



# **Why No One Believes Us: Cognitive Neuroscience and Radiation Risk**

**R. E. Toohey, Ph.D., CHP  
President-Elect, HPS**

# What's Going On

- **We have made tremendous efforts in public education and risk communication**
- **We believe that if we can just explain “the truth about radiation” to the public, they will be as accepting of radiation risk as we are**
- **We have been advised to present information in non-technical, non-threatening terms**
- **However, our efforts to inform workers, government officials, and the public about radiation risks are not very effective, in terms of changing behavior**
- **This has come to the forefront in my experience dealing with various stakeholders in the U. S. workers' compensation program**

# Opposing Perceptions 1

- **“It was so hot in there, they only let us work there for two minutes each, then somebody else had to go in.”**
- **Worker perception: proof of high hazard and overexposure**
- **Health Physicist perception: use of time limitation as a means of controlling exposure**

# Opposing Perceptions 2

- **“I told them to move that box of waste up over the rear axle of my truck, and the radcon guy said ‘no, we have to put it right at the back end.’”**
- **Worker perception: proof of high hazard and overexposure**
- **Health Physicist perception: use of distance as a means of controlling exposure**

# Is Perception Reality?

- **“My Dad was never sick a day in his life until he got exposed at that plant.”**
- **Communication expert guidance: “This is an emotional reaction; allow it to be expressed, but it need not be addressed.”**
- **Reality: the reaction is based on perfectly valid reasoning and judgment and cannot be challenged by intellectual argument**
- **We may need to overhaul our entire communication effort**

# Factors Affecting Perception, and Therefore Decision-Making

- **Personality type**
- **Brain anatomy and physiology**
- **Cultural memes**
- **Individual experience**
- **Generational type**

# Myers-Briggs Personality Types

- **A way of classifying a person's preferred approaches to dealing with life, based on Jungian principles**
  - **Introvert (I) vs. Extrovert (E)**
  - **Sensing (S) vs. Intuitive (N)**
  - **Thinking (T) vs. Feeling (F)**
  - **Judging (J) vs. Perceiving (P)**
- **There are then 16 personality types, e.g., ISTJ, ENFP, INTP, etc.**

