

Japan Nuclear Fears

The Psychology of Radiation Safety

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A briefing by

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- PhD Studies, Radio and Nuclear Chemistry (1966-1972), Rensselaer Polytechnic Inst.
- Greater Washington Inst. for Transactional Analysis - Counseling (1977-1980)
- American Board of Health Physics Certification (1983 – present)
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Experience

- 2010 –Pres. Director, Radiation Safety Counseling Institute, workshops, training, and counseling for individuals, companies, universities, or government agencies with concerns or questions about radiation safety.
- 2007- Pres. VP, Training Programs, Dade Moeller & Associates, training and consulting in radiation safety.
- 1984-2007 Director, Radiation Safety Academy. Providing x-ray and radiation safety training, audits, and consulting to industry (nuclear gauges and x-ray), universities, research facilities, and professional organizations. Specialist in helping people understand radiation, risk communication, worker counseling, psychology of radiation safety, and dealing with fears of radiation and nuclear terrorism for homeland security.
- 1988-2006 Manager and Contractor to National Institutes of Health (NIH) for radiation safety audits of 3,500 research laboratories and 2,500 instrument calibrations a year, along with environmental monitoring, hot lab and analytic lab operations, and accelerators and x-ray inspections.
- 1990-2005 President of Key Technology, Inc. a manufacturer and primary laboratory for radon analysis with over 1,500,000 measurements since 1985. Primary instructor at Rutgers University 1990-1998 for radon, radon measurements, radiation risks, radiation instruments, and radon risk communication courses.
- 1986-1988 Laboratory Director, RSO, Inc. Directed analytical programs and Quality Assurance for samples from NIH, Aberdeen Proving Ground, radiopharmaceutical companies, and the nuclear industry.
- 1970-1985 Chief, Radiation Surveillance Branch, EPA, Office of Radiation Programs. Directed studies of radiological quality of US, coordinated 7 Federal agencies for nuclear fallout events, QA officer 8 years. Head of US delegations to I.A.E.A and N.E.A. on radioactive waste disposal. ANSI N-13, (1975-1985). Retired PHS Commissioned Officer (0-6) in 1985 with 29 years of service.
- 1963-1970 U.S.P.H.S. Directed development of radiation monitoring techniques at DOE National Labs, nuclear plants, and shipyards in the US and Chalk River Nuclear Laboratory in Canada.

Health Physics and Professional Activities

Health Physics Society (HPS) plenary member 1966; President-elect, President, Past President (1998-2001), Fellow (2000), Treasurer (1995-1998); Secretary (1992-1995); Executive Cmte. (1992-2001), Chair, Finance Cmte. (1996-1998); Head of U.S. delegation to IRPA X (2000). RSO Section Founder and Secretary/Treasurer (1997-2000); Co-founder and President, Radon Section (1995-1996). Co-Chair Local Arrangements Cmte. Annual Meeting in DC (1991); Public Info. Cmte. (1985-1988); Summer School Co-Chair (2004); Chair, President's Emeritus, Cmte (2006); Chair, Awards Cmte. (2002); Chair, History Cmte. (2005-Pres.); Continuing Education Cmte. (2005-Pres.). Treasurer, AAHP (2008 – Pres.). Academic Dean for HPS Professional Development School on Radiation Risk Communication (2010). PEP, CEL and AAHP Instructor; Journal Reviewer; Baltimore-Washington Chapter: President (1990-1991) and Honorary Life Member; Newsletter Editor (1983-2005); Public Info. Chair (1983-1991), Science Teacher Workshop Leader (1995 – Pres.). New England Chapter: Newsletter Editor, Board of Directors, Education Chair (1968-1972). President, American Association of Radon Scientists and Technologists (1995-1998) and Honorary Life Member, Charter Member; Board of Directors; Newsletter Editor (1990-1993). Founder and first President, National Radon Safety Board (NRSB) (1997-1999). Member of Sigma Xi (1966-Pres.); ANS (1983-Pres.), Society for Risk Analysis (1984-Pres.); AIHA, CRPA, CRCPD (1997-Pres.), Studied H.P. communication styles and presented Myers-Briggs seminars to over 3500 H.P.s since 1984. Over 30 professional society awards. Registered Professional Engineer since 1965. Certified Health Physicist since 1983.

Publications

Authored over 500 book chapters, articles, professional papers, training manuals, technical reports, and presentations on radiation safety. Author of monthly column, "Insights in Communication" HPS Newsletter 1984 - 1989 and 1994 -2001.

“Japan Nuclear Fears - The Psychology of Radiation Safety”

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The earthquake and tsunami in Japan, with subsequent damage to several nuclear plants, have given the media a new source of alarming news about dangers of radiation. The media and antinuclear advocates now have a great opportunity to speculate about deadly radiation not only in Japan but wherever nuclear plants are located. The evolving drama of the nuclear plants lends itself to daily news events while the earthquake and tsunami are now old news. This is interesting because thousands have died from natural forces and no one has died as a result of radiation. Based on what we know of radiation effects, it is likely that either none or very few deaths will be traced directly to the Japan nuclear incidents. And yet, fears of radiation are rampant, not only in Japan but in other countries including the US.

Fears of radiation have made the profession of radiation safety what it is today. Where would the profession of radiation safety be if people were not afraid of radiation? The primary motivation for developments in technology and regulations for radiation safety has been fears of radiation. Fears are the basis of antinuclear sentiments and aversion to nuclear power, nuclear wastes, and especially nuclear bombs. Fears of radiation have moved the profession of radiation safety to very conservative practices in the name of radiation safety. And yet, psychologists know that fear is a good thing as a natural response of our brains for our protection. We have survived as a species by knowing when to be afraid and when to react for safety. Psychologists define fear as an emotional response to a specific stimulus, such as pain or immediate threat of danger. Since radiation does not produce any sensation in our bodies, then our fears of radiation have to be based on imagination. Thus, fear of radiation is not a true fear based on something happening right now, but a manufactured fear based in images of terrible consequences. Our imaginations drive worries and anxieties.

