claimed to have created a directed-energy weapon (a death-ray), but died before unveiling a prototype to the public and left behind no blueprints.



Nikola Tesla, photographed here in 1898, displays one of his many inventions, a phosphorescent wireless light bulb.

Solutions

Insight problem: Pick up the second bowl and empty its contents into the fifth bowl. Put the second bowl back in its original position.

Remote Associations: A) cheese B) window

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Cognition and Language

Test bank questions

THE STRUCTURE OF COGNITION

Cognition

Level Key: Level 1 = Demonstrates understanding of basic facts and key terms; Level 2 = Demonstrates an understanding of the relationship among terms/concepts; Level 3 = Demonstrates the ability to apply concepts and may expressed in multiple-choice or short answer format.

Assessment Question1

Level: 1

Question: Which one of the following best characterizes what *cognition* refers to?

Options
A: The processes involved in obtaining, organizing, and using knowledge
B: A set of specific brain processes that mammals have but that other animals lack
C: The ability to reason logically without interference from emotions and feelings
D: The brain's ability to regulate basic bodily functions

Assessment Question2

Level: 1

Question: Which one of the following would NOT fall under the umbrella of cognition?

Options
A: Decision making
B: Categorization
C: Problem solving
D: Reflex action

Assessment Question3

Level: 2

Question: Which one of the following about cognition is false?

Options
A: Emotion can play a role in cognition
B: External tools can augment cognitive processes
C: Cognition refers to higher-level mental functions
D: Animals that lack a neocortex do not have any cognitive abilities

Assessment Question4

Level: 2

Question: Why is it difficult to separate low-level and high-level mental functions?

Options
A: Only some people have high-level mental functions.
B: There are many people who do not use low-level mental functions.
C: Many high-level mental functions are deeply interconnected with putatively low-level functions.
D: Some animals lack high-level mental functions.

Application Question 1

Question: What cognitive processes would you need to exercise in order to make peanut butter and jelly sandwich?

Short Answer: A good answer would say something about perceptual recognition skills, decision making for choosing which peanut butter and jelly brand, memory for where things are stored in a kitchen, conceptual knowledge of what a sandwich is, and so on.

Mental Images and Concepts

Assessment Question1

Level: 1

Question: The mental categories we use to organize our world knowledge are known as __________.

Options
A: concepts
B: scripts
C: examples
D: depictive representations

Assessment Question2

Level: 1

Question: Psychologists use the general term ____________ to refer to internal states that carry information about a particular domain.

Options
A: propositional representation
B: script
C: mental representation
D: mental imagery

Assessment Question3

Level: 1

Question: ________________ representations preserve the physical relationships between the items they represent.

Options
A: Conceptual
B: Symbolic
C: Propositional
D: Analog

Assessment Question4

Level: 1

Question: Words like “words” are ______________ representations because they do not preserve any of the physical features of the things they represent.

Options
A: symbolic
B: depictive
C: analogy
D: propositional

Assessment Question5

Level: 1

Question: Sentences that convey complex meanings are examples of ____________ representations.

Options
A: symbolic
B: depictive
C: analogy
<u>D: propositional</u>

<u>Assessment Question6</u>

Level: 1

Question: The mental categories we use to organize our knowledge of the world are known as __________.

Options
A: mental images
B: scripts
<u>C: concepts</u>
D: symbols

<u>Assessment Question7</u>

Level: 1

Question: Our knowledge of the ordered sequence of actions and events that will occur in a particular setting is known as a ______________.

Options
<u>A: script</u>
B: symbol
C: mental image
D: concept

<u>Assessment Question8</u>

Level: 1

Question: If you close your eyes and think about how a rose smells, you are relying on ______________.

Options
A: concepts
B: scripts
C: mental imagery
D: symbols

Assessment Question9

Level: 2

Question: Studies on mental scanning and mental rotation provide evidence in favor of the idea that mental imagery is supported by _________________ representations.

Options
A: analog
B: symbolic
C: conceptual
D: propositional

Assessment Question10

Level: 2

Question: People are typically ____________ to reinterpret mental images of ambiguous figures.

Options
A: able
B: unable
C: prone
D: obliged

Assessment Question11

Level: 3

Question: If you imagine a song by your favorite rock band, the ____________ portion of your brain is likely to become active.

Options
A: visual
<u>B: auditory</u>
C: olfactory
D: gustatory

Application Question 1

Question: Please consider the following question: who is depicted on a $5 bill. How were you able to come up with your answer?

Answer: A good answer might be that they imagined it and used their mental imagery to figure it out, but others might have simply stored this information as a propositional representation that is part of their money concept.

Concept Formation

Assessment Question1

Level: 1

Question: Plato's theory of concepts is best described as______________.
Options
<u>A: nativism</u>
B: empiricism
C: family resemblances
D: prototype

Assessment Question2

Level: 1

Question: Plato's student Aristotle was a proponent of the view that concepts are learned from experience, a perspective known as______________.

Options
A: classical theory
<u>B: concept empiricism</u>
C: prototype theory
D: family resemblances

Assessment Question3

Level: 1

Question: According to the ____________ theory, concepts are defined by certain necessary and sufficient conditions for category membership.

Options
A: classical
B: prototype
C: exemplar
D: family resemblances

Assessment Question4

Level: 1

Question: According to the ____________ theory, concepts are organized by an average or ideal category member.

Options
A: classical
B: prototype
C: exemplar
D: family resemblances

Assessment Question5

Level: 1

Question: According to the ____________ theory, concepts consist of all of the specific instances of the category that we have stored away in memory.

Options
A: classical
B: prototype
C: exemplar
D: family resemblances

Assessment Question6

Level: 2

Question: One advantage of the ______________ theory is that it helps account for fuzzy boundaries between conceptual categories.

Options
A: classical
<u>B: prototype</u>
C: nativist
D: empiricist

<u>Assessment Question7</u>

Level: 2

Question: One weakness of the ______________ theory is that it cannot account for typicality effects in categorization.

Options
<u>A: classical</u>
B: prototype
C: exemplar
D: empiricist

<u>Assessment Question8</u>

Level: 2

Question: One weakness of the _______________ theory is that it does not do a good job of explaining the fact that we know a lot about specific instances of any given conceptual category.

Options
A: classical
<u>B: prototype</u>
C: exemplar
D: family resemblances

<u>Assessment Question9</u>

Level: 3

Question: Which one of the following would be closest to your prototype of a pet?

Options
<u>A: A medium-sized dog</u>
B: A hairy spider
C: A rare species of owl
D: A South American lizard

<u>Assessment Question10</u>

Level: 3

Question: Which one of the following concepts would be difficult to explain using the major theories of concept formation discussed in this section?

Options
A: Pet fish
B: Shoes I'd like to wear on vacation
C: Justice
<u>D: All of the above</u>

LANGUAGE

Introduction to Language

<u>Assessment Question1</u>

Level: 1

Question: Which one of the following is one of the five most critical components of language?