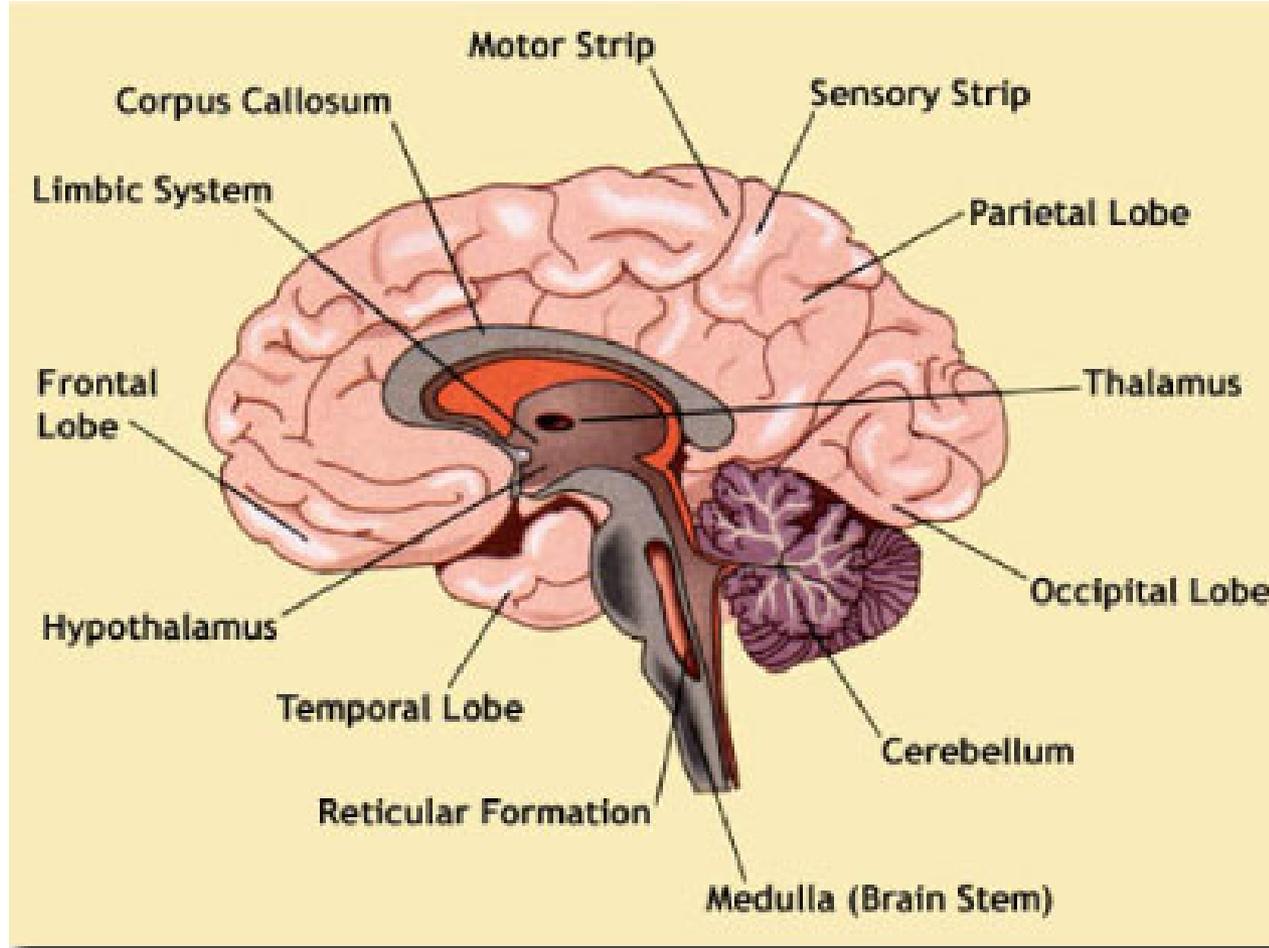
# Us vs. Them

- **Voluntary testing of 3200 radiation protection professionals showed that 51% of those tested fell into only four types: ISTJ (21), INTJ (13), ENTJ (10), and INTP (7).**
- **These four types represent only 13% of the general population; only 15% of RP professionals fall into the 6 types that represent 57% of the public**
- **Different types have very different approaches to decision-making, communication, recreation, and the rest of life**
- **Myers-Briggs analysis is commonly used in management training courses to improve communications**

# Communicating by Type

- **Most of us consider knowledge to be the primary solution**
- **Unfortunately, our “rational” approach (e.g., Cdr. Spock and Lt.Cdr. Data of “Star Trek”) is not preferred by > 80% of our audience (who are perhaps more like Dr. McCoy and Counselor Troi).**
- **We are great at communicating with each other, but uncomfortable dealing with people who have different preferred styles of information exchange**

# The Three-Pound Enigma



**Brief Brain Anatomy**

<http://www.neurosurgerytoday.org/images/brainmetastasis2.jpg>

# Brain Operations

- **Controlled**
  - **Frontal and pre-frontal cortices, thalamus**
  - **Communication**
  - **Decision-making**
- **Automatic**
  - **Limbic system (hypothalamus, amygdala)**
  - **Motor control**
  - **Life support**
  - **Flight or fight**
  - **Emotions**