The primary delivery vehicle for radiation fears is the news media. As the wealthiest nation in the world, the US also has the luxury of being afraid of virtually everything. Although, it's hard not to worry when fear is sprayed at us like tear gas from our TV 24/7. The media thrives on telling us of calamities and dangers everywhere in the world, and seems to especially like stories of “deadly radiation.” In fact those words have been used to portray radiation for so long (at least 60 years) that now subconsciously people automatically react to the word “radiation” with aversion. Unfortunately, much of what the media reports is based on radiation mythology (common beliefs which are not technically true). For example, most public concerns are fueled by misconceptions of the Linear Non- threshold dose model.

Regulators are also driven by fears (what if they are not seen as responsive to scared constituents, what if they do not provide for adequate safety regulations, what if people are harmed from their negligence, etc.?). Radiation safety professionals may be driven by fears as well, such as fear of criticism for not doing their jobs well, irresponsibility, carelessness, or neglect. Thus the profession of radiation safety is built around fears. Even the words which describe our work “radiation safety” imply that there is something to be afraid of, something to be avoided, something for which caution is needed, or something which threatens us.

Psychological and Mental Health Aspects of Ionizing Radiation Exposure

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Synopsis

The reporting of radiation stories as bad news over the past 65 years has created a general mindset that radiation is deadly. Consequently, most everyone is now afraid of radiation. While we know that radiation can cause death, this will occur only under unusually extreme circumstances. A historical study of radiation fears seems to show that most people's fears are based on myths about radiation which by repetition over time have come to be accepted as facts. For example, it is common to describe radiation as deadly radiation without considering the steps from cause to effect, such as the type and quantity of radiation, how one could be exposed, and the amount of radiation energy deposited in the body. The popular model for radiation effects, called the linear non-threshold model, shows health effects down to zero dose. People generally do not understand that zero health effects start at 560,000 cancer deaths a year and zero radiation starts at a natural background radiation dose of 100s to 1,000s of millirem a year. People's fears are fueled not only by radiation mythology, but by images of consequences of exposure to radiation. Helping people with fears of radiation may be enhanced by hearing, identifying, and reflecting their fearful feelings about radiation. Active listening is the key to dealing with people's fears of radiation.

Key Words

Radiation, fear, radiation mythology, radiation views, LNT dose model, images of radiation, learning, memory, active listening, feelings, safety,

Nomenclature

Radiation dose – radiation energy deposited in the body is quantified in units of rem or Sv (Sievert). One Sv == 100 rem

Millirem (mrem) - 1 mrem = 0.001 rem. Or conversely 1 rem = 1,000 mrem.

Millisievert (mSv) = 100 mrem

MBTI (Myers-Briggs Type Indicator) – a personality profile instrument published by Consulting Psychologists Press, Inc. Mountain View, CA.

Psychological and Mental Health Aspects of Ionizing Radiation Exposure

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Introduction

Fears of exposure to radiation may be of far greater consequences than actual physical radiation effects. Beginning with gruesome pictures from the atomic bombs in Japan, communications through the media have created a general mindset over the past 65 years that radiation is deadly. Thus, virtually everyone today is afraid of radiation. People have heard about deadly radiation for so long, that those words have become the basis for the definition and understanding of radiation exposures. While we know radiation can cause death, this will occur only under unusually extreme circumstances. Medical practitioners, who use radiation to treat cancer by killing tumor cells, know that it is actually very difficult to seriously harm someone with radiation. Radiation is used for cancer treatment because tumor cells are more sensitive to radiation than normal cells. However, exceedingly large amounts of radiation are required to kill tumor cells.

The Basis for Radiation Fears

In part, people are automatically fearful of radiation because they have mostly heard about radiation only as bad news. While good news stories about radiation abound everyday through the lifesaving benefits to millions of people from the use of radiation in medical diagnostics and cancer treatment, such good news stories do not often get reported. Continuous reporting of radiation as bad news has resulted in strongly ingrained fears of radiation. A historical study of radiation fears, however, seems to indicate that most of what people are afraid of is based on myths about radiation which over time have come to be accepted as facts. Radiation mythology has also contributed to images in people's minds of unacceptable consequences of radiation exposures.

How Mythology Affects What People Believe About Radiation

The word "myth" has several meanings including a collective opinion, belief, illusion, delusion, or ideal that is based on false premises or the product of fallacious reasoning. The opposite of a myth is historical fact, real-life occurrences, truth, and actuality.

The media has reported some radiation myths, such as "deadly radiation," for so many decades that most everyone believes these two words go together automatically. Putting these two words together, however, assumes a direct link from cause (radiation) to effect (health risk). In fact, concerns for radiation effects can only be addressed by consideration of several questions or steps as follows:

- What is the radiation source? Is it a solid, liquid, gas, or a radiation producing machine and how large is the source?
- What kind of radiation is emitted from the source? Is it alpha, beta, gamma, neutrons, or x-rays? Also, we need to know how much radiation is emitted.
- Where is the radiation source and how far away is the source from people?
- Is the radiation source contained? Many radiation sources are sealed in metal capsules.
- What will happen to the radioactive material if the container is broken?
- How will anyone be exposed to the radiation, such as external exposure to gamma rays or x-rays, or internal exposure from the ingestion or inhalation of materials emitting alpha or beta particles?
- Most importantly, how much radiation energy will be deposited in the body and what part of the body may be affected?

With answers to these questions we can then estimate possible consequences based on observations of people who have been exposed to radiation and for whom we have observed the effects. Primarily, our basis for estimating health effects from radiation is from studies of survivors of the atomic bombs in Japan. After observing about 87,000 survivors over the past 65 years, in comparison with a similar number outside the range of the bombs, we now conclude that about 450 people have died as a result of their radiation exposures. This is only about one half of one percent of the survivors. This tells us that for those who survived the blast, heat, and immediate radiation exposures, the chances of dying from radiation at a later time, are very small.