Options
A: <u>Communication</u>
B: Signs made with hands
C: Vocal expression
D: Writing

<u>Assessment Question2</u>

Level: 1

Question: Which one of the following is NOT one of the five most critical components of language?

Options
A: Arbitrary symbols
B: Generative grammar
C: Levels of structure
D: Proper punctuation

Assessment Question3

Level: 1

_________ is a combinatorial system that allows us to generate an infinite number of sentences.

Options
A: Grammar
B: Semantics
C: Symbolic representation
D: The lexicon

Assessment Question4

Level: 1

A __________ is the smallest unit of sound used in a language.

Options
A: morpheme
B: phoneme
C: symbol
D: word

Assessment Question5

Level: 1

The smallest meaningful unit of language is called a ____________.

Options
A: morpheme

B: phoneme
C: symbol
D: word

Assessment Question6

Level: 1

Words are arbitrarily linked to ___________.

Options
A: concepts
B: morphemes
C: phonemes
D: the lexicon

Assessment Question7

Level: 1

_________ allows us to understand the relationship between words in a sentence.

Options
A: Generative grammar
B: Morphology
C: Semantics
D: Syntax

Assessment Question8

Level: 2

Which one of the following are built from phonemes?
Options
A: Morphemes
B: Words
C: Sentences
D: All of the above

Assessment Question9

Level: 3

Question: Patients with Broca's aphasia have a difficult time figuring out the relationship between words in a sentence. This is a deficit of which one of the following?

Options
A: Lexical access
B: Phoneme perception
C: Semantic slanting
<u>D: Syntactic processing</u>

<u>Assessment Question10</u>

Level: 3

Humans will never run out of novels things to say because we have a_______________.

Options
<u>A: generative grammar</u>
B: large lexicon
C: multitude of morphemes
D: surplus of syntax

<u>Assessment Question11</u>

Level: 2

Which one of the following options is arbitrarily linked to concepts?

Options
A: Sounds
B: Symbols
C: Words
<u>D: All of the above</u>

<u>Assessment Question12</u>

Level: 2

Syntax allows us to understand _____________.

Options
A: symbols
B: relationships between words
C: word meaning
D: all of the above

Assessment Question13

Level: 3

Linguist Noam Chomsky created the sentence, “Colorless green ideas sleep furiously.” This sentence is strange because it is_________________ at the _____________ level.

Options
A: semantically meaningless; sentence
B: semantically meaningless; word
C: syntactically ill-formed; sentence
D: syntactically ill-formed; word

Assessment Question14

Level: 2

A specific sentence is an example of a ______________, while the concepts conveyed by the sentence are the _____________.

Options
A: deep structure; surface structure
B: lexical entry; syntax
C: surface structure; deep structure
D: syntactic structure; lexicon

Assessment Question15

Level: 3

Puns are amusing because the ___________ map(s) to multiple _____________.

Options
A: semantics; surface structures

B: semantics; symbols
<u>C: surface structure; deep structures</u>
D: word; symbols

Stages of Language Acquisition

<u>Assessment Question1</u>

Level: 1

Question: A newborn infant can do which one of the following?

Options
<u>A: Discriminate between familiar and foreign language</u>
B: Link sound to meaning
C: Pick out individual words from a stream of sound
D: Produce reduplicated babble

<u>Assessment Question2</u>

Level: 1

Question: An 8-month-old infant can do which one of the following?

Options
A: Adhere to word order rules
B: <u>Perform speech segmentation</u>
C: Understand 100 words
D: Use holophrases

<u>Assessment Question3</u>

Level: 1

Question: A 15-month-old infant can do which one of the following?

Options
A: Produce grammatical sentences
B: Produce multiword phrases
C: Say 100 words

D: <u>Use holophrases</u>

<u>Assessment Question4</u>

Level: 1

Question: A newborn infant is *unable* to do which one of the following?

Options
A: <u>Babble</u>
B: Discriminate between familiar and foreign language
C: Identify its mother's voice
D: Recognize stories

<u>Assessment Question5</u>

Level: 1

Question: An 8-month-old infant is *unable* to do which one of the following?

Options
A: Babble
B: Link sound to meaning
C: Perform speech segmentation
D: <u>Produce words</u>

<u>Assessment Question6</u>

Level: 1

Question: A 15-month-old infant is *unable* to do which one of the following?

Options
A: <u>Combine words into phrases</u>
B: Produce words
C: Understand at least 50 words
D: Use holophrases

<u>Assessment Question7</u>

Level: 2

Question: The ability to segment speech is crucial for language acquisition because it enables an infant to do which one of the following?

Options
A: Avoid overgeneralizations
B: Learn word meaning
C: Learn word order rules
D: <u>Pick out individual words from a stream of sound</u>

<u>Assessment Question8</u>

Level: 2

The fact that infants who learn sign language babble on their hands indicates that babbling is ____________.

Options
A: a form of vocal play
B: <u>a linguistic activity</u>
C: an exploration of motor skills
D: not tied to language development

<u>Assessment Question9</u>

Level: 2

Question: Which one of the following statements is true?

Options
A: All infants hit linguistic milestones at the same age.
B: <u>An infant understands many more words than she can say.</u>
C: Cognitive development does not determine the rate of language acquisition.
D: The number of words an infant can say is equal to the number of words she understands.

<u>Assessment Question10</u>

Level: 2

Question: General mechanisms for learning and memory are tied to which of the following aspects of language?

Options

A: Speech segregation

B: Vocabulary size

C: <u>Both A and B</u>

D: Neither A nor B

<u>Assessment Question11</u>

Level: 2

Question: A child's speech during the multiword stage indicates which one of the following?

Options

A: A failure to understand word order rules

B: A mastery of the grammatical rules of language

C: An inability to conceptualize relationships between words

D: <u>An understanding of word order rules</u>

<u>Assessment Question12</u>

Level: 2

Question: Overgeneralizations indicate which one of the following about a child?

Options

A: <u>She is applying grammar rules.</u>

B: She relies solely on phonological memory.

C: Her language development has regressed.

D: Her parents speak ungrammatically.

<u>Application Question 1</u>

Question: A 5-year-old child is discovered living alone in a forest. The child's behaviors demonstrated that she has normal cognitive skills, but she appears to have no linguistic skills. Considering that it takes newborns four years to master the grammatical rules of language, do you think it will also take this child four years to achieve grammatical mastery? Why or why not?

Answer: Since the time course of language acquisition is tied to cognitive development, the child should *not* need four whole years to master language. Since the child has the cognitive skills of a 5-year-old, she should be able to master language very quickly.

Application Question 2

Question: Briefly explain how general mechanisms involved in learning and memory support language acquisition.

Answer: Statistical learning supports an infant's ability to segment speech, enabling the infant to indentify individual words in a stream of sound. Phonological memory capacity is tied to the rate at which a child's vocabulary expands. A child who produces telegraphic speech may lack the working memory resources needed to produce complete sentences. Children may apply general rule learning mechanisms to extract grammatical rules from the language to which they are exposed.