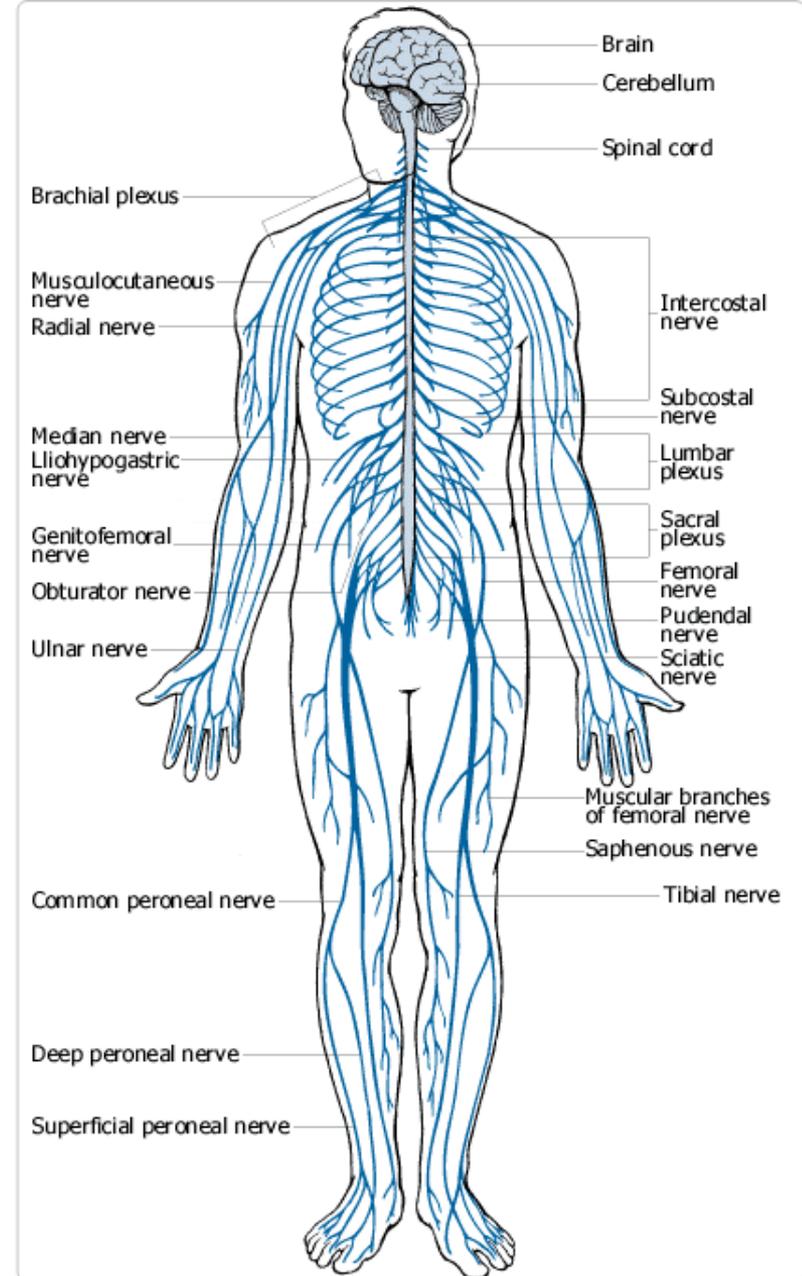
# Automatic reactions occur first

- **Sensory input travels first to the thalamus, then to the appropriate sensory cortex, then to the amygdala for a flight-or-fight response, and then to the frontal cortex for controlled analysis and decision-making.**
- **However, a small portion of the sensory input is sent by the thalamus directly to the amygdala.**
- **Therefore, automatic responses are primed before controlled processing even begins.**
- **Because the amygdala has more connections to the rest of the brain than the frontal cortex does, it is difficult to overrule.**
- **Obviously this conferred a survival advantage; if you have to think about fleeing, it might be too late!**

# The Nervous System

- Although we always focus on the brain, the entire nervous system is involved in both automatic and controlled processes
- The nerves provide continuous status reports to the brain on the state of the body

<http://www.ama-assn.org/ama/pub/category/7172.html>



# Descartes Was Wrong

- **“Reason” and “Emotion” are not separate**
- **In fact, there is no “reason” without the “emotions” (i.e., cognitive functions/circuits in the automatic system) forming the basis for “rational” conclusions**
- **This produces “Emotional Intelligence,” which according to some researchers, is really the only kind of intelligence**
- **Therefore, simply providing information doesn’t accomplish much, even if the information is understandable, presented in a non-threatening manner, after credibility and trust have been established, etc., etc., etc.**

# There is such a thing as human nature

- Our brains are hard-wired with certain “templates” or patterns of thought
- Identified templates include:
  - Intuitive physics      Goal-oriented motion
  - Face recognition      Kin selection
  - Contagion**                      **Pattern-seeking**
  - Justice**
- These are contained in automatic brain circuits that have been strongly selected by evolution, as they contribute to survival

# The Contagion Template

- **We automatically avoid yucky stuff**
- **Every culture has procedures for dealing with dead bodies**
- **If you become sick after eating something, then just the smell of it makes you nauseated**
- **Rule: any contact confers the entire risk**
- **Since radiation is known to cause death and disease, the contagion template tells us to avoid it**
- **People are starting to worry even if the radiation is iatrogenic**