Again, we know technically that radiation is only deadly under extreme conditions. The analogy with describing radiation as deadly is similar to taking an extreme amount of aspirin (100 tablets could be deadly) and then describing the use of a single tablet for a headache as a dose of deadly aspirin.

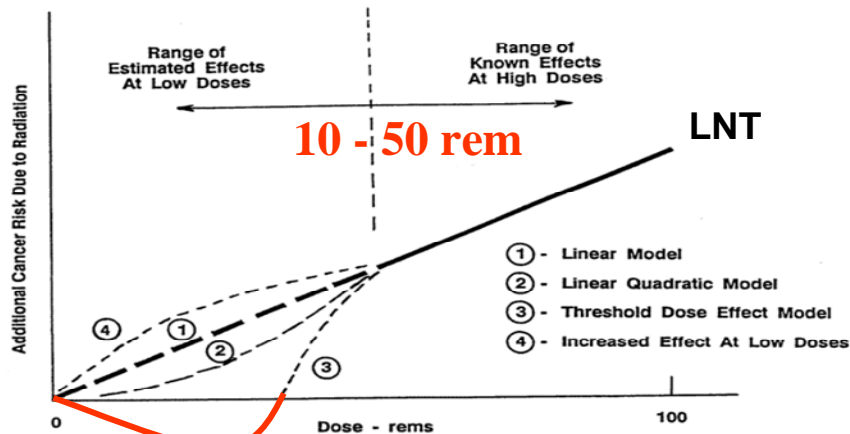
Many radiation messages reported by the media are myths that have come to be accepted as facts by repetitious reporting over decades. The subtlety of radiation mythology is that reporters do not know they are perpetuating myths. Reporters are reporting what is “reality” to them based on what they have always heard. The result of such perpetuation of radiation myths is that fears of radiation seem out of proportion to risks from radiation as specialists in radiation safety would understand them.

Because the media only seem to report “bad news” about radiation, everyone has learned to fear and avoid radiation at all costs. People tend to be most afraid of what they know the least about, and most people do not know much about radiation, except the myths perpetuated by the media. Discussion of a few radiation myths follows, as examples.

There is No Safe Level of Radiation. This is a conclusion about radiation for which even radiation professionals do not have uniform agreement. This conclusion is predicted by the linear non-threshold (LNT) model of radiation dose and cancer risk as shown in Fig. 1. The straight dashed line down to zero dose indicates that radiation effects (cancer) should be expected as soon as radiation doses rise above zero.

Figure 1

Models for Estimating Radiation Effects



Hormesis

Are small doses of radiation beneficial ?

The assumption that LNT is the correct model can lead to many conclusions.

- 1) There is no safe level of radiation
- 2) There is no level of radiation that is without risk
- 3) The only safe level of radiation is zero
- 4) Every radioactive atom is harmful
- 5) Every atom of radioactive material must be avoided
- 6) All radiation should be avoided, at all costs

Unfortunately, there are many additional factors that people do not generally understand about radiation. In particular most people do not know that there is no zero as shown in Figure 1. The “zero” on the health effects scale does not really mean zero cancer risk. Cancer is one of the prevailing causes of death in the United States and from 1/3 to 1/2 of all people will suffer from some form of cancer in their lifetime. Thus, for the LNT model, zero health effects means zero for radiation effects, but the health effects scale actually starts at 560,000 or more cancer deaths that occur every year in the US.

There is also no point in our lives when we have “zero” radiation. We live in a sea of natural radiation from outer space, from the ground, and from the food and air that we take into our bodies. In the US, these sources of natural radiation have been estimated at 310 mrem a year on the average. (millirem, a unit of radiation energy deposited in the body) In other parts of the world, normal background radiation can give annual doses from a 1,000 mrem to 25,000 mrem, without effects that can be observed. Again, for the LNT model, zero radiation starts at whatever the normal level of radiation may be and in many cases it is far from actual zero.

Since the prevailing belief in the LNT model has shaped fears of radiation for several generations, there are two additional factors that people should know about. Namely, the reason that the model shows dashed lines below radiation doses of about 10

to 50 rem (a rem is 1,000 mrem) is that actual data on health effects are very limited below such radiation doses. In the absence of significant data showing health effects below those doses, we have to rely on assumptions about what could happen. Because most radiation safety specialists believe that the LNT assumption is likely to overestimate the risks, the LNT model has been adopted around the world for regulating radiation exposures cautiously for radiation safety. Unfortunately, while beliefs in LNT have fueled fears of radiation, people have not understood that LNT is only a model for developing regulatory guidance. It is not intended to predict actual health effects from radiation. In fact there is a substantial and growing body of scientific data which show that small amounts of radiation are actually beneficial. Evidence indicates that radiation may follow the principle of hormesis. This term applies to materials which in large amounts are harmful and in small amounts may stimulate a beneficial response. For example, one aspirin is helpful whereas 100 would be extremely hazardous. Hormesis applies to many dietary factors, for example, vitamins, trace minerals, and ordinary table salt.

Since the debate on low dose radiation effects will likely go on forever, due to lack of conclusive data, perhaps we need a new myth busting message, namely, "It is actually very difficult to seriously harm someone with radiation." This message is based on the amount of radiation that it takes to kill tumor cells, which are more sensitive to radiation than normal cells. A typical dose for cancer treatment may require as much as 5 to 8 million millirem or more (50 to 80 Gray, a Gray = 100 rem or 100,000 mrem).

