Building the Knowledge of Human Perception into E-Learning

Shalin Hai-Jew
SIDLIT
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Human Perception in E-Learning

- Human perceptual systems—for sight, sound, taste, touch, and smell (and maybe even embodied proprioception)—may offer some guidelines for how to build multimedia e-learning: immersive 3D simulations, imagery for analysis, sight-and-sound distributions of information channels, and other applications. This will offer a brief overview of human perception (with a little human cognition thrown in) and some light applications to the design of e-learning.

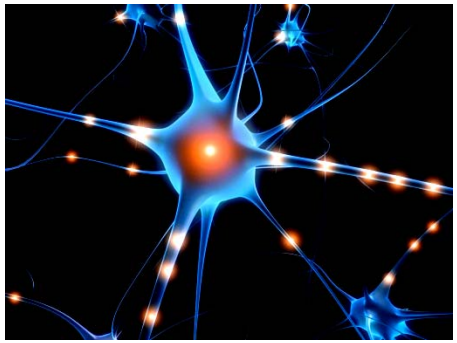
Overview

- Human Perception
- Basics
- Terminology
- The Human Senses and the Brain
- Sight, Hearing, Touch, Smell and Taste
- Perception and E-Learning
- Some Common Mistakes
- Instructional Design Issues
- Multimedia: Affordances and Constraints

Overview (cont.)

- Learning / Course Management Systems (L/CMSes): Affordances and Constraints
- Virtual Worlds: 3D Immersion
- Strategies: Priming
- Strategies: Cognition
- Strategies: Short-term and Long-term Memory
- Perception, E-Learning, and Accessibility
- Resources
- Conclusion and Contact

Initial Group Work

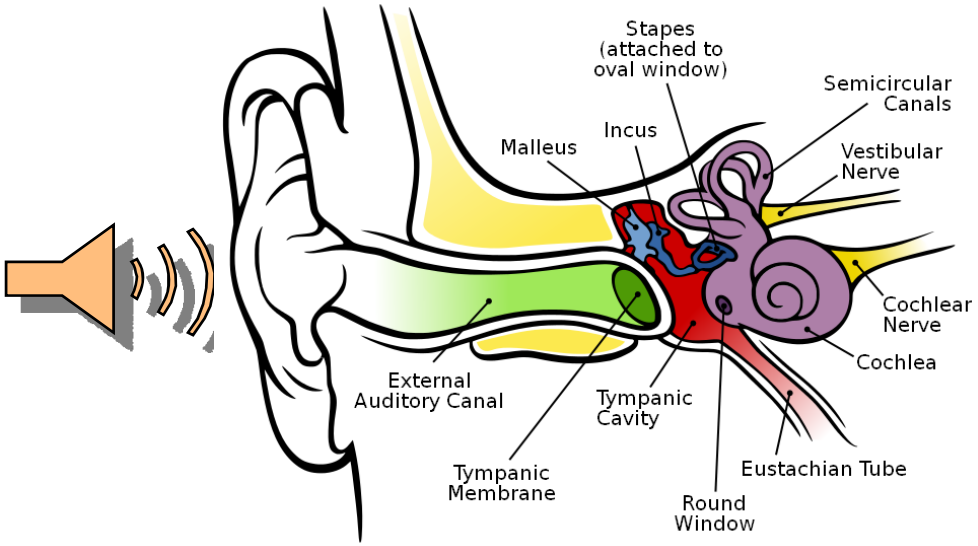


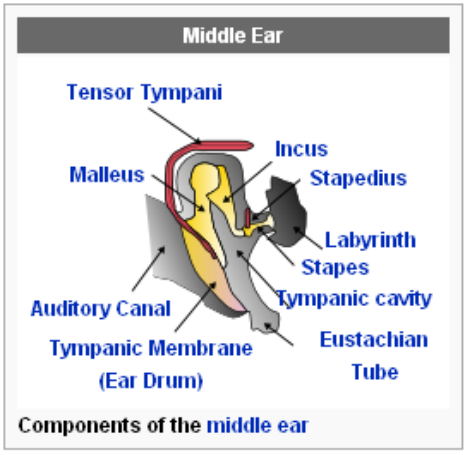
Directions:

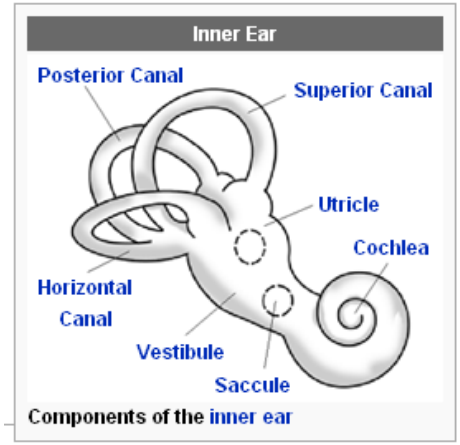
Join one of the five groups.
Choose two of the questions below for a preliminary discussion.