# The Pattern-Seeking Template

- **A creature that can detect patterns has a better chance at survival than one that cannot**
- **If a predator notices that prey comes to the waterhole every night for a drink, it usually eats better**
- **We constantly seek and find patterns where none exist, although sometimes correlation does indeed imply causality (especially in the behavior of other humans)**
- **Casinos are proof of this hard-wired template**

# The Justice Template

- **If I share my food with you when you have none, I actually improve my odds of survival IF you will share yours with me when I have none**
- **Reciprocal altruism is an evolutionarily stable strategy**
- **But if you cheat me, I will demand justice!**
- **Commonly heard cry in a schoolyard: “No fair!”**
- **We have very highly evolved methods of detecting deception in other humans**

# Templates and Radiation

- **Radiation (at high doses and dose rates, but that is irrelevant) can cause illness and death (contagion)**
- **If I worked with radiation and became ill, the radiation must have caused it (pattern-seeking)**
- **If I became ill after being exposed to radiation, I am owed compensation (justice)**
- **Note that the exposure level, the shape of the dose-response curve, and the risk coefficient are all irrelevant**

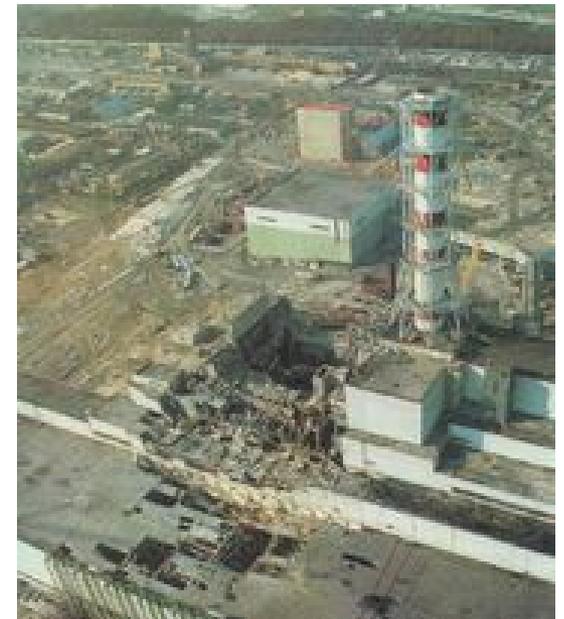
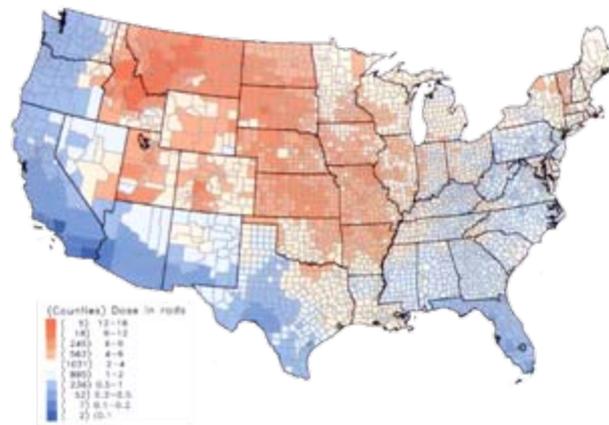
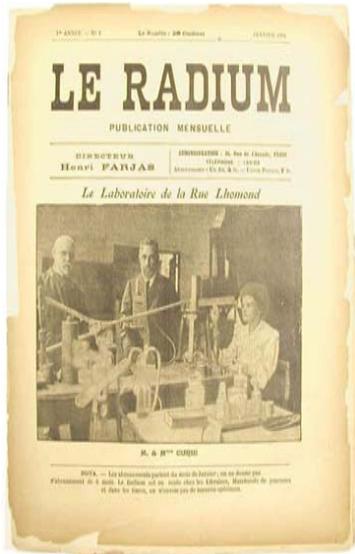
# What about learned behavior?