"Radiation Will Kill You" is another popular myth. However, contrary to predictions of the media after the atomic bombs in Japan, which concluded that Japanese lives would change for centuries and genetic effects would occur for the next 1,000 years, no such damage has appeared. Atomic bomb survivors may actually be living longer than normal. Contrary to popular beliefs, radiation is not the most destructive result of a nuclear bomb. Based on observations in Japan, if you survive the heat and the blast, the chances of dying from radiation are relatively small. Again, contrary to the idea that radiation will kill you, many people go to Montana radon health mines because they feel better. Also, no one has died from radiation in nuclear power in the United States, and yet the media continues to foster that you are going to be killed by radiation,

"The Myth of Chernobyl Deaths" If you do a word search on the internet for Chernobyl Deaths, you will find hundreds of websites reporting from 100,000 to 500,000 deaths from Chernobyl. If these numbers are true, where are the bodies? How many deaths do we actually know about? The answer is about 40, among those who were first responders and plant workers dealing with the accident. About 15 additional deaths have been attributed to childhood thyroid cancer. So then, where do the hundreds of thousands of deaths come from? The answer is based on using the LNT dose conversion factor of one death per 1,000 person-rem and then applying microrem doses to billions of people in the northern hemisphere. Thus, the projected deaths are theoretical calculations, but the websites do not tell you that. Specialists in radiation safety know that such theoretical calculations have no basis in good science.

"Radon and CT Scans are OK" From the way the public and media seem to perceive radiation risks, it appears that radon exposures in homes and exposures to CT scans are not considered dangerous. People seem to have a concept of good radiation and bad radiation. If the radiation is naturally occurring (such as radon) or if it is prescribed

by a medical doctor (such as CT scans or fluoroscopy), apparently those kinds of radiation are OK. At least the public does not seem to be very worried about these sources. Every other type of radiation is bad, and the public is very concerned (such as radiation from nuclear plants and radioactive wastes, or today the possibility of unsecured radioactive materials being used for a dirty bomb). The question to consider here is whether our bodies react differently according to the source of radiation? Of course our bodies do not make that distinction. Most people do not seem to worry that they could be getting 100s or 1,000s of mrem per year from radon in their homes, or that a whole body CT scan could give them from 1,000 to 2000 mrem (10 to 20 mSv, a milliSievert = 100 mrem) or more per scan.

“Radiation Will Make You Glow” Every radiation safety specialist has a favorite “glow in the dark” anecdote. The notion of glowing as a reaction to radiation seems to be one of the most popular ideas that people have about radiation. When someone hears that you work with radiation they may say, “Then you don’t have to turn on the lights at night.” The origin of this myth is not clear, but may be traced back to the use of radium fluorescent paint for night time illumination of clocks, watches, and instruments, etc. in the 1920s to 1950s.

“Granite Countertops are Dangerous” This is a current myth developing through the news media. Homeowners are now being told by the media that they should be afraid of radiation from granite countertops. The news reports are partly right, granite may contain small amounts of uranium and radium. Actually these radioactive elements are found in all materials that come from the ground. They are a natural part of the composition of all earthen materials. Granite, in particular, has long been known for having measurable amounts of radium and also to be a source of measurable gamma radiation.

With the recent publicity about granite as a radioactive material, many people across the country have attempted to make measurements to determine the levels of radiation with a common pancake or end-window Geiger (GM) detector. Unfortunately, the common GM detector is not very well suited for such measurements for two reasons. One is that a GM detector is best suited for measuring beta particles and not very efficient for measuring gamma rays. What this means is that the signal from granite with a pancake or end-window GM detector will be 90 to 95% beta particles. On this basis alone, GM exposure readings in milliroentgen per hour (mR/hr) will be too high by at least a factor of 10 to 20 or more.

Regrettably, reporters have been given data from GM readings taken in the air (which is called background radiation - gamma rays from the ground and outer space) and compared with mostly beta particle readings from granite counter tops, as if the measurements are comparable. The second reason the GM readings are not valid is that most likely the detectors are not calibrated for readings from beta particles which cannot be measured in units of mR/hr (milliRoentgen per hour is a measure of exposure to x-rays and gamma rays in air). Thus, the media have reported erroneous high readings for radiation and unnecessarily scared much of the public with a new myth about granite countertops.

Why Are Radiation Myths So Popular?

Myths help to explain the “unexplainable” in terms that are easy to understand and seem simple, direct, and make sense to the general public. Reporters use myths because they relate to what has been said before and popularly accepted. Radiation myths sound credible and can often be reinforced with pictures or with anecdotes provided by virtually anyone. The myth of “deadly radiation” helps bridge the links from radiation (the cause) to cancer (the effect). Myths also help to point to the blame for risks of radiation which the public usually does not understand.

It's easy to believe people who say what we already agree with. It is also easier to believe hearsay, rumor, and gossip which reiterate what we have always heard before. On the other hand, it is harder to believe those who say something different than we have always heard, especially when they only speak the language of “radiation science.”

Studies with personality profile instruments, such as the Myers-Briggs Type Indicator (MBTI), show that people do not absorb information in a deliberate manner. People will commonly rely on “rules of thumb” to tell them the meaning of science. The media is good at providing the rules-of-thumb (myths) to tell people the meaning of radiation. Also, once a myth has been reported, denying it can serve to reinforce the myth. Over time the “negative tags” offered by specialists in radiation safety may fall out of memory. Denials and clarifications, for all of their rational appeal, may contribute to the resiliency of myths. The reason is shown by the MBTI. Namely, rational appeals apply to logical thinking, but at least half of the population makes decisions on the way they feel. Ignoring myths does not work either. An unchallenged mythical claim gains the ring of truth.

Historically radiation safety specialists have attempted to deal with radiation myths by countering bad information with good information. While this can be helpful and needs to be continued, we should also not be surprised when many people do not hear or understand what we are saying as rational thinkers. People who are afraid of radiation (most everyone) come to that state on the basis of feelings, not rational thinking. Fears are feelings based on images of unacceptable consequences.

The Power of Images Behind Fears of Radiation Consequences

Because of the repeated use of the words “deadly radiation”, it is common to assume that the presence of radiation will lead directly to terrible effects, usually cancer and death. With such images in mind (of terrible consequences related to radiation) we should not be surprised that virtually everyone is afraid of radiation. The mythology based fears of radiation play directly into the hands of those most strongly opposed to radiation. Since everyone is already afraid of radiation, it is easy to build upon those ingrained fears to create feelings of great concern among people who, for example, hear for the first time that they may be exposed to unexpected radiation, such as from granite countertops.