Application Question 3

Question: Anton is 3-years-old. He and his brother Jerome are playing with toy soldiers. Jerome decides to show his brother how to perform a sneak attack that he calls a "shiff." When he keeps repeating this move against Anton's soldiers Anton complains, "Stop shiffing my mans! You shiffed my favorite soldier! Stop!" Why is Anton able to create the present and past tense forms of this new word, and yet he is unable to correctly pluralize "man"?

Answer: He's able to apply grammar rules to this new word, transforming it into the past tense. He produced "mans" instead of "men" because he applied the standard rule for pluralization to a noun that has an irregular plural. This is an overgeneralization, but it indicates that Anton understands the grammatical rule for creating plurals.

Theories of Language Acquisition

Assessment Question1

Level: 1

Psychologists who believe that we acquire language via the same general mechanisms we use to learn about every other aspect of our experience are supporters of the ____________ perspective.

Options
A: developmentalist
B: nativist
C: nurturist
D: separatist

Assessment Question2

Level: 1

B. F. Skinner argued that ________________ was involved in acquiring all manner of complex behavioral skills, including language.

Options
A: classical conditioning
B: reinforcement learning
C: similarity conditioning
D: statistical learning

Assessment Question3

Level: 1

Supporters of the ______________ perspective argue that language acquisition is made possible via an innate and specialized brain mechanism.

Options
A: developmentalist
B: nativist
C: nurturist
D: separatist

Assessment Question4

Level: 1

Question: When Noam Chomsky argues that there is a poverty of the stimulus in language acquisition, he means that there is not enough information in the experience of children _____________________.

Options
A: Who are deaf to ever learn a language.
B: To ever learn the grammar of a language.
C: To ever learn the words in a language.
D: Living in poverty to learn a language.

Assessment Question5

Level: 1

The scholar most associated with the nativist perspective is _______________.

Options
A: Chomsky
B: Skinner
C: Chimpsky
D: Schooner

Assessment Question6

Level: 1

Question: Scholars who support the emergentist perspective on language argue that language emerges from ___________.

Options
A: caregivers reinforcing the behavior of their children.
B: a combination of maturational constraints in the brain and specialized learning mechanisms.
C: the operation of specialized brain mechanisms and the child's interactions with their surroundings.
D: the social interactions between a child and caregiver and the operation of powerful, general learning mechanisms.

Assessment Question7

Level: 2

Question: In which one of the following ways does the emergentist perspective on language acquisition differ from the more traditional nurturist perspective?

Options
A: It highlights the role of a specialized language acquisition device.
B: It highlights the role of social processes interacting with general learning mechanisms.
C: It supports many of the claims Chomsky made about language acquisition and grammatical structure.
D: It views language as emerging from an evolved language instinct.

Assessment Question8

Level: 2

Question: In which one of the following ways is the emergentist perspective on language acquisition similar to the more traditional nurturist perspective?

Options
A: They both reject the need to posit an innate, specialized language acquisition device.
B: They both downplay the power of general learning mechanisms.
C: They both agree that there is something special about language acquisition.
D: They both rely on arguments based on the poverty of the stimulus.

Assessment Question 9

Level: 1

Question: Which one of the following was NOT used as evidence for the nativist perspective of language acquisition?

Options
A: Children can understand and generate sentences they have never been exposed to before.
B: Computer simulations show that knowledge of grammatical structure can be acquired via general learning mechanisms.
C: Children of immigrant parents learn the language of their new homeland without direct reinforcement from their parents.
D: Deaf children of hearing parents spontaneously create novel, meaningful gestures.

Assessment Question 10

Level: 2

Question: Which of the following best characterizes the scientific consensus about language acquisition?

Options
A: Most scholars accept Skinner's nurturist perspective.
B: Most scholars reject Chomsky's nativist perspective.
C: Most scholars side with the emergentist perspective.
D: Most scholars agree that there isn't any consensus on this issue.

Application Question 1

Question: The fact that the deaf children of hearing parents spontaneously generate meaningful gestures has been used as evidence for the nativist perspective on language acquisition. How might a supporter of the nurturist perspective explain this phenomenon?

Short answer: A good answer would be to tell a story about how reinforcement learning could be applied in this case. Deaf children, no less than hearing children, can still learn via reinforcement. So perhaps one day the baby was moving his arms around and the mother brought him a bottle. Over time, a particular gesture might be gradually reinforced in this way until it became somewhat standardized and understood by the caregivers.

Application Question 2

Question: The debate about language acquisition is often pitched as a debate between nature (nativist perspective) and nurture (nurturist perspective). However, this is really an oversimplification. In what way does the nativist perspective actually rely on *nurture* to explain language acquisition? In what way does the nurturist (or emergentist) perspective actually rely on *nature*?

Short answer: Nativists still agree that children learn the specific language they are exposed to, so even if there is an innate language acquisition device, the environment is still very important for what language is learned. Nurturists argue that powerful learning mechanisms capable of acquiring language must be innate. Emergentists further add that many innate social processes contribute to language learning.

Is Language Unique to Humans?

Assessment Question1

Level: 1

Question: An animal communication system *cannot* be considered linguistic unless it has which one of the following sets of components?

Options
A: Generativity and syntax
B: Generativity, organizational rules, and words

C: Organizational rules
D: Words, syntax, and symbols

Assessment Question2

Level: 2

The study of animal communication systems can help us understand the origin of human language, as the differences across species can help us determine which one of the following?

Options
A: How to communicate abstract thoughts to chimps
B: How to teach language to nonhuman animals
C: Whether humans evolved from the same ancestors as chimps
D: Whether language has a genetic component

Assessment Question3

Level: 2

Question: Bird communication does not fit the definition of language for which one of the following reasons?

Options
A: Birdcalls don’t communicate specific concepts.
B: Birds don’t organize their calls in a generative manner.
C: Birdsong isn’t generative.
D: Birdsong doesn’t follow organizational rules.

Assessment Question4

Level: 2

Question: Whalesong does not fit the definition of language for which one of the following reasons?

Options
B: It lacks organizational rules.
C: It lacks word-like elements.
D: It is not generative.
D: None of the above

Assessment Question5

Level: 2

Question: Vervet monkeys and rhesus macaques can communicate about predators and the quality of food. Does this mean that they have language?

Options
A: No, they don't combine their words in a generative, rule-governed manner.
B: No, they don't have words, only sounds.
C: Yes, they have words and therefore meet the definition of language.
D: Yes, they have words that they combine according to generative rules.

Assessment Question6

Level: 3

Question: Which one of the following options best explains the motivation for attempting to teach Washoe and Nim sign language?

Options
A: The researchers were testing whether chimps could learn language as easily as children if they were raised in the same environment.
B: The researchers hypothesized that language acquisition was shaped not by genetics but by environment.
C: They were testing whether the chimps' inability to produce speech sounds was masking its true linguistic potential.
D: All of the above.