- **Since the Enlightenment, many have considered all behavior to be learned, and therefore un-learnable.**
- **Learned behavior is most influential when it reinforces innate behavior.**
- **The more we hear something, the more likely we are to believe it**
- **“Well, who you gonna believe, me or your own eyes?” (C. Marx, Duck Soup, 1933)**
- **The product of advocacy and credibility is NOT a constant (sorry, Dr. Heisenberg)**

# Cultural Memes

- **How did “Life-giving Rays” become “Deadly Radiation”?**
- **Richard Dawkins, in “The Selfish Gene” proposed the existence of “memes”: self-replicating ideas (spreading from brain to brain) that compete with each other for survival**
- **Darwinian theory states that the meme best adapted to its environment will come to predominate**

# 100 Years of Radiological Images



# People are Bayesians

- **Decision making is based on prior experience**
- **The remembered brain state (a record of all inputs from the rest of the nervous system, primarily in automatic circuitry) directly influences the prefrontal cortex, where decisions are made**
- **The remembered brain state causes physiological response through the autonomic nervous system**
- **The term “gut reaction” is actually quite literal**
- **Override by the prefrontal cortex is difficult to achieve, and takes motivated effort**

# Example guaranteed to fail

- The chances of a low dose of radiation (e.g., 1  $\mu\text{Sv}$ ) causing cancer, according to ICRP is  $5 \times 10^{-8}$
- This is roughly equivalent to one's chances of winning top prize in a national lottery
- But every so often, someone does win the lottery!
- The numerator (5) makes an impression; the denominator ( $10^8$ ) does not
- Therefore, some people will die from that exposure, and what if it's me?

# Cyclical History

- **Four cycles, each about 20 years, or one generation, seem to repeat (Strauss & Howe, 1991, 1997):**
  - High
  - Awakening
  - Unraveling
  - Crisis
- **The “social contract” cycles:**
  - maximum cohesion (High: late 1940s-early 60s)
  - upheaval (Awakening: cultural revolution: late 60s-70s)
  - minimum cohesion (Unraveling: 80s-90s)
  - rebuilding (Crisis: 2000s-20s)
  - maximum cohesion again.

# Generational Differences

- **People's reaction to events are a function of the world in which they grew up**
- **Four generational archetypes:**
  - **Civics or "Heroes" ("greatest generation," b. 1905-25)**
  - **Adaptives or "Nomads" ("lost generation," b. 1926-45)**
  - **Idealists or "Prophets" ("baby boomers," b. 1946-63)**
  - **Reactives or "Artists" ("gen X-ers," b. 1964-80)**
  - **Next set of "Heroes" ("millennials/next-ers" b. 1981-2001)**
- **Reactions of the "ruling" generation shape the world for the next generations, so the cycle repeats**

# Generational Responses

**Heroes (“greatest generation”, “millennials”)  
tend generally to trust authority and value  
societal norms**

**Nomads (“lost generation”) tend to be low-key,  
and go along to get along**

**Prophets (“baby boomers”) tend not to trust  
authority and hold individual expression  
paramount**

**Artists (“Gen X-ers”) tend to be cynical and  
self-reliant**

# The Fourth Turning

- **Predicted in 1997 that next crisis due to start around 2010**
- **Gen-Xers and Millennials will be more accepting of societal needs and technological “fixes” than Boomers**
- **The perceived benefits of nuclear technology are very likely to be considered to outweigh the perceived risks**
- **A “nuclear renaissance” may indeed become socially acceptable**

# So Now Where?

- **How can we use the findings of cognitive neuroscience and evolutionary psychology to improve the effectiveness of our public communications efforts?**
- **Working hypothesis: public acceptance of nuclear technology can only be achieved by replacing automatic negative reactions with controlled positive ones (an uphill struggle!)**

# Not a New Idea

**“An affect cannot be restrained or neutralized except by a contrary affect that is stronger than the affect to be restrained.”**

**-- B. Spinoza (1632-1677), The Ethics, Part IV, Proposition 7.**

**“Subduing of the passions should be accomplished by reason-induced emotion and not by pure reason alone.”**

**-- A. Damasio, Looking for Spinoza, 2003**

# **Four Rules from Dean Westen: “The Political Brain”**

- 1. If you don't feel it, don't use it**
- 2. Frame messages for emotional impact**
- 3. Pitch the message at the right level**
- 4. Appeal to the whole brain**