Appallingly, actual radiation does not even have to be present to trigger the fears, only the possibility. People's imaginations will take over and likely lead to decisions founded on mythology based fears, rather than reality. In fact fears are almost never

about reality, but rather are triggered by our imaginations of consequences of what is to come.

Psychologists know that all fears can be tracked back to underlying images. The fearful person is not aware that their fear is related to any particular image. They just know and feel that their fear is prudent and justified. A person fearful of heights will automatically want to avoid high places. A person fearful of snakes will want to avoid places where snakes may live. A person fearful of radiation will want to avoid most associations with radiation. Although it is interesting to note that most people have come to accept medical applications of radiation as beneficial. Likewise most people accept exposures to radon in their homes as a natural part of the environment. However, any radiation that is not medical or natural is often automatically considered to be bad.

The images behind the fear of radiation may be identified by asking the question, "What's so bad about that?" This question has to be used gently and should not be used while a person is experiencing their fear. This question is most useful when helping a person understand their reaction to some event (such as discovering that they may have radiation exposures in their workplace). To invite workers to consider how they might react when confronted with a radiation scenario, for example, I often use a scenario involving a truck with a radioactive placard on the back door. I ask workers to imagine they are approaching the truck on a highway and they notice that the truck seems to be doing something strange. I then ask what would they do? Workers usually answer immediately that they would quickly go past the truck, or they would back off.

A cardiologist in one class said that he would back off. When asked why he would do that, he said that the truck might crash. I then asked, "So what?" He said that it might spill radioactive material. I again asked, "So what?" He replied that he might drive through the material. I again asked, "So what?" He then said that he might get radioactive material on him. Then I asked the most important question, "What's so bad about that?" He was quiet for a moment and then he said, "Oh my God, I will melt!" Of course, the class all laughed at this point.

I believe that any of us who thought that exposure to radiation would cause us to melt, would likely do everything possible to avoid radiation exposure. The idea of melting was a vivid image in the mind of this student. He did not know that his decision to back off from the suspicious truck was based on an image of melting. His decision seemed justified and prudent for the circumstances. In fact his reaction would be normal for any of us driving on a busy highway and alert for possible dangers of people changing lanes or slowing down in front of us. We would likely make the same decisions regarding any large truck.

Even before we attempt to talk with people about radiation, they will likely already have ideas (or images in their minds) about radiation. In fact these ideas may be very strong and may overshadow the best information that we can present. When telling people what is known about the health effects of radiation, much of what they will hear will be contrary to all that they have ever heard or believed about radiation (described as radiation mythology above). If what you tell them does not match up with what they have always heard, they may discount your best information or your credibility. If what you say does not sound believable from their point of reference, they may not accept anything that you tell them. Or they may appear to be listening and understanding, but when they have to make decisions about radiation safety, they may automatically revert

to the images and what they have believed their entire lifetimes. Thus, guidelines for acceptable radiation exposures may be totally forgotten and replaced by an instinctive response, "If radiation is there, it is bad!"

The Gift of Fear

We have all been endowed with gifts of fears that we have acquired over our lifetimes for self protection. True fear is part of our natural defense system as a signal of imminent danger. Other fears (worries or anxieties) are based upon our memories or our imagination. For example, worry is not a true fear but something that we manufacture and it is not part of our defense system. Worry is a choice, but true fear is involuntary. True fear can be a gift, other fears can be a curse. Now the question is, "Does anyone have a true fear of radiation?"

Some fears may be natural or instinctive. For example, infants often react in great fear to a sudden loud noise. This is a true and involuntary fear that prepares our body for defense. Other fears we learn from experience (our memories) or what we are told by our families, our friends, our schools, or our society and the media. For example, we learn about fear of heights by falling or seeing someone else fall and get injured. For some this fear is overwhelming when confronted with heights. For others, the fear prompts careful precautions (holding on to the ladder tightly or avoiding high places).

Since no one has ever had an experience of radiation, then fears of radiation are not true fears, but manufactured fears. The answer to manufactured fears is better predictions of consequences. Thus, rather than asking the person fearful of radiation, "What could happen, if you are exposed?" It could be better to ask, "Will this happen?" or "Is this happening?" This suggests that one way to deal with people's fears of radiation is to provide a better understanding of the consequences of exposures as a basis for determining if the fears are really warranted.

How We Learn About Radiation

In addition to images that may prevent hearing new information on radiation, we also have a middle brain that acts as a filter on what is transferred to long-term memory. The middle brain controls our hormonal system, our emotions, and an important part of our long-term memory. Thus, our emotions play a key role in what we remember. Our middle brain serves as a switchboard that filters or transmits information on to the neo-cortex or thinking brain. Information with a positive appeal to the emotions is transmitted for thinking and processing. Negative emotions, such as fear, anxiety, or stress, may result in suppression of the information which never gets to the thinking brain. If the anxiety is high enough the thinking brain goes blank. We all have times under stress when we just cannot (or do not want to) "think" any more. Such stress may be more than the worry or concerns for which you are aware. Stress could be the result of previous difficulties in learning such that a person feels threatened by new learning experiences. This may result in a vicious cycle in which a person with poor learning experience feels threatened and their brain receives less information. When a person is anxious, less of their thinking brain's potential is available. All of this means that for best learning to occur for radiation or any other subject, the learner needs a positive mental attitude. Real

learning may only occur when the learner is stress-free, calm, comfortable, trusting in the instructor, and therefore open to hearing new information.