1. The Visual Group

1. **Light in the World:** Where does light usually come from in the world? This light is known as "full spectrum" light. What does that mean? How does the full spectrum support human vision? Humans are diurnal, which means they are awake in the daytime. Their vision acuity in the daytime and the nighttime are quite different. How so?
2. **Eyes and High Res:** What parts of the eyes offer the highest level of resolution and detail? Which parts offer the least? Why?
3. **Reflectances:** What direction does light come from? Why? Most light that people see is "reflected" light. What is reflected light? How is reflected light informative of forms and textures? Some types of artificial light are emitted lights. What are these types of lights? How do they differ from reflected lights?
4. **Color Perception:** Color is created by different wavelengths of light reflected off particular surfaces. Do people perceive colors the same way as others? Why or why not?
5. **Getting Gists:** How quickly will it take for a person to get the "gist" (a high-level semantic description") of a scene?
6. **Saccades:** Human eyes are constantly making saccadic eye movements. During the ms movements, humans are functionally blind. Why are saccades ("jumps") necessary to eyes and to vision?
7. **Expectations and Blindness:** Due to top-down attention, people tend to be "blind" to things they do not expect to see (or perceive). What are some strategies to getting past this blindness?



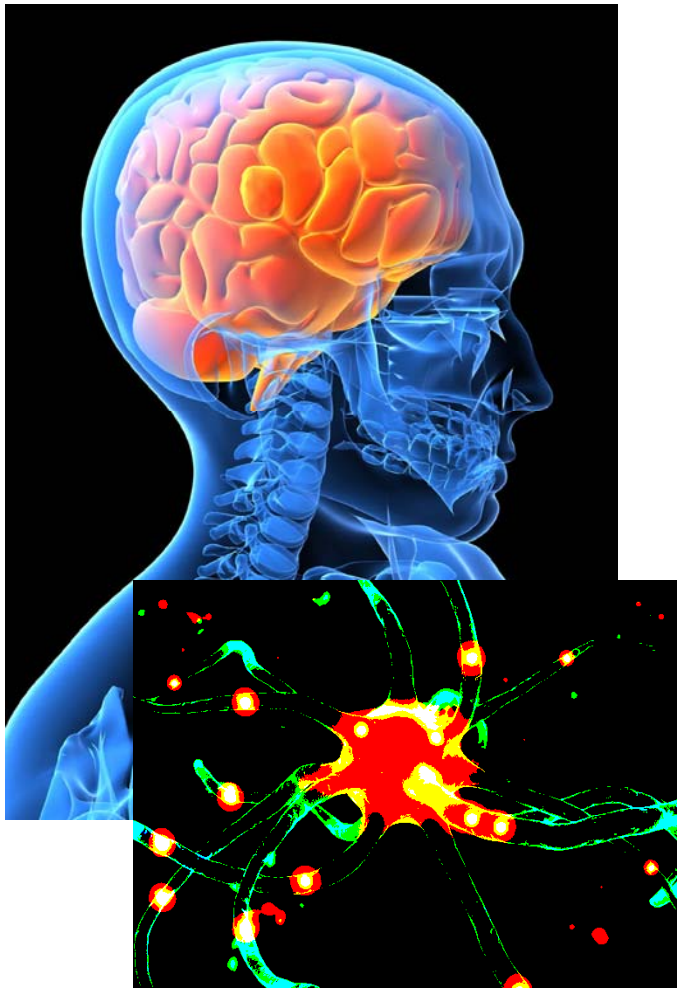




2. The Sound Group

1. **Sound:** What is sound? Why do people refer to sound "waves"? How does sound affect molecules? How does sound move through the air? Through solid objects?
2. **Sound Localization:** In terms of sound localization, from which direction would it be hardest for a person to detect the source of sound information? What are some strategies people can use to identify the location of a sound?
3. **Ear Structures and Functionality:** How does the pinna (outer ear) enhance the capture of sound? How does the spiral structure of the inner ears work to locate sound?
4. **How People Sound to Themselves:** People who are new to audio and video captures of themselves may be surprised by how they sound. Why do their recorded selves sound different to themselves? (Hint: Bone conduction)
5. **Types of Deafness:** What are various types of deafness? How are these (partially) mitigated to promote human hearing?