**Very few presentations by health physicists  
follow any of these rules, much less all four!**

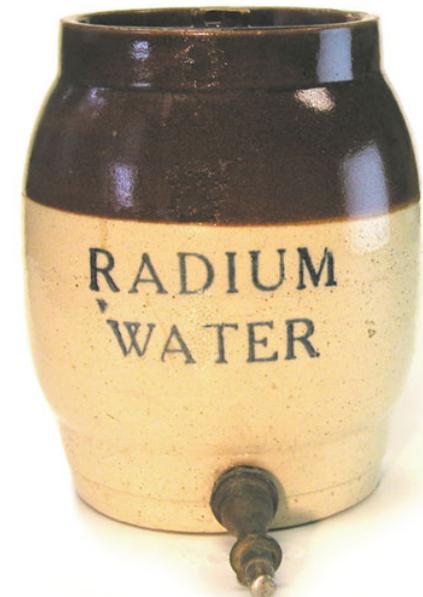
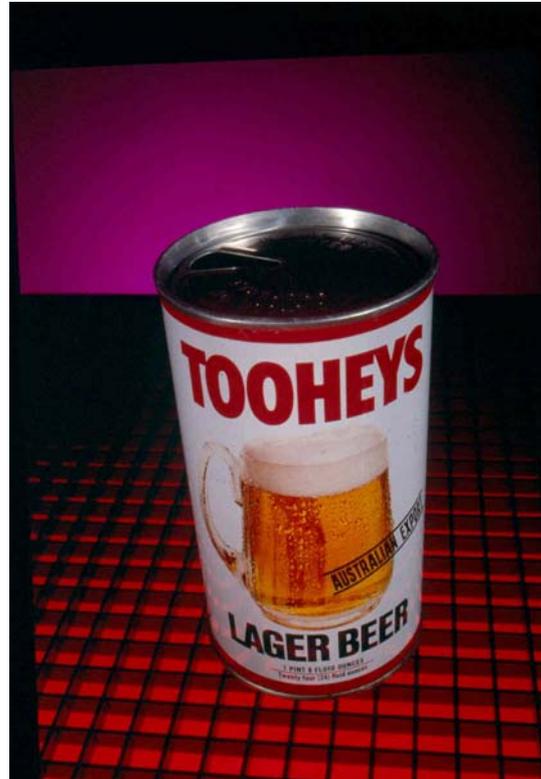
# Some Ideas?

- **Bunny rabbits cavorting around cooling towers (Areva ad)**
- **Nuclear power is preferable to melting the polar icecaps (“Waterworld”)**
- **Nuclear power reduces dependence on foreign oil—nuclear power helps prevent nuclear war**
- **Fuel recycling reduces proliferation risk and long-term waste disposal issues**
- **Swords can indeed be beaten into plowshares (downblending Enr.U; MOX fuel fabrication)**
- **Nuclear power cleanses the earth of long-lived radioactivity**

# Suggested HPS communication strategy

- **Continue to be an independent source of unbiased information**
- **Work with other organizations to develop outreach materials, e.g., the radiation primer**
- **Focus outreach/communication on critical groups, i.e., health care providers, via joint efforts with AAPM, SNM, ACR, APHA, etc.**
- **Improve cross-generational outreach: web-based, multimedia, etc.**
- **I will appoint an ad-hoc committee on communication strategy and outreach to generate specific initiatives**

# This Talk Brought to You by HPS and:



# Further Reading

- **Boyer, Pascal. Religion Explained—The Evolutionary Basis of Religious Thought (2001).**
- **Damasio, Antonio. Descartes' Error (1994); The Feeling of What Happens (1999), Looking for Spinoza (2003).**
- **Dawkins, Richard. The Selfish Gene (1976).**
- **Gladwell, Malcolm. Blink (2002).**
- **Goleman, Daniel. Emotional Intelligence (1995).**
- **Moffett, Shannon. The Three-Pound Enigma (2006).**
- **Pinker, Steven. How the Mind Works (1997); The Blank Slate (2002).**
- **Restak, Richard. The Naked Brain (2006).**
- **Strauss, William and Howe, Neil. Generations (1991); The Fourth Turning (1997).**
- **Weart, Spencer. Nuclear Fear: a History of Images (1988).**
- **Westen, Dean. The Political Brain (2007).**