Assessment Question7

Level: 2

Question: Why did Nim fail to acquire language?

Options
A: Nim *did* acquire language.
B: He couldn't combine words.
C: He was unable to learn word order rules.
D: Sign language is not a real language.

Application Question 1

Question: How does our understanding of animal communication inform our understanding of the origins of language?

Answer: Examining whether other animals have language enables us to examine whether humans are genetically wired for language acquisition. Nonhuman animals possess some characteristics of language, such as words, the ability to generate novel sequences from discrete units (such as symbols or meaningless sounds), and the ability to order these units according to organizational rules. However, humans appear to be the only species that combines all three of these essential characteristics into a communicative system. Failed attempts to teach other species language suggest that there is a genetic component to the origins of human language. However, we don't know whether the genetic components that enable humans to acquire language evolved specifically to enable language acquisition or if these components evolved as general cognitive mechanisms that happen to enable humans to acquire language.

Application Question 2

Question: What can we conclude from the attempts to teach language to Washoe and Nim Chimpsky?

Answer: We can conclude that language cannot be learned through environmental exposure and behavioral reinforcement alone. This supports the theory that there is a genetic component to language acquisition. We cannot, however, conclude that the chimps were unable to acquire language because they're lacking a language instinct or language acquisition device. It is possible that they are lacking general purpose cognitive mechanisms that are necessary for language acquisition.

The Influence of Language on Thought

Assessment Question1

Level: 1

________________ is the idea that languages differ in how they carve up the world and that the language you speak shapes the way you think.

Options
A: Linguistic Impermanence
B: The Pinker-Chomsky hypothesis

C: The language hypothesis
<u>D: Linguistic Relativity</u>

<u>Assessment Question2</u>

Level: 1

Linguistic relativity is also known as __________________.

Options
A: linguistic determination
<u>B: the Sapir-Whorf hypothesis</u>
C: the language hypothesis
D: linguistic Impermanence

<u>Assessment Question3</u>

Level: 1

The principle of linguistic relativity is commonly associated with the work of __________________.

Options
<u>A: Benjamin Lee Whorf</u>
B: Noam Chomsky
C: Steven Pinker
D: Jerry Fodor

<u>Assessment Question4</u>

Level: 1

___________________ is the idea that your thoughts are rigidly determined by the language you speak.

Options
A: Linguistic Dimunition
B: Linguistic Impermanence
<u>C: Linguistic Determinism</u>
D: Linguistic Relativity

<u>Assessment Question5</u>

Level: 1

Question: Which one of the following was NOT a reason for why scholars became skeptical of linguistic relativity in the second half of the 20th century?

Options

A: Whorf relied on circular reasoning when articulating the principle of linguistic relativity.

B: Most cognitive processes were believed to be universal and independent of language.

C: English has words to refer to both the relative and absolute spatial reference frames.

D: Some linguists argued that the Hopi language could talk about *time*.

Assessment Question6

Level: 1

Question: Why do dried plums sell better than prunes?

Options

A: The word "prune" is associated with negative concepts like old age and digestive problems.

B: Dried plums taste better than prunes.

C: Advertisers have done a better job designing the packaging materials for dried plums.

D: There is no real reason, they just do.

Assessment Question7

Level: 1

Question: What can you ask someone to increase the chances that they will vote in the next election?

Options

A: How important it is for them to vote in the election.

B: How important it is for them to be a voter in the election.

C: How important it is for them that their preferred candidate wins.

D: How important it is for them to receive a sticker for voting.

Assessment Question8

Level: 2

Question: Which one of the following observations did Whorf make in support of his viewpoint?

Options
A: The Pirahã do not have any words for exact numbers.
B: Most cognitive processes are universal and independent of language.
<u>C: The Hopi language has no words that refer to *time* in the way that English does.</u>
D: Languages differ in the way that they talk about the domain of space.

<u>Assessment Question9</u>

Level: 3

Question: In which one of the following ways does language function as a tool that augments our ability to think?

Options
A: Different languages can talk about spatial locations in distinct ways.
B: Language never functions as a tool for thinking.
C: Specific words are associated with distinct concepts or ideas.
<u>D: Number words help us keep track of exact quantities.</u>

<u>Assessment Question10</u>

Level: 3

If I tell you that your computer is to the left of the printer, I am relying on the ___________ frame of reference.

Options
<u>A: relative</u>
B: absolute
C: intrinsic
D: picture

<u>Assessment Question11</u>

Level: 3

If I tell you that your computer is to the north of the printer, I am relying on the ___________ frame of reference.

Options
A: relative
B: absolute
C: intrinsic
D: picture

Assessment Question12

Level: 2

Question: Speakers of Kuuk Thaayorre, an Australian aboriginal language, have no relative spatial terms in their language. If you showed them a set of objects arranged in a line, which one of the following statements best characterizes what their memory for this event would be?

Options
A: They would remember how the objects were arranged in relation to their viewpoint.
B: They would remember how the objects were arranged in relation to their absolute position in the environment.
C: They would not remember exactly how the objects were arranged.
D: They would remember how the objects were arranged in relation any number of different reference frames.

Application Question 1

Question: In a controversial episode of the animated TV series *The Simpsons*, the principal of Springfield Elementary reveals that he is not actually Seymour Skinner, but a man named Armin Tamzarian who stole the real Skinner's identity more than two decades ago. Though most people in town are quick to shun Armin, young Lisa Simpson defends him, paraphrasing Shakespeare when she claims, "His name doesn't matter. A rose by any other name would smell as sweet." Her brother Bart swiftly retorts, "Not if you called him Stench Blossom." Which sibling is right? Design an experiment to test whether labels might actually affect the perceived sweet odor of flowers.

Short answer: A good response would be something like: Put roses into separate opaque containers (we don't want visual properties to bias the responses) and label the containers in different ways (e.g. rose, sweet flower, stench blossom, stink weed). Then have participants smell each flower and rate how sweet they smell to see if the labels matter.

Application Question 2

Question: Many people believe we should modify our language to be more “politically correct.” For example, instead of using the word “chairman” to refer to the head of a company, they suggest we should use the more gender neutral term, “chair.” What effect might this have in our society?

Short answer: A good response would be to say that “chairman” is associated with the idea that men should be the boss at a company, which could make it harder for qualified women to get a chance to be promoted.

Making Decisions

Assessment Question1

Level: 1

Question: Our ability to make fast, automatic decisions is influenced by all of the following options *except* ______________.

Options
A: careful deliberation
B: emotion
C: expertise
D: prior knowledge

Assessment Question2

Level: 3

Question: There are two routes that you can take to get to your favorite coffee shop. These two routes are considered ________________.

Options
A: alternatives
B: consequences
C: heuristics
D: strategies

Assessment Question3

Level: 3

Question: When deciding between routes A and B, you consider the amount of time each route would probably take and the different scenery you would pass on each route. You are considering your beliefs about the probable___________ of either route.

