An Integrated Model of Human Cognition For Digital Product Development

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Abstract

Cognitive Psychologists strive to understand why people do the things they do. As Internet usage continues to rise, it is important to understand how humans process this flood of information, what they decide to attend to and what information they dismiss. Although the human brain is capable of incredible feats of processing and problem solving, it is also capable of spectacular errors, which can have serious ramifications. Understanding how human cognition works and how it fails is the foundation for creating digital products that are efficient and effective to use.

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In November 2015, Internet usage exceeded 46% of the world population. This represents an 832.5% increase in usage from 2002. In North America alone, Internet usage has penetrated 87.9% of the population (Argaez, 2015). Every day the Internet is becoming more accessible to people around the world. How humans process the massive amount of digital information available to them, how they decide what to pay attention to and what to disregard and how they remember and use digital information is a function of human cognition.

Aristotle believed humans think and acquire knowledge as a result of how they perceive the world around them. This idea has formed the basis of human cognition theory, which has evolved over time (Sternberg & Sternberg, 2012). Cognitive psychology theory developed in the1950's and continued to grow as a dominant perspective well into the 1990's. Replacing behaviorism as the primary model of psychology, cognitive theory was influenced by progress made with the personal computer. The personal computer revolutionized the way cognitive psychologists talked about how the brain functions because they now had a highly relatable metaphor to describe information processing (McLeod, 2008).

Through empirical experimentation, cognitive psychologists strive to understand why humans do the things they do. As information floods the Internet, having an understanding of how humans process and attend to this information is increasingly important for the people who craft and maintain digital products. The experience a person has with digital tools is strongly influenced by how much the product designer understood about the people using them (Weinschenk, 2011). Digital products are created to be used by humans; therefore, it is essential to understand cognition so that the products can be both productive and useful (Natoli, 2013).

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Humans perceive the endless stream of environmental stimuli through our senses. It is our senses that provide us with information about the world around us, however our awareness is limited by what our senses are able to detect (Green, 2014). Humans have as many as 21 senses, debunking the common misconception that we are served by only five (Mercola, 2005). However, in digital product development the senses of sound, touch and vision are most frequently accessed.

According to Dr. Rishi Desai, our brain perceives sound when sounds waves reach our ear through the cochlea and travel across the basal membrane until it makes contact with the hair cells that are in tuned to that particular frequency. The hair cells activate and then transform into a signal, which eventually reaches the brain through the auditory nerve. Each signal is mapped to a particular part of the brain. The primary auditory cortex is the area of the brain that is responsible for receiving information from the cochlea and it allows humans to distinguish between different sounds (Desai, 2014).

In digital product development, awareness of sound typically takes a variety of forms: alert, feedback, communication and entertainment. Alert sounds warn of an error that has just occurred or warning of an impending event. Feedback sounds help to let users know that an action was successful. This can take several forms. The sound of the “click” as a person types on the keyboard provides feedback that a letter was pressed. The sound of a “ding” when the Send button is activated informs the user that their action to send an email was successful. Intelligent personal assistants like Apple’s Siri, use speech interpretation and voice recognition to engage in artificially intelligent conversations. Sound is used for entertainment to enhance the experience interacting with a digital interface.

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Our sense of touch allows humans to gain knowledge about the outside world through the skin. Humans perceive touch pressure, temperature changes and pain through the sense of touch. Nerve cells and connective tissue in the skin are specialized to detect different types of touch. When someone feels changes in the temperature or pressure, pressure signals activate and send a message to the central nervous system so that humans can make sense of what they are feeling (Cinti, 2013).

Touch sensitive panels have become a ubiquitous part of modern day life. From bank ATM's to touch screen phones, our central nervous system processes information from interacting with touch devices almost daily. Using gestures on touch devices will create a sensory memory that helps to remember how to easily complete tasks. For designers, this means it is important to build standard gestures into your digital product, as users will have an easier time interacting with the product or tool (Weinschenk, 2016).