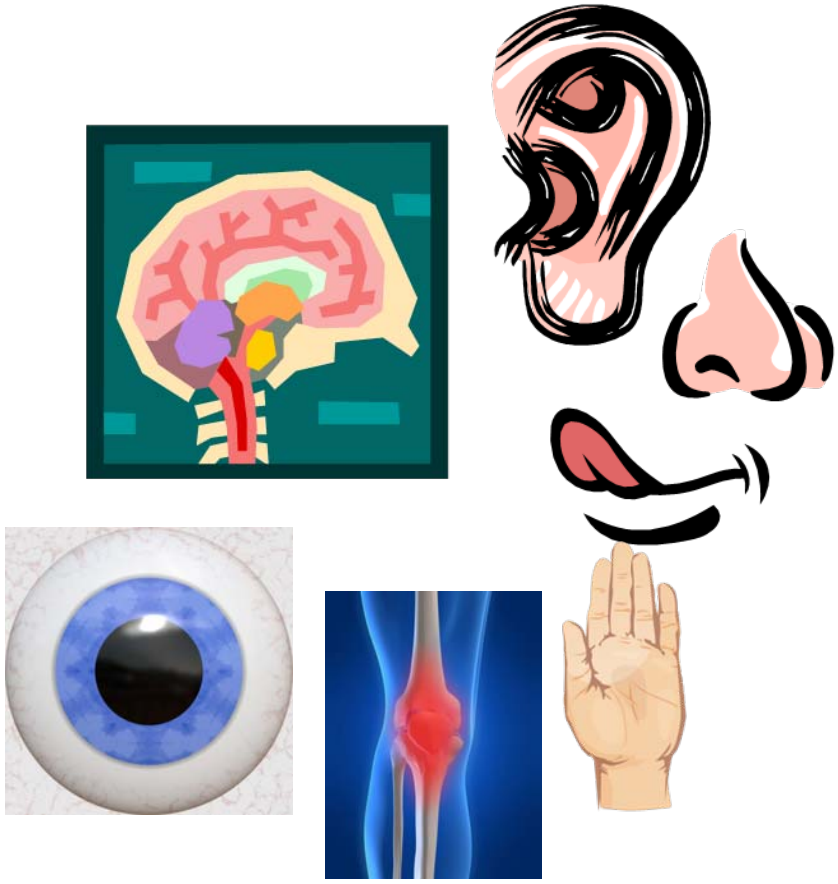
3. The Tactual Sensations Group



1. **Differential Sensitivity:** Not all parts of the human body are equally sensitive in terms of touch / tactual sensations. Why are there these differences? What evolutionary benefits are there for different touch sensitivities? When is it a benefit to have few sensors? When is it a benefit to have many sensors?
2. **Useful Touch Information:** What sorts of useful real-world information may be collected through the sense of touch? Heat? Cold? Tension? Texture? How is touch used in learning?
3. **Professions:** What is the role of touch in various professions? In surgery? In nursing? In professional cooking? In art? In geology? Other fields?

4. The Attention Group

1. **Human Attentional Effects:** What effects does human attention (mental focus) have on neural activity? Does attention enhance or harm the processing of locating particular sensory stimuli in the environment?
2. **Sensory Stimuli and Mental Events:** Attention may be paid to sensory stimuli from the world and "mental events" from internal states of the observer (dreams, visualizations, imagination, and memories). In terms of your lived experiences (in the world), what are some examples of sensory stimuli? What are some mental events?
3. **Change Blindness:** What is "change blindness"? Why would the gist of the scene matter to whether a person notices changes or not?
4. **Attention without Perception:** Can there be attention paid without conscious perception? (Here, "attention" refers to the capturing of information; "consciousness" refers to a "summarizing (of) all information that pertains to the current state of the organism and its environment…and rational thought") (Koch & Tsuchiya, 2006).