The Importance of Memory

Without the ability to learn, store, and recall appropriate responses to dangers from our memory, we would not be able to survive. There are three areas of memory. 1) The sensory memory provides short-term storage of impressions received from our five senses. 2) The working memory consciously processes information. It integrates information from the senses with stored knowledge to think about it or talk about. Information is stored at this level for only 15 to 20 seconds and either forgotten or forwarded to 3) long-term memory. Adding an emotional hook plays a key role in learning or long-term memory. Teaching for long-term memory is not about covering the material and encouraging memorization. Long-term retention may be more a matter of processing the information over time where more connections are made among brain cells (neurons) and memory is improved. Thus learning is enhanced by allowing learners to reflect on the information, relating it to something they already know, and forming meaningful mental associations.

Comparisons with Antique Items

One technique that has been found helpful for learning about radiation in the workplace involves demonstration of antique glassware items that contain uranium oxide as a coloring agent. Items such as green depression glass, Vaseline glass, and red Fiesta ware typically produce readings of one to five millirem per hour in contact. Workers are shown the items and then invited to make measurements with their radiation meters. The workers are asked to remember these readings and they are then invited out on the plant floor to measure the signal from an x-ray machine, an industrial nuclear gauge, or radium in pipe scale. Often the workers will observe that the readings on the antique items are 10, 100, or 1,000 times greater than the signal from their licensed or registered radiation source. From this comparison, workers can see with their own eyes that their radiation source may produce a very small signal relative to antique items that would be considered innocuous. What workers discover by their own hands is much more meaningful than being told that their radiation sources are not likely to be a cause for concern.

Thus, helping people learn about radiation is more than a matter of presenting good technical information on radiation. It involves presentations in a way that allows the middle brain to pass along the information to the thinking brain for rational analysis and understanding. This means the communicator needs to consider ways to reduce stress and resistance to hearing new information. Effective communication is a process that enables people to relate new information to what they already know, or experience that they have had or can identify with. The process also involves repeated evaluations of radiation risk perceptions, questions, and understanding as you gently introduce new information on radiation that may confront all that people have heard before. The approach that seems most helpful uses “show-and-tell” as much as possible to take the mystery out of radiation. Comparisons of the sources of concern with the radiation signal

from radioactive antiques is helpful to provide perspective on magnitudes of potential radiation exposures.

How to Deal with Images that Drive People's Concerns for Radiation

Better information may make a difference in the images or attitudes that workers may have about radiation. For such changes to occur, the workers need to be invited to compare new information that you may present to their previous experience or expectations. When they are aware of differences, it's important to talk about them right away. This may mean interrupting a presentation to respond to skepticism from a single worker. Pushing on in the face of skepticism is almost assuredly going to result in not meeting the goals for training. Remember, be gentle about confronting skepticism. You do not have to convince them of any particular answer. You are a resource for information, which they may or may not accept. The choice is theirs.

Workers may change their views when provided with new experiences, observations, or credible data from which they can revise their images. New images then give new perceptions and become the basis for a more informed understanding. For adult education it is important to note that some people need to have a dialogue with the instructor to assimilate new data, because they learn from what they hear. Others need to see the evidence for themselves, because they learn from what they see. Some will only learn when they have the opportunity for hands-on experience. Some will need time to reflect and digest the new information. We learn from what we can see, hear, touch, smell, or taste.

Approaches that enhance understanding by adults include:

1. Demonstrate new information by show-and-tell
2. Provide options for hands-on learning, such as handling instruments
3. Prove everything that you can by demonstration
4. Challenge the audience to verify everything that they can
5. Connect new information to experience or information that the workers already have
6. Use anecdotes that the workers can identify with
7. Anchor each learning experience with humor

There is an axiom for learning that says: "We learn to the extent that we can connect new information to information or experience that we already have."

To enhance learning by connections to previous experience we need to use analogies, illustrations, demonstrations, stories, and real-life experiences that relate to the world of the workers in our class. To facilitate such connections requires knowing as much about the attendees as possible. This means asking lots of questions and paying attention to the answers, including the words, the feelings, and the body language.

Hearing, Identifying, and Reflecting People's Feelings about Radiation

Concerns for radiation safety are based on fears of radiation and the consequences of exposure. The only thing most people have heard about radiation is that "it's bad." For over sixty years the news media has built a mental mindset in the population that

radiation is deadly and causes cancer or birth defects. Fears of radiation exposures can be addressed by inviting workers to examine the basis of their beliefs and values. This can best be done by asking lots of questions, such as:

1. What is radiation?
2. What do you think, or feel, about exposure to radiation or x-rays?
3. What have you heard or read about radiation?
4. Is it OK to be exposed to radiation?
5. If you are exposed to radiation, what will happen to you?
6. What's so bad about exposure to radiation?
7. What are the risks?
8. What if you are pregnant?
9. What is safe?
10. Who decides?
11. How do we know?
12. What is the evidence?

While interacting with workers, it can be helpful to keep asking such questions, perhaps in different ways. The most important question is, "What will happen to you if you are exposed to radiation?" When asking this question, you should be very careful not to discount any images or feelings people may share about radiation. All are OK. Hearing feelings is more important than giving detailed technical answers.

Reflecting People's Feelings about Radiation

The best answer for helping workers, who are afraid, is to hear and reflect their feelings. This does not mean telling the person, "I know how you feel." We can never be sure what another person feels and when we say we know, the other person knows we are not really sure. What we can do is to describe the feeling we perceive and let the other person correct our perception until they are satisfied that we know how they feel. This requires a dialogue in which you as the listener do not try to interpret or rationalize the other persons' feelings, but simply paraphrase and reflect back to the other person the feeling that you believe you are hearing. If the feeling you define is not accurate the other person will correct you.

For example, a person says, "I don't want to go in the room with the radiation sign on the door." You reflect with, "The radiation sign makes you nervous?" "Yes, it makes me nervous, I might still like to have children." "You are afraid that radiation may affect whether you can have children?" "Yes, and I don't want my children to have three eyes." "So your real concern is that exposure to radiation may affect your future children." "Yes!" "OK, I also had that concern at one time and here is what I have learned from studies over the past 50 years."