Options
A: <u>consequences</u>
B: representativeness
C: transitivity
D: utility

<u>Assessment Question4</u>

Level: 3

Question: When deciding between routes A and B, you would rather arrive at your location quickly than see nice scenery along the way. To you, a speedy arrival has higher ________.

Options
A: availability
B: hindsight bias
C: representativeness
D: <u>utility</u>

<u>Assessment Question5</u>

Level: 1

Question: Each decision is associated with __________, the chain of events triggered by the decision.

Options
A: alternatives
B: <u>consequences</u>
C: heuristics
D: utility

<u>Assessment Question6</u>

Level: 1

Question: The gambling study demonstrates that __________ can drive our decisions and behaviors.

Options
A: deliberation
B: <u>emotions</u>
C: heuristics
D: random chance

Assessment Question7

Level: 2

Question: The gambling study demonstrates that we _______________ what is driving our decisions and behaviors.

Options
A: can never determine
B: <u>do not always have conscious awareness of</u>
C: usually understand
D: should not attempt to understand

Assessment Question8

Level: 3

Question: Tania has purchased a designer purse online. She's a little concerned about the authenticity of the purse, since its origins are uncertain. When it arrives, she is very pleased and has no doubt that it is an authentic designer purse. She eagerly shows her new purse to her friend Pedro, who is a professional fashion designer. Pedro immediately recognizes that it a high quality knock-off, not an authentic designer purse. Which one of the following enabled Pedro to easily make this judgment?

Options
A: Additive strategy
B: Careful deliberation
C: Elimination by aspects
D: <u>Expert knowledge</u>

Assessment Question9

Level: 1

Question: When there are so many alternatives that we cannot evaluate each one thoroughly, we may reduce our options by excluding alternatives according to specific criteria. This is an example of which one of the following?

Options
A: Additive strategy
B: Availability heuristic
C: <u>Elimination by aspects</u>
D: Satisficing

<u>Assessment Question10</u>

Level: 1

Question: When considering possible outcomes, we evaluate _____________, how much we personally value each outcome.

Options
A: alternatives
B: beliefs
C: consequences
D: <u>utility</u>

<u>Assessment Question11</u>

Level: 3

Question: You've just received two job offers, but you aren't sure which one to accept. You make lists of all the pros and cons of each job, and you decide to take the job that has the most pros and the least cons. This decision reflects the use of ____________________.

Options
A: <u>an additive strategy</u>
B: the availability heuristic
C: elimination by aspects
D: satisficing

<u>Assessment Question12</u>

Level: 2

Question: When trying to choose between many alternatives, we may use certain criteria to exclude many of the options. Then, of the remaining alternatives, we may choose the first one that matches our criteria. This reflects the use of which one of the following two strategies?

Options

A: Additive strategy and satisficing

B: Elimination by aspects and additive strategy

C: Elimination by aspects and availability heuristic

D: <u>Elimination by aspects and satisficing</u>

<u>Assessment Question13</u>

Level: 3

Question: Michael is asked to judge which musical instrument is most popular among young adult males: the piano, trumpet, or guitar. After thinking about the instruments used in the music that he's been listening to lately, he decides that the guitar is probably the most popular. Dominic's answer indicates use of ________________.

Options

A: elimination by aspects

B: satisficing

C: <u>the availability heuristic</u>

D: the representativeness heuristic

<u>Assessment Question14</u>

Level: 3

Question: Kayla woke up with a large, itchy bug bite on her arm. When Kayla's mother asks her whether she thinks it's a mosquito bite or a spider bite, Kayla says that she's sure it's a mosquito bite because of how it looks and feels. Kayla's answer indicates use of ________________.

Options

A: elimination by aspects

B: satisficing

C: the availability heuristic

D: <u>the representativeness heuristic</u>

Application Question 1

Application Question: Several firemen were inside a house, trying to put out what appeared to be a typical kitchen fire. Despite their efforts, the fire raged on. The captain was surprised that the fire persisted, and he noticed that the house was unusually hot. Suddenly, his instincts told him that something was very wrong, although he couldn't consciously put his finger on what it was. He immediately ordered his men out of the house, which collapsed only moments after his men made it to safety. It turned out that the fire was not coming from the kitchen, but from the basement. What enabled the captain to make this instinctive, life-saving decision?

Answer:
The best answers will hit upon three key factors that drive decisions: expertise, emotion, and representativeness.

Example answer:
After years of fighting fires, the chief had *expert knowledge* of different types of fires, including how long it generally takes to extinguish certain types of fires and the amount of heat produced by those specific types of fires. While the crew believed this to be a kitchen fire, the chief was able to recognize that this fire had characteristics that didn't match those of kitchen fires. This may have involved the application of the *representativeness heuristic*. However, the chief didn't consciously know what was wrong, only that something was very wrong. This *emotion* drove his decision to evacuate. It is likely that his brain had subconsciously recognized that there was a fire raging directly below them, as this would have been the most probable cause of the excessive heat. This elicited an automatic fear response and triggered the appropriate behavior: the flight response. Years of training enabled the chief's brain to recognize the situation for what it was and trigger a flight response. Those years of experience also enabled the chief to know that he should trust his instincts.

Models of Decision Making

Assessment Question1

Level: 1

Question: According to _____________, the best decision is the one that results in the largest gain after taking probability into account.

Options
A: the prospect theory
B: the expected utility model

C: the expected value model
D: Tversky and Kahneman

Assessment Question2

Level: 1

Question: According to _____________, the best decision is the one that reflects the personal values that we apply to specific outcomes, weighted by the probability of the outcome.

Options
A: the prospect theory
B: the expected utility model
C: the expected value model
D: Tversky and Kahneman

Assessment Question3

Level: 1

Question: According to ___________, people exhibit risk aversion when making decisions about potential gains and exhibit risk seeking behavior when making decisions about potential losses.

Options
A: common sense
B: the prospect theory
C: the expected utility model
D: the expected value model

Assessment Question4

Level: 3

Question: Natalia places the highest personal value on winning the highest amount possible. When asked to choose between gamble A, which has a 50% chance of winning $100, and gamble B, which has a 35% chance of winning $200, she chooses gamble B. When asked to choose between gamble B and gamble C, which has a 20% chance of winning $300, she chooses gamble C. Butwhen asked to choose between gamble A and gamble C, Natalia chooses gamble A. This illustrates which one of the following?

Options

A: An unrealistic example of decision making
B: Application of the expected utility model
C: Application of the expected value model
D: A violation of transitivity

Assessment Question5

Level: 3

Question: When Kelly is faced with deciding between buying 1 banana for $1 or 4 bananas for $2.50, she buys 4 bananas. When faced with deciding between buying 4 bananas for $2.50 or 50 bananas for $20, she buys 4 bananas. Kelly's decisions indicate which one of the following?