Visual processing is the sensory workhorse in digital product development. According to Hank Green, vision is considered the dominant sense of humans (Green, 2015). Visual processing begins in the back of the eye. Light enters the eye through the cornea through a hole in the pupil and then through retina cells at the back of the eye. Rods and cones in the retina react to different colors and those signals are sent along the optic nerve to the brain (Green, 2015). Our brain attempts to find meaning in the stimuli it sees. It does this by finding relationships with past input and then assigning meaning to those relationships (Younger, 2013).

People will make a decision about a digital interface in less than a second. This first impression carries through to how they feel about the interface as they continue to interact with it (Weinschenk, 2016). This presents a challenge to designers to create meaningful and visually

appealing interfaces that are simple enough that the value of the visit is understood in a split second.

What humans observe in their environment is not always the same as what the brain sees. Our environment is overloaded with stimuli and it would be very taxing for our brain to attend to it all. To compensate for this overload, our brain will take shortcuts, or heuristics, that help to determine what is important and what is not (Sternberg & Sternberg, 2012). While this is necessary for the healthy operation of our brain, it can also sometimes lead to mistakes. Our brain determines what is important enough to pay attention to based on our background, knowledge, experience with what we are observing and our expectations of what we see (Weinshenck 2011).

Humans process environmental stimuli through our senses and the neural network that sends messages to our brain. Evolutionary Psychologists look at the brain not as one elusive area of our bodies but as an organ with three distinct parts that each have a critical role in how we think, remember, solve problems and process information. Dr. Susan Weinschenk describes these regions as the old brain, mid brain and new brain. (Weinschenk, 2009). Evolutionary psychologists believe that the way our brain functions is an adaptation over time through the evolutionary need of survival. According to Weinschenk, the old brain is concerned with our survival, the mid brain handles emotion and the new brain processes language, thinking and problem solving. Evolutionary psychologists believe most of the information processed in our brains happens on a subconscious level whereas we are only aware of information processes that occur in the new brain.

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Evolutionary psychology draws on the fundamental principles of cognitive psychology and evolutionary biology and is based on the following principles (Cosmidesc& Tooby, 1997):

1. Like cognitive psychology and behaviorism, information is processed in our brains in response to external inputs (cognitive psychology) and stimuli (behaviorism).
2. Our brains have adapted over time due to the need for survival.
3. Specialized mechanisms in our brain exist to help us solve problems we faced as our species evolved.
4. Thee specialized evolving mechanisms have resulted in “modern humans with stone age minds”.
5. The majority or brain processing happens in our sub conscious.
6. The complexities of the brain processing mechanisms work together to produce behavior.

In addition to the distinct parts of the brain that determine how we think, remember and process information, the brain has individual systems that will activate depending on how we need to think. Daniel Kahneman explores this idea in his book “Thinking, Fast and Slow”. According to Kahneman, we have two systems of thinking, system 1 and system 2. System 1 thinking is fast and intuitive. It is the type of thinking a human does without really thinking about it (Kahneman, 2013). Humans are mostly in System 1 thinking mode. System 2 thinking

requires more work and energy and is a slower form of thinking that is also more challenging. Computing math problems in your head is an example of System 2 thinking (Kahneman, 2013).

In general digital products perform best if they are so intuitive the users does not have to think while using them. This would be designing for System 1 thinking. However, there are times when you would want users to stop and think about what they are doing before they do it. If a task is complicated, like dealing with finances, or carries severe penalties if an error occurred, like flying a plane, you would want a person to think carefully about what they were doing. For example, if a user is interacting with their retirement accounts online, we would want them to think carefully about selling, trading or moving their assets. Designing for this interaction is fairly easy by slowing down the process. This can be done either by adding screens or steps to the process or by introducing italicized text. According to Weinchecnk, you can force people into System 2 mode from System 1 by showing them text in a font that is hard to read (Weinschenk, 2016).

Most scientists and cognitive psychologists who study memory, behavior and information processing agree on these foundational principles:

1. Mental capacity is limited which means constraints exist in how much information we can process (Huitt, 2003). This is due to a number of factors including the health and age of the person, lack of sleep, genetics, hormonal imbalances, diet, substance abuse and stress.
2. Controls exist to oversee information processing capacity. Certain processing tasks take more effort than others.