You could have made assumptions about why this worker did not want to enter a posted room and attempted to provide answers right away. However, you would have missed the opportunity to connect with the other person's feelings and the real reason for their concern. By listening and responding to the feelings first you will establish a basis of rapport and credibility with the other person, whereby they may hear what you have to

say. Otherwise, they may not be ready or willing to listen to your answers. When you go immediately to answers, you may also discover that your answers are not about what was really troubling the other person. Besides, fearful people are not always looking for specific answers, but rather they would like others to know what they are feeling.

Thus, one of the ways to deal with the worker concerns for radiation is to hear their feelings. This will require a dialogue with individual workers or in a group. Most technical people do not like to hear or attempt to deal with feelings, especially feelings of fear and terror. We want to give people our best technical understanding rather than deal with their feelings. We usually believe that if people could understand our technical views then they would have different feelings and be less afraid. While providing technical answers may be helpful, it may not reduce people's fears. Dealing with worker concerns may be more a matter of dealing with feelings rather than dealing with technical answers. People may not care how much you know, until they know how much you care.

The Most Powerful Tool for Effective Radiation Risk Communication - Active Listening

Perhaps our greatest challenge when talking with people about radiation risks is when the dialogue gets emotional. We may find ourselves not knowing what to do when our best technical data and logical analyses are not accepted by those who are afraid of radiation. What can we do when confronted with hypothetical questions which do not seem to have clear rational answers? How can we respond when our best answers seem to be causing the other person to become more and more upset? Suppose we do not have the data from which to give a good technical answer? Is there any hope?

The effectiveness of any communication is not about the message that we send, but the response of the other person. Thus, the best opportunity for communication is to start with what the other person is saying. This may be difficult for specialists in radiation safety when the information provided by the other person does not make any technical sense. Typically we want to hear good data for which we can apply our well developed analytical logic to resolve the problem and give an answer accordingly. When the other person appears to be speaking emotional nonsense, what options do we have? The answer is active listening. This may be the single most powerful tool for effective risk communications.

Active listening does not take ownership of the problem. In other words, we do not have to give a problem-solving answer. Active listening is also non-defensive and avoids a dozen roadblocks to effective communications. Active listening is based on the insight that every communication has two parts, a feeling or emotional part and a content part. By training and experience, we are usually very good at hearing the content part of a message. Identifying the feelings is more difficult. For technical types, it may help to suggest that all feelings can be captured by synonyms of four words, "mad, sad, glad, and afraid."

An active listening response paraphrases the content and identifies the underlying feeling. For example, a person says, "Radiation, I don't want anything to do with that!" An active listening response could be, "You are worried that radiation may be harmful for you." By hearing the feelings first, we may find that the feelings are defused (when you really hear the feeling, the other person does not have to keep trying to express that

feeling). Hearing feelings also opens the door for further dialogue and helps identify the real issues.

Most technical people find that active listening is not easy and may question whether it is worth the effort. Active listening is especially difficult for technical specialists in radiation safety, experts, and managers (especially for those who rely on logical thinking for making decisions). For most technical people, their natural response is to give answers. Their lives are about giving answers and the chances are that their roles as experts, supervisors, or managers are primarily as the “giver of answers.” Now, there is nothing inherently wrong with giving answers. It’s a matter of options. However, there are two precautions or questions to consider when giving answers:

1. Are you answering the right questions?
2. Who owns the problem?

When you give answers, you automatically take responsibility for the problem. By giving the answers, you may take away other people’s opportunity to find their own answers. In other words, when you solve other people’s problems for them, you may take away from their options or ability to solve their own problems. By giving answers, you may also set up opportunities for adversity. People have a vested interest in their answers, and may reject your answers.

Active listening is a way to hear and respond to another person’s feelings without discounting their views or knowledge (or lack of knowledge). For those who have trouble identifying feelings (most everyone), remember that all feelings can be captured by synonyms of four words: Mad, Sad, Glad, and Afraid.

By reflecting your perceptions of one of these feelings, you open doors to the “real issues.” The active listening approach also does not take away from other people’s rights, responsibilities, and capacity to solve their own problems.

There are two axioms on listening that may be helpful to understand.

1. Feelings are more important than what is said.
2. Listening is more important than solving problems.

The best answer for a fearful person is to hear and reflect the feelings. You can do this by describing the feeling that you perceive. Do not interpret, but simply paraphrase and reflect back. If your paraphrase is not what the speaker intended, they will correct you. Thus, you do not have to identify the feeling exactly. Simply reflect the feeling the best that you can. For example, if you reflect, “That sounds really frustrating.” If this is not accurate, the other person may say, “I’m not frustrated so much as I am angry with - - - -.” You can then reflect, “This - - - - situation makes you angry.” When you apply the principles of active listening, you open the door for establishing rapport as a basis for presenting your risk message. By this approach you also get down to the real issues of concerns for radiation risks.

The temptation for technical people is to go directly to technical answers, especially if the other person appears to be asking for answers or data. Again, there is nothing wrong with giving technical answers, however, it might be better to establish rapport first

by hearing the feelings. Hearing feelings first establishes rapport and credibility, because this approach shows that you care. Without establishing the feeling rapport, the other person may not hear your answers. You may also discover that your answers are about the wrong question or concern. The fearful person also may not expect answers, they just want someone to hear their fears.

Why Not Just Tell Workers, “It is Safe?”

Although, “Is it safe?” is the main concern of ancillary personnel and radiation workers alike, it may be difficult to answer that question directly. Essentially this question is unanswerable or at least not directly answerable without any supporting information. There are two reasons why it is difficult to answer that question. First of all, what does “safe” mean to a particular person? For many people safe means “no radiation.” This view would seem to be supported by the linear non-threshold dose response model for radiation risks. Secondly, if we try to share what we believe is safe, the workers can disagree and discount our views. Rather than trying to answer the question, a better approach may be to provide information and evidence from which the workers can arrive at their own answers on what safe means for them. Choices on safety also involve feelings and feelings come from lifetime values. When it comes to values, everyone is an expert. Thus, everyone has a sense of what safe means, although everyone’s meaning of the word may be different. The answer to “What is safe?” is also related to perceptions of radiation risks and the images of consequences to radiation exposures. Perhaps the best way to answer the question “Is it safe?” is to provide information as described above to allow ancillary personnel to answer the question for themselves.