Options
A: The expected value model can explain some decisions, and the expected utility model can explain others.
B: Kelly wants to pay the lowest price, but has no use for 50 bananas.
C: Kelly's decisions lack transitivity.
D: All of the above

Assessment Question6

Level: 2

Question: The expected _________ model states that we should choose the outcome with the largest possible gain, and the expected _________model counters that the largest possible gain may not accurately reflect the outcome with the highest personal value.

Options
A: utility; value
B: prospect; value
C: utility; prospect
D: value; utility

Assessment Question7

Level: 3

Question: Jenelle was charged with breaking and entering. Her lawyer advises her that if she pleads guilty, she will most likely spend 30 days in jail. If she pleads innocent, she has a 25% chance of being found innocent and doing no jail time and a 75% chance of being found guilty and spending 60 days in jail. She decides to plead innocent. Which one of the following best explains her decision?

Options
A: Her desire for 60 days of room and board provided by tax payer dollars
B: Prospect theory
C: The expected utility model
D: The expected value model

Barriers in Decision Making

Assessment Question1

Level: 1

Question: ___________ rely on our prior knowledge and beliefs to help us arrive at best guess solutions.

Options
A: Alternatives
B: Anchors
C: Base rates
D: Heuristics

Assessment Question2

Level: 2

Question: Heuristics usually enable us to make good decisions, but sometimes they introduce _______, resulting in systematic errors.

Options
A: bias
B: confirmation bias
C: consequence bias
D: hindsight bias

Assessment Question 2A

Level: 1

Question: Heuristics usually enable us to make good decisions, but sometimes they introduce bias, resulting in____________________.

Options
A; accurate assessments.
B: consequence bias.
C: poor hindsight.
D: systematic errors.

<u>Assessment Question3</u>

Level: 1

Question: Which one of the following involves searching your memory for relevant events and information and basing your judgments on the ease of recall?

Options
A: Confirmation bias
B: Hindsight bias
C: <u>The availability heuristic</u>
D: The representativeness heuristic

<u>Assessment Question4</u>

Level: 3

Question: Dominic is asked to estimate the percentage of annual deaths that are the result of homicide. After thinking about the number of homicides that he's seen reported on the news lately, he comes up with an estimate that is much higher than the actual value. Dominic's answer reflects bias introduced by use of which one of the following?

Options
A: Anchoring
B: <u>Availability heuristic</u>
C: Belief bias
D: Representativeness heuristic

<u>Assessment Question5</u>

Level: 1

Question: Which one of the following uses the typicality of an item to estimate the probability that it belongs to a certain category?

Options
A: Confirmation bias
B: Hindsight bias
C: The availability heuristic
D: The representativeness heuristic

Assessment Question6

Level: 3

Question: Chris is 6'5'' and weighs 320 pounds, rides a motorcycle, has arms covered by tattoos, and has been arrested multiple times for getting in bar fights. When asked whether Chris is a man or a woman, most people would judge that Chris is a man. Which one of the following enables people to make this categorization?

Options
A: Anchoring
B: Belief bias
C: Confirmation bias
D: Representativeness heuristic

Assessment Question7

Level: 2

Question: Kahneman and Tversky found that participants relied so heavily on ___________ that they ignored ___________.

Options
A: anchoring; representativeness
B: base rates; belief bias
C: the representativeness heuristic; base rates
D: the availability heuristic; belief bias

Assessment Question8

Level: 3

Question: Sean plays the same lottery numbers every day. He believes that since those numbers have never been chosen, they're due to come up relatively soon. Sean is making which one of the following judgment errors?

Options
A: Availability error
B: Debtor's dilemma
C: Gambler's fallacy
D: Hindsight bias

Assessment Question9

Level: 1

Question: ____________ occurs when we allow a starting value to determine the range of our subsequent estimates.

Options
A: Anchoring
B: Availability bias
C: Base rate bias
D: Estimation bias

Assessment Question10

Level: 2

Question: Consider Kahneman and Tversky's description of Steve, who is "very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail." When participants are asked to judge whether Steve is a librarian or a farmer, most people choose librarian. Which one of the following leads participants to this choice?

Options
A: Confirmation bias
B: Hindsight bias
C: The availability heuristic
D: The representativeness heuristic

Assessment Question11

Level: 3

Question: Consider Kahneman and Tversky's description of Steve, who is "very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail." When participants are asked to judge whether Steve is a librarian or a farmer, most people choose librarian. What information do people overlook when making this choice?

Options
A: Availability
B: <u>Base rates</u>
C: Beliefs
D: Representativeness

<u>Assessment Question12</u>

Level: 1

Question: ______________ bias occurs when people tend to seek evidence that is consistent with their own beliefs.

Options
A: Belief
B: <u>Confirmation</u>
C: Hindsight
D: Representativeness

<u>Assessment Question13</u>

Level: 1

Question: When we try to remember how we felt about something before it happened, we exhibit __________ bias, an overestimation of how certain we were about the ultimate outcome.

Options
A: belief
B: confirmation
C: <u>hindsight</u>
D: representativeness

Assessment Question14

Level: 1

Question: People exhibit ___________ bias when they reject information that contradicts their beliefs.

Options
A: belief
B: confirmation
C: hindsight
D: representativeness

Assessment Question15

Level: 3

Question: Angela believes that the moon landing was a conspiracy. She loves reading about the pieces of evidence that suggest the landing was staged on a film set. She was particularly excited to learn that the moon landing was going to be featured on Myth Busters. But after watching the program for a couple minutes, she realized that the Myth Busters were actually busting conspiracy theories (not the moon landing itself, as she had hoped). She immediately decided to watch something else. Her decision to not watch Myth Busters is an example of which one of the following?

Options
A: Belief bias
B: Confirmation bias
C: Gambler's fallacy
D: Hindsight bias

The Process of Solving Problems

Assessment Question1

Level: 1

Question: When your current state does not match your desired goal state, we refer to this as a ______________.

Options

A: issue
<u>B: problem</u>
C: riddle
D: situation

<u>Assessment Question2</u>

Level: 1

Question: A problem that has a clearly specified goal state and where the actions you are allowed to take are spelled out in advance is known as a(n) _______________.

Options
A: ill-defined problem
B: insight problem
C: riddle
<u>D: well-defined problem</u>

<u>Assessment Question3</u>

Level: 1

Question: A problem that does not have a clearly specified goal state and where the actions you are allowed to take are not spelled out in advance is known as a(n) _______________.

Options
<u>A: ill-defined problem</u>
B: insight problem
C: riddle
D: well-defined problem

<u>Assessment Question4</u>

Level: 1

Question: A problem that is difficult to solve incrementally using a general problem-solving strategy and where the solution just seems to hit you all at once is known as a(n) _______________.

Options

A: ill-defined problem
B: insight problem
C: riddle
D: well-defined problem

Assessment Question5

Level: 3

Question: The game of chess would be an example of a(n) ______________.

Options
A: ill-defined problem
B: insight problem
C: riddle
D: well-defined problem

Assessment Question6

Level: 3

Question: Imagine you are an artist and that you are interested in creating a painting that represents your current neurotic, yet hopeful, state of mind. This would be best characterized as a(n) ______________.