3. Information flows in and out in a two-way stream, which helps us make sense of the world around us (Huitt, 2003).
4. Humans are genetically predisposed to process information in a specific way. According to Huitt (2003), “a human infant is more likely to look at a human face than any other stimulus. Given that the field of focus of a human infant is 12 to 18 inches, one can surmise that this is an important aspect of the infant's survival.”
5. Information processing is executed in a series of stages including sensing, perceiving, decision-making and taking action.

Memory is a fundamental component of information processing and is vital to understanding how humans think. When memories form in the brain, it is a result of neurons activating and firing. This same action happens when we retrieve a memory and this can cause memories to change each time we retrieve them (Weinschenk, 2016). Autobiographical memories specifically relate to something that happened in your own life. Autobiographical memories are prone to errors because each time you recall the memory it is reconstructed (Sternberg & Sternberg, 2012). Flashbulb memories are memories that occur in highly emotional situations and tend to be stronger and less likely to be reconstructed with errors (Weinschenk, 2016). Semantic memories are memories of factual information. They are strengthened through repetition and are less likely to be altered in recall. Sensory memory is the connection between environmental stimuli that is activated through our senses and our brain. It is very short lived but plays a very important role as sensory memory can determine what we pay attention to and what we disregard. Sensory memory occurs outside our conscious control and determines what information is important enough to be processed by the brain in that moment (Mastin, 2010).

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When people interact with a digital product they are using all types of memory. As a user performs specific tasks with a digital product, they do so by retrieving memories. According to Weinschenk, digital product designers need to take this into consideration and intentionally design so that it is easy to store and recall memories. One technique to accomplish this would be to design product layouts in an expected way with the elements in the same place, use consistent symbols and iconography and by using accepted design patterns that people are used to seeing and interacting with. (Weinschenk, 2016).

Humans need to make decisions on a daily basis and like to think they are in control of the choices they make. Recent research shows however, that most decisions are made in our sub conscious mind (Weinschenk, 2016). Because we are flooded with information that frequently requires a choice, our brain will take short cuts, or heuristics, in an effort to not overwhelm our information processing system. While these shortcuts do help to lighten the cognitive load, they also increase the chance of making a thinking error (Sternberg & Sternberg, 2012).

Problem solving is the higher order cognitive skill that attempts to reduce thinking errors when solving complex problems. When humans solve problems, they usually have a focus on solving the problem quickly or accurately. Using a trial and error technique or an algorithm can increase accuracy but may take a long time to complete. As mentioned earlier, heuristics help to solve a problem quickly but are prone to errors (Green, 2014).

Studies conducted in 2011 by Joseph Mikels concluded that when faced with a really complex decision, humans tend to disregard trial and error, algorithms or heuristics in favor of making gut decisions. Mikels also found that people who used their gut to make a decision were happier with their decision over time (Mikels, Maglio, Reed, & Kaplowitz, 2011).

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What this means for designers creating digital products is to consider the type of decisions people need to make with your digital product and incorporate design elements that help them make good decisions. This can be accomplished by delivering the appropriate amount of information to users at the correct time to allow them to focus on how they feel about a decision instead of analyzing data about it (Weinschenk, 2016).

Cognitive biases are the thinking and judgment errors humans make. Some factors contributing to bias errors are using mental shortcuts, or heuristics, limitations of the brain's ability to process information, memory limitations, and external factors like stimulus distractions that affect attention (Sternberg & Sternberg, 2012).

Biases occur when there is a disconnect between what is true and what people perceive to be true. Fallacies are mistakes people make in logical thought processes. Unlike biases that are widespread and can be habitual, fallacies are problems with the argument itself that make the argument invalid. Fallacy arguments are problematic because they are often made to sound true (Sternberg & Sternberg, 2012).

According to Hank Green, "cognition is what makes us truly human and all the elements that come with it are what make us the individuals that we are" (Green, 2014). Humans strive to find meaning in the world around them and we use the complexities of cognition to accomplish this goal. Digital products are constantly changing. As technology use continues to rise, our world becomes a more cluttered place. Our minds are capable of processing incredible amounts of data and performing amazing feats of problem solving but they are also capable of making spectacular thinking errors. It is critical for designers to understand how people know,

remember, understand, communicate and learn so that we can continue to build products that are efficient and effective for them.

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