Historically radiation safety specialists have also been hampered in responding to worker or public concerns for radiation safety by the LNT model which implies radiation risks down to zero dose. Thus, we have found it difficult to conclude or defend that any level of radiation is inherently safe, ie, without any risk. On the other hand, we have come to accept that typical occupational exposures are well within tolerable levels of risk, especially when compared to other risks that we confront everyday.

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Web-based Resources

Health Physics Society, Ask the Expert, over 9,000 answered questions on radiation.

<http://hps.org/publicinformation/asktheexperts.cfm>

Japan Nuclear Fears The Psychology of Radiation Safety



Ray Johnson, MS, SE, PE, FHPS, CHP
Dade Moeller & Associates
Radiation Safety Counseling Institute

Questions for Japan Today

- What is safe ?
- What does safe mean ?
- How will they know ?
- Who decides if radiation is safe ?
- What information will be needed to decide on safety ?
- What can be done for safety ?

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Questions on Radiation

- Can you remember ever hearing anything good about radiation ?
- If you could avoid exposure to radiation, would that be good ?
- Have any of you been exposed to radiation today ?
- If you are exposed to radiation, what will happen to you ?

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Basis of Radiation Fears

- When did radiation become fearsome?
 - 1945 – Hiroshima / Nagasaki
 - 1979 – Three Mile Island
 - 1986 – Chernobyl
 - 2011 - Japan, Fukushima Reactors
- Is there a good basis for radiation fears?
- Is radiation deadly?
- What is the evidence?
- How many people in the US have died from radiation exposures? Where? When?
- How much radiation does it take to cause effects? Death?

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Radiation Risk Perceptions (views about radiation)

- Why are we interested in radiation risk perceptions or views on radiation?
- Perceptions drive our beliefs, decisions, and reactions to radiation
- Fear of radiation is common
 - Have you ever heard anything good about radiation?
- Understanding these fears is helpful for understanding radiation
- Without understanding, fears take over
 - We are most afraid of what we know the least about

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Fears are Natural and OK

- Our minds are always alert to danger
- We have survived by paying attention to our fears
- Radiation fears are based on imagination
 - Not a true fear based on imminent danger
- Many radiation fears are based on mythology
 - Something believed which is not technically true
 - Based on false premises and misunderstanding

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Radiation - An Abstract Concept

- Radiation symbol has a learned meaning
- What images come to mind?
 - Fallout shelters
 - Atomic bombs
 - Nuclear power
 - Cancer
- Images convey feelings or sense of danger



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Examples of Risk Perceptions

"Radiation, I don't want anything to do with that!!"

"Does that clicking Geiger counter mean that I won't be able to have any children?"

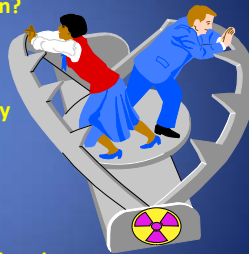
- What is the basis for such perceptions?

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How Safe is Safe ?

- How do we answer the question?
 - What does "safe" mean?
 - Are we conservative for radiation safety?
- Workers make choices on safety
 - Involving feelings
 - Feelings come from lifestyle values
 - Everyone is an expert on their own feelings
- Answer to "What is safe?" is related to images of consequences



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Dread of Radiation

- You cannot see it, smell it, or feel it
 - We rely on our five senses to warn us of danger
 - No one has ever had a direct experience of radiation
 - Like touching a hot pan or a live electric wire
- Many feel defenseless against radiation
- Many may conclude,
 - "If radiation is there, it is bad for you!!!"
 - Therefore, for many people no radiation is acceptable

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Two Word Risk Assessments

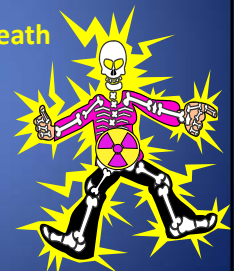
- Media avoids complex risk assessments with only 2 words
 - **Deadly radiation**
 - Is there any other kind?
 - Is all radiation deadly?
 - Does the type or amount matter?
- Media has created and perpetuates a mindset against radiation,
- Now part of everyone's subconscious alert to danger
- Putting these two words together
 - Assumes - Cause and Effect

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Instinct vs Science

- Many people instinctively assume:
 - radiation = cancer and death
- What is missing?
 - Scientific approach
 - Steps from cause to effect



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Steps from Cause to Effect

1. What are properties of RAM (α , β , γ , x-ray)?
 - form and quantity?
2. Where is it located?
3. How is it contained?
4. How will it move in the environment?
5. What are the exposure conditions?
6. How much energy is deposited in body?
7. What doses are known to produce effects?
 - Is it difficult to seriously harm someone with radiation !

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Principles of Radiation Safety What to do for Safety

- **Time** – spend little time near source
- **Distance** – exposure reduced by four as distance is doubled
- **Shielding** – use lead or steel for shielding of x-rays

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Sources of Radiation Exposure Around Us Every Day

Sources of Radiation in U.S. (620 mrem / year)

Natural – 50 % of dose	Man-made – 50 % of dose
<ul style="list-style-type: none">• cosmic• terrestrial• radon• internal – food and water	<ul style="list-style-type: none">• medical• industrial (< 0.1%)• occupational (< 0.1%)• consumer products

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We Live in a Sea of Natural Radiation

Natural Radiation Dose
310 mrem / year = 50 % of total

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Terrestrial Radiation

Terrestrial Radiation Dose
19 mrem / year = 3 % of Total

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