5. The Sensory Information Collection Group

1. **Environment Sampling:** How do humans sample the environment for perceptual information? When is such sampling automatic? When it is purposive? (Consider issues of sight, hearing, taste, smell, and touch.)
2. **Sensory Perception Over Time:** What sorts of sensory perception and learning improve with experience over time? Why? What sorts of sensory perception and learning degrade over time?
3. **Proprioception**: Describe the sensation of embodied senses. How is learning "in the body" different than learning "virtually" (through cognition alone)? How would you describe this sixth sense?
4. **Unified Senses**: The brain and nervous system collect plenty of environmental and internal information simultaneously. It coordinates the "multi-modal" sensory information streams in a smooth way, without any conscious perception of glitches. How do you think this is done? On a side note, what is "synaesthesia"?

A Very Brief Intro

… to a complex topic…

"Human Perception"

- **A Kind of Signals Detection:** Human perception involves the capture of environmental "energy" information through the human / animal sensory organs and processed in the brain. This data is captured and transduced into electronic signals in the brain, which is interpreted as sensory signals. People have to differentiate between true signals and background noise.
- **Ecological Perspective:** Sensory information helps animals survive and interact in their particular niche environments.
- **Mind-Body Dualism:** The mind-body dualism suggests that there are different channels of information. The "soul" may be one channel of information; the "brain" may be another channel. (The latter is supported by empirical research.)

"Human Perception" (cont.)

- **Lower-Order Perception:** "Lower order" brain processes capture sensory information at the detail level.
- **Higher-Order Perception:** "Higher order" brain processes help organize perceptual information. These help direct human attention, decision-making, and action. These analyze and organize new information. These also control interacting systems in the body for a "coalition" of aspects that promote perception and action.
- **Extenders:** "Ego extenders" enhance human perception. These may be technologies that serve as intermediaries in capturing information.

"Human Perception" (cont.)

- **Evolutionary Ideas:** The "primitive" or ancient brain contains low-level sensory capture. The more evolved brain contains higher level color perception, depth perception, and greater visual sensitivity—in terms of sight. "Genetic memory" is an underlying assumption of evolution in terms of human perception.
- **Amplification and Suppression**: Some perceptual signals are amplified, and others are suppressed depending on the value of that perceptual signal to human survival and functioning.

Basics: Perception and the World

- **Environmental Energy – Perception:** The perception of energy in the environment (lightwave energy / sight, air dislocation / sound, pressure / touch, molecules / taste and smell) is seldom 1-1. People perceive different sensory feedback with varying levels of sensitivity. Much of the world's energy is beyond the range of human perception and is therefore undetectable without additional aids / equipment.
- **Non-veridicality of Perception:** Perception is non-veridical (It doesn't match the world's inputs in terms of either full accuracy or magnitude), with subjective interpretations. (Also, "metamers" which emulate certain stimuli may add confusion to human perception.)
- **A Continuum of Perspectives:** A naïve view is that the world is as a person perceives it—with the human limits and illusions. Solipsism (aka mentalism) is the concept that the world only exists in the human mind. These are the two ends of a perception continuum.

Basics: Underlying Meta-Theories

Direct Perception / Ecological Model

- The world provides sufficient information for full perception if people would sample the environment sufficiently and take in the information.
- Memory is not required for perception.
- Each animal—based on its affordances and constraints—will perceive the environment differently. There is a mutuality or synergy between the animal and the environment. (Michaels & Carello, 1981)

Indirect Perception / Constructivism

- The world does not provide sufficient information. The brain has to "augment" the sensory experience with prior experiences and analysis and contextualization to create sense meaning.
- The human brain interpolates information by filling in informational gaps.