Options
A: ill-defined problem
B: insight problem
C: riddle
D: well-defined problem

Assessment Question7

Level: 3

Question: Though crossword puzzles are relatively well-defined problems, figuring out each individual word can be tricky because the clues sometimes require that you spontaneously restructure how you interpret the clue itself. These sorts of clues are best characterized as ______________ problems.

Options

A: clever
B: ill-defined
<u>C: insight</u>
D: well-defined

<u>Assessment Question8</u>

Level: 1

Question: When you break down a larger problem into a smaller task that you will accomplish first, you have created which of the following?

Options
A: Insight problem
B: Means-ends analysis
C: Riddle
<u>D: Subgoal</u>

<u>Assessment Question9</u>

Level: 1

Question: The general process of generating a plan to get you from your current state to your desired goal state by minimizing the difference between the two is known as a(n) ______________.

Options
A: insight problem
<u>B: means-ends analysis</u>
C: riddle
D: subgoal

Problem Solving Strategies

<u>Assessment Question1</u>

Level: 1

Question: Which one of the following refers to the problem-solving strategy that involves attempting different possible solutions and ruling out the ones that don’t work until a viable solution is reached?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question2

Level: 1

Question: Which one of the following describes the problem-solving strategy that involves using a shortcut or rule-of-thumb procedure for efficiently generating a satisfactory solution?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question3

Level: 1

Question: Which one of the following describes the problem-solving strategy that involves a step-by-step formula or procedure that guarantees an optimal solution will be discovered?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question4

Level: 1

Question: Which one of the following describes the problem-solving strategy that involves using a known solution to a similar problem encountered in the past to generate a viable solution to a novel problem?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question5

Level: 2

Question: Every problem-solving strategy has different strengths and weaknesses. Which one of the following strategies guarantees that a solution will be found, but can be very slow or inefficient to implement?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question6

Level: 2

Question: Which one of the following problem-solving strategies is useful for generating a quick solution to a problem but runs the risk of yielding an incorrect or suboptimal solution?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question7

Level: 3

Question: Michelle is working on her algebra homework and has to solve a bunch of problems where the goal is to figure out the value of X. Instead of doing all of the algebraic operations she learned in class, she simply plugs different values of X into each equation until she comes upon the right answer. Michelle is utilizing which one of the following problem-solving strategies?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question8

Level: 3

Question: Carlos has a problem: he needs to find the perfect anniversary present for his girlfriend, but he does not have time to go to every store in town or to talk to her friends about what she wants. He decides to just go buy her a necklace from a jewelry store he knows she likes. Carlos is utilizing which one of the following problem-solving strategies?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics
D: Trial and error

Assessment Question9

Level: 3

Question: Scientists have long been interested in discovering the structure of the atoms that make up our universe. One popular model of the atom was inspired by the structure of the solar system: just like the solar system consists of smaller planetary bodies (planets) orbiting around a larger central body (the sun), the atom consists of smaller particles (electrons) orbiting around a larger central nucleus (protons and neutrons). This demonstrates which one of the following approaches to problem solving?

Options
A: Algorithm
B: Analogical problem solving
C: Heuristics

D: Trial and error

<u>Assessment Question10</u>

Level: 3

Question: For her art history class, Marissa needs to locate the oldest painting on display at the local art museum and write a report about it. To do this, she decides to go to the museum and walk down every hallway and gallery, taking note of each painting on display and when it was painted. Once she has been through every section of the museum, she will check her list and determine which painting is the oldest. Marissa is using which one of the following problem-solving strategies?

Options
<u>A: Algorithm</u>
B: Analogical problem solving
C: Heuristics
D: Trial and error

<u>Assessment Question11</u>

Level: 3

Question: Peter is in the same art history class as Marissa and has the same assignment—find the oldest painting on display at the local art museum and write a report about it. He decides that the most efficient way of doing this is to just look in the “medieval art” gallery and pick the oldest painting there. Peter is relying on which one of the following problem-solving strategies?

Options
A: Algorithm
B: Analogical problem solving
<u>C: Heuristics</u>
D: Trial and error

Problem Solving Barriers

<u>Assessment Question1</u>

Level: 1

Question: Which one of the following describes the tendency to approach a novel problem in the same way that you have approached similar problems in the past?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
D: Mental set

Assessment Question2

Level: 1

Question: Which one of the following refers to the tendency to treat objects as if they have specific, unchanging functions?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
D: Mental set

Assessment Question3

Level: 1

Question: Which one of the following describes the idea that when we approach a new problem we sometimes assume that there are certain actions or strategies we cannot take in trying to solve the problem?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
D: Mental set

Assessment Question4

Level: 2

Question: In the classic candle problem, people struggle to attach a candle to a wall because they do not think to use the box that holds tacks as a tray for the candle. Which one of the following describes the barrier to problem solving illustrated by this finding?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
D: Mental set

Assessment Question5

Level: 2

Question: In the 9-Dots problem, people struggle to connect all of the dots with 4 straight lines without lifting their pen from the page because they assume they cannot extend the lines outside of the square defined by the matrix of dots. Which one of the following describes the barrier to problem solving illustrated by this finding?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
D: Mental set

Assessment Question6

Level: 2

Question: In the water jug exercise, people who have solved a series of problems using a particular formula end up using that same formula to solve a new problem that has a much simpler solution. Which one of the following barriers to problem solving does this illustrate?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
D: Mental set

Assessment Question7

Level: 3

Question: Jose's roommates decided to pull a prank on him and barricaded the door to his room, trapping him inside. Jose thought of using the window to escape, but his room was three stories up and he was afraid he might hurt himself if he jumped. The fact that he did not think about using his bed sheets as a rope to climb down out of the window is an example of which one of the following?

Options
<u>A: Functional fixedness</u>
B: Heuristic
C: Impose additional constraints
D: Mental set

<u>Assessment Question8</u>

Level: 3

Question: As an investigative journalist, Sarah spends most days doing undercover research to find out everything she can about the lives of the people she writes articles about. Just recently, she spent two months digging into the private life of a prominent judge in her town, and before that she spent five months tailing a suspected mob boss. Her new assignment is to write about a local police chief, and she immediately decided to go into her undercover mode and learn everything she can by tailing him around town. It turns out she could have saved a lot of time and effort if she just asked to interview him, since he would actually be more than willing to answer all of her questions and tell her anything she would like to know. Sarah's behavior is indicative of which one of the following barriers to problem solving?

Options
A: Functional fixedness
B: Heuristic
C: Impose additional constraints
<u>D: Mental set</u>

<u>Assessment Question9</u>

Level: 3

Question: Jacob was working on a take-home exam for his history class and he was really struggling with one question about the role of the United States in World War II, so he decided to just leave it blank. Jacob assumed that this was a closed-book exam, even though his professor never said anything about that and assumed most students would use their notes while taking the test. Jacob's behavior illustrates which one of the following barriers to problem solving?