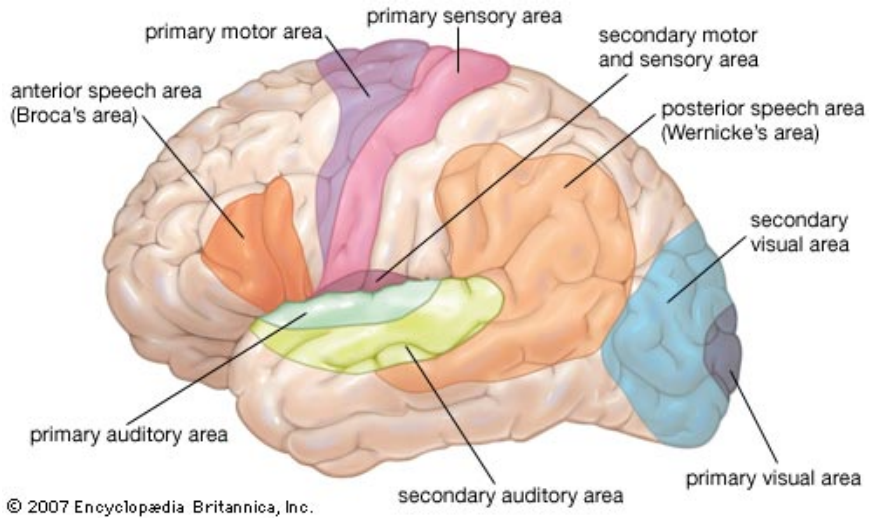
Terminology

- **Invariants**: Objects that maintain perceptual constancy (properties: size, brightness, shape, and color, for example) no matter the perspective of the viewer; objects that follow the laws of physics; objects that are quantifiable by math and geometry. These objects reflect physical realities in the world.
- **Optic Array**: The way visual objects orient in the world to a disappearing point on the horizon

The Human Senses and the Brain

- Five senses:
  - Far senses: sight and sound
  - Near senses: touch, smell, and taste
- The sixth sense: proprioceptive (embodied "knowing" of the creature beyond the brain knowledge)
  - Nerve endings
  - Joints
  - Muscles
  - Limb postures

The Human Senses and the Brain (cont.)



- Brain processing: defined channels for specific sensory information
- Polysensory receptors
- Interpretive brain functions regarding perception
- Specialized cells for certain types of sensory information
- Specialized brain processing locales
- Cortical magnification of particular signals

The Human Senses and the Brain (cont.)

- **Patterning:** There are "carpentered" environmental and experiential influences on information capture. The brain shows preparation for information patterns in the world, with heightened sensitivity to visual faces and hands.
- **Brain Preferences**: The brain prefers the familiar and tends to notice the unfamiliar. The learning brain moves towards complexity vs. simplicity.

The Human Senses and the Brain (cont.)

- **Research**: Lesion studies *(in vivo)*, various types of electrophysiological studies; brain scanning and neural cell-level / single cell recording research *(in vitro)*, human experiential research (*both in vivo and in vitro)*
- **Internal Signaling:** Dark light or intrinsic light refers to brain activities that result in perceived sensations (but which are not from the external environment) ; “spontaneous emissions” and “phantom tones” (illusory “Zwicker tones”) refer to sound signals without any external sound wave.

Human Perception and E-Learning

- Progression of the “far” senses
- Some work with the near-sense of touch
- Little work in smell and taste

Sight

- The uses of captured images and video for detection, analysis, and planning
- Illusory motion (in films, in video games) is created by a flashing of pixels (dots) to create a sense of motion.
- Geometrically-sound 3D captures

Hearing

- Conveyance of information
- Intercommunications and information exchange
- Artistry and entertainment
- Mood setting in simulations and scenarios

Touch

- Haptic input / output devices for computers
- Braille devices
- Physical – digital simulations (flight simulator rooms)
- Augmented reality (digitally-augmented learning in physical spaces)
- Biofeedback kits (USB-connected)

Smell

- Plug-in chemical “boxes” to evoke smell sensations
- “Spritzers” (as on entertainment rides)
- Long-term efforts recreating smells through computerized devices

Taste

- “Kits” to enhance e-learning
- Augmented reality spaces / smart rooms

Some Common Mistakes

- Not considering human capabilities (the limits of perception, cognition, memory, and learning; concurrent capabilities—as through the "multiple resources" theory)
- Insufficient / lossy visual information (photo-realistic images without white color balance, without scale, and without clear depth perception; 3D imagery not built to scale—so lacking size familiarity and possibly resulting in "negative learning"); not making up for the "degenerative" nature of artificial visual depictions with "selective fidelity" / mental model creation

Some Common Mistakes (cont.)

- Insufficient capitalizing on perceptual processing information channels (using visuals and text strategically; using audio and text strategically); overloading of the perceptual paths
- Triggering concurrent “time-shared” attentional resource competition in a task allocation / high demand situation (leading to overload and decrements in performance); “sharing” non-sharable resources (like voice with multiple vocal streams; visual reading of two sources)

Some Common Mistakes (cont.)