Options
A: Functional fixedness
B: Heuristic
<u>C: Impose additional constraints</u>
D: Mental set

Characteristics of Creativity

<u>Assessment Question1</u>

Level: 1

Question: Creativity is the ability to generate ideas that are both _________ and __________.

Options
A: new; different
B: novel; original
C: <u>original; valuable</u>
D: useful; appealing

<u>Assessment Question2</u>

Level: 1

Question: Creative ideas may be __________ to society as a whole or to the individual who developed the idea without knowledge of anyone else having had the same idea.

Options
A: convergent
B: divergent
C: fluent
D: <u>original</u>

<u>Assessment Question3</u>

Level: 1

Question: _____________, the ability to shift between different problem solving strategies and perspectives, is a characteristic of creativity.

Options
A: Convergent thinking
B: <u>Flexibility</u>
C: Fluency
D: Originality

<u>Assessment Question4</u>

Level: 1

Question: ___________, the ability to generate many possible solutions, is a characteristic of creativity.

Options
A: Convergent thinking
B: Flexibility
C: <u>Fluency</u>
D: Originality

<u>Assessment Question5</u>

Level: 1

Question: Creativity is associated with which one of the following?

Options
A: Convergent thinking
B: <u>Divergent thinking</u>
C: Identifying the only solution
D: Using one problem-solving strategy

<u>Assessment Question6</u>

Level: 2

Question: Which one of the following is <u>NOT</u> true about divergent thinking?

Options

A: It involves multiple problem-solving strategies.
B: <u>It is used on most academic assessments.</u>
C: It is used when there is not a single “correct” answer.
D: It leads to multiple solutions.

<u>Assessment Question7</u>

Level: 2

Question: Which one of the following is <u>NOT</u> true about convergent thinking?

Options
A: <u>It drives the majority of creative thinking.</u>
B: It is used to find a single solution.
C: It is used on most academic assessments.
D: You are using it to answer this question.

<u>Assessment Question8</u>

Level: 3

Question: Which of the following activities <u>does NOT</u> require divergent thinking?

Options
A: Composing a song
B: Listing a variety of possible uses for a spoon
C: <u>Singing along with the radio</u>
D: Writing a story

Measuring Creativity

<u>Assessment Question1</u>

Level: 2

Question: The Terman study illustrates which one of the following?

Options
A: <u>IQ scores are not predictive of creative output.</u>
B: IQ scores are predictive of creative output.

C: The Termites went on to be the most successful members of their generation.
D: The Termites were not truly intelligent.

<u>Assessment Question2</u>

Level: 2

Question: IQ tests measure ____________, so they are unable to truly capture one's _____________ ability.

Options
A: <u>convergent thinking; creative</u>
B: creativity; convergent thinking
C: creativity; divergent thinking
D: divergent thinking; creative

<u>Assessment Question3</u>

Level: 1

Question: ___________ thinking leads to multiple possible solutions, whereas ___________ thinking leads to a single possible solution.

Options
A: Convergent; creative
B: Convergent; divergent
C: Creative; divergent
D: <u>Divergent; convergent</u>

<u>Assessment Question4</u>

Level: 1

Question: The Alternative Uses task involves all of the following except for _____________.

Options
A: brainstorming
B: <u>convergent thinking</u>
C: creative thinking
D: divergent thinking

Assessment Question5

Level: 1

Question: Divergent thinking tests are assessed according to which of the following sets of criteria?

Options
A: Assimilation, flexibility, fluency, originality
B: Assimilation, elaboration, flexibility, originality
C: Elaboration, flexibility, fluency, originality
D: Elaboration, fluency, novelty, originality

Assessment Question6

Level: 2

Question: Which one of the following assessment criteria best reflects whether one has viewed a problem from different perspectives?

Options
A: Assimilation
B: Elaboration
C: Flexibility
D: Originality

Assessment Question7

Level: 2

Question: Insight problems generally require which one of the following?

Options
A: Convergent thinking
B: Divergent thinking
C: Elaboration
D: Originality

Assessment Question8

Level: 3

Question: Alfredo was asked to list as many uses of a blanket as he could. He came up with a long list of uses, including the following: to catch people who are jumping from a burning building, to put my dirty laundry in when I cannot find my laundry bag, and to use as a parachute for my little sister's dolls so I have an excuse to chuck them out the window without her freaking out. When Tommy was given the same test, his long list of uses included the following: to catch stuff, to carry stuff, and for a parachute. Their answers have similar content, but Alfredo would be given a much higher score on which one of the following?

Options
A: Convergence
B: Elaboration
C: Flexibility
D: Originality

Enhancing Creativity

Assessment Question1

Level: 1

Question: _____________ occurs most readily when the mind is allowed to wander.

Options
A: Extrinsic motivation
B: Intrinsic motivation
C: Incubation
D: Persistence

Assessment Question2

Level: 1

Question: Making note of minor annoyances instead of dismissing them is a step in the creative process known as _____________.

Options
A: counterfactual thinking
B: divergent thinking
C: incubation

D: problem finding

Assessment Question3

Level: 1

Question: ____________ motivation is driven by curiosity and one's personal desire to learn.

Options
A: Autonomic
B: Extrinsic
C: Intrinsic
D: Social

Assessment Question4

Level: 1

Question: ____________ motivation is driven by external rewards, such as money and social approval.

Options
A: Autonomic
B: Extrinsic
C: Intrinsic
D: Social

Assessment Question5

Level: 2

Question: Creative thought is more likely to occur when a person's motivation is _________ than when it is ___________.

Options
A: autonomic; social
B: extrinsic; intrinsic
C: intrinsic; extrinsic
D: social; extrinsic

Assessment Question6

Level: 1

Question: ___________ is a creative thought process in which one considers a problem from multiple perspectives and generates a variety of possible solutions.

Options
A: Convergent thinking
B: Divergent thinking
C: Problem finding
D: Solution seeking

Assessment Question7

Level: 2

Question: Stepping away from a problem can help us find a creative solution because it enables us to_______________.

Options
A: conserve mental resources
B: consult the internet
C: forget inappropriate fixations
D: procrastinate

Assessment Question8

Level: 2

Question: Spending time abroad helps one see problems from multiple perspectives, improving one's ___________.

Options
A: extrinsic motivation
B: flexibility of thought
C: intrinsic motivation
D: persistence

Assessment Question9

Level: 2

Question: People who have ________________ are more likely to make creative contributions than those who do not.

Options
A: a deadline
B: a financial incentive
C: conformist beliefs
D: <u>expert knowledge</u>

<u>Assessment Question10</u>

Level: 3

Question: Milo is ten years old and has just begun learning to play the piano. He is actively trying to compose his own music and puts in effort on a daily basis, but he is having trouble coming up with anything original. Which one of following crucial building blocks of creativity does Milo currently lack?

Options
A: <u>Expert knowledge</u>
B: Extrinsic motivation
C: Persistence
D: The creativity gene