- Triggering high emotions and stress in learners, which dampen or suppress learning
- Not considering learner fatigue
- Not being selective in sensory stimuli
- "Masking" or covering over one sensory stimuli with another (the first stimulus covers up the latter; the latter stimulus covers up the first); introducing perceptual "noise," which may lead to confusion or inaccurate receipt of the sensory "signal"
- Not designing online spaces to direct attention (both automatic / experiential cognition and conscious / directed cognition)

Instructional Design Issues

- Rich multi-sensory resources
- Designed for learning
- Creating a learning context
- Annotating for value-added
- Transcribing audio and video for value-added; alt-texting still images for value-added
- Maximizing human perception and cognition
- Using multiple channels
- Promoting accessibility (mitigating for color-based information, for example)

Instructional Design Issues (cont.)

- Allowing learners to control the speed of an online experience, including its recordability and its replayability (review)

Multimedia Affordances and Constraints

Information Capture Equipment

Affordances

- Huge information richness in captures
- Machine-enabled specs
- Automated metadata capture (GIS)

Constraints

- Limited capture environments
- Unwieldy equipment

Software Editing / Authoring / Design Tools

Affordances

- Imaginary depictions possible
- Portability of digital files
- Integration of digital files
- Multi-sensory depictions

Constraints

- High learning curves to design

L/CMS Affordances and Constraints

- Types of deliverable files available (visual, auditory, and polysensory)
- Ability to package online learning (contextualization)
- Ability to download relevant contents
- Ability to sequence online learning
- Learner access and control

Virtual Worlds: 3D Immersion

- Simulated depth perception
- Full sensory immersions and experiential "fidelity"
- Locative (location sensitive) sound creation
- Value-added annotations
- User control of some sequencing

Strategies: Priming

- Millisecond images and subconscious priming
- Purposive sparking of learner motivations
- Focusing learner attention ("a family of mechanisms that restrict processing in various ways") (Wolfe, et al., 2008)
- Setting the context, Gestalt theory
- Using relevant information-rich visual information (but not decorative information)

Strategies: Priming (cont.)

Subconscious

- Millisecond imagery or other sensory information
- With or without the notification of learners

Conscious

- Defining learner expectations
- Explaining the limits of the simulation
- Packaging contents
- Setting the learning context
- Asking relevant questions
- Assigning relevant research to learners in preparation for the multimedia learning
- Parsing and segmenting the learning

Strategies: Cognition

Perceptions	Cognition	Learning
AUTOMATIC •Capturing the sensory stimuli (in working memory) **CONSCIOUS** •Paying attention •Being motivated to focus on the senses •Rehearsing to push the perceptions into long-term memory	**AUTOMATIC** •Parsing sensory information **CONSCIOUS** •Analyzing •Categorizing •Labeling •Assessing •Comparing and contrasting •Comparison with past learning •Classification •Verbal reportability •Metacognition	**DISCIPLINES AND HABITS OF MIND** •Reviewing •Selective exposure to particular information and experiences •Applying / work •Designing •Collaborating •Researching

Strategies:
Short-term and Long-Term Memory

- Short-term perceptual memory is fleeting and easily forgotten; it is malleable and sensitive to various manipulations.
- "The world it its own memory…" (O'Regan, 1992, as cited in Ware, 2004).
- Information may be moved from short-term memory to long-term with reinforcement and strong exposure. Practice and review may also enhance this shift into the long-term.
- Long-term memory tends to be more stable. Retrieval, though, may be faulty and incomplete. A digital version of the perceptual information may enhance learning.

Perception, E-Learning, and Accessibility

Perception	Perceptual Loss
Sight	Visual acuity, color-blindness, night vision
Hearing	Conduction loss, sensory/neural loss; loss of high frequency perceptions with age
Touch	Loss of feeling
Smell	Loss of acuity
Taste	Loss of sensitivity
Proprioception / physical motion	Mobility, disembodiment in e-learning

Cognition: And mental processing…symbolic processing…
And spatial logic…

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Conclusion and Contact

Dr. Shalin Hai-Jew
Kansas State University
iTAC
shalin@k-state.edu
(785) 532-5262 (work phone)
(785) 532-3199 (fax number)
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