Glyphosate and Communicating Risk

Kaci Buhl, MS
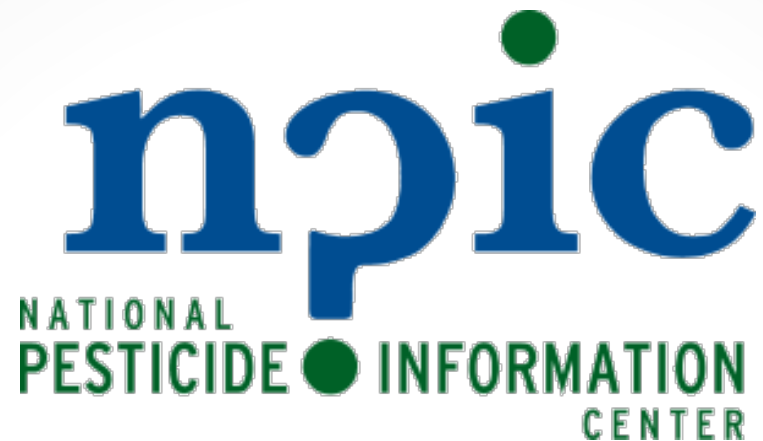
OSU
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In Today's Webinar

- What is the National Pesticide Information Center (NPIC)?
- The problem(s) with *glyphosate*
- The science of risk perception
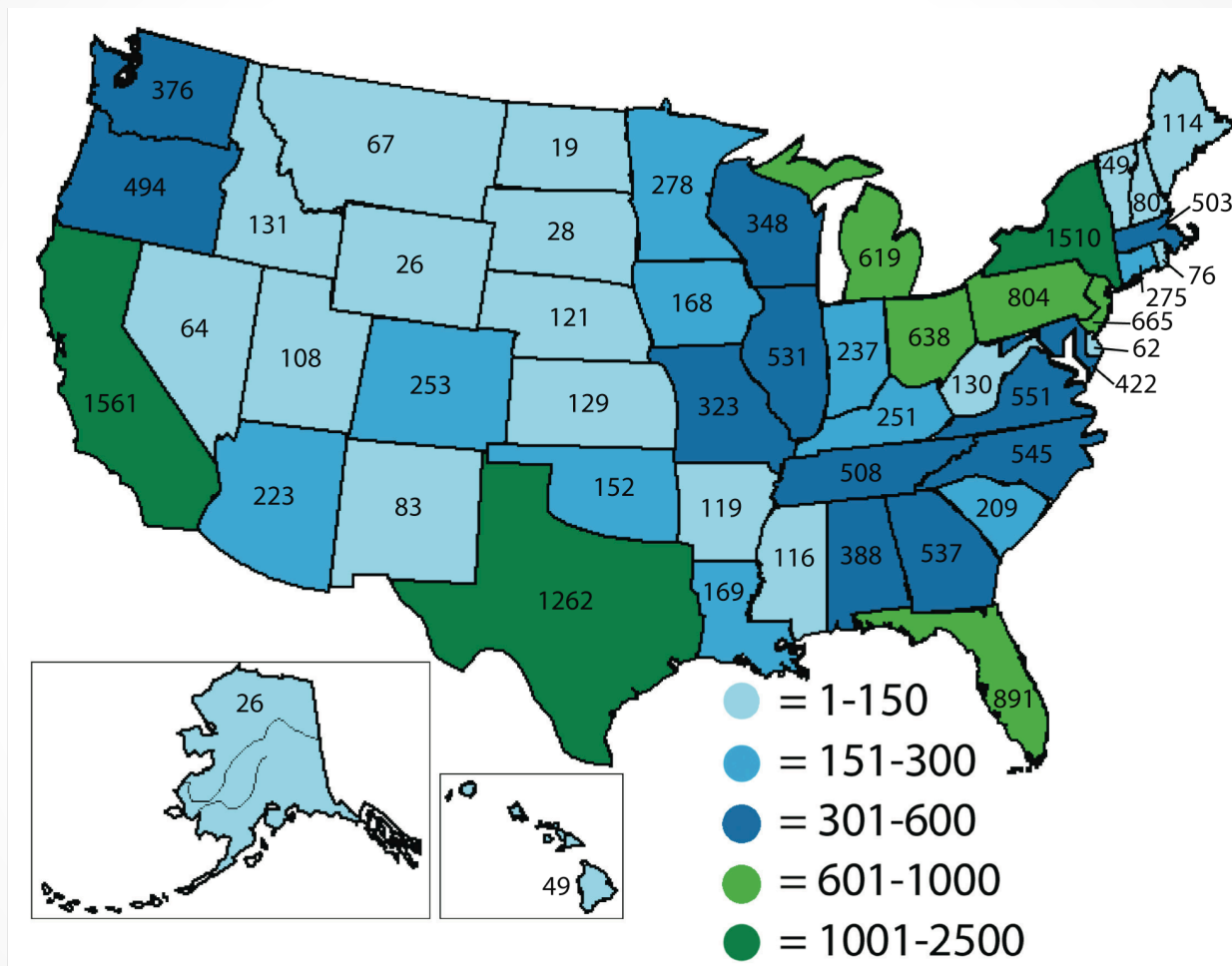- A framework for risk communication
- Questions & Answers

Call the National Pesticide Information Center

1.800.858.7378

- An objective information service for pesticides
- Toll-free phone service available:
- 11:00 – 3:00 Eastern; 8:00 – 12:00 Pacific
- Funded through a cooperative agreement with EPA

Inquiries to NPIC in 2016

~ 12,000 inquiries per year

Call the National Pesticide Information Center

1.800.858.7378

- To compare the toxicity of products
- To evaluate the persistence of pesticides
- To discuss specific pesticides and potential health effects
- To discuss risk to groundwater, fish, bees, or pets
- For help with confusing label statements
- To find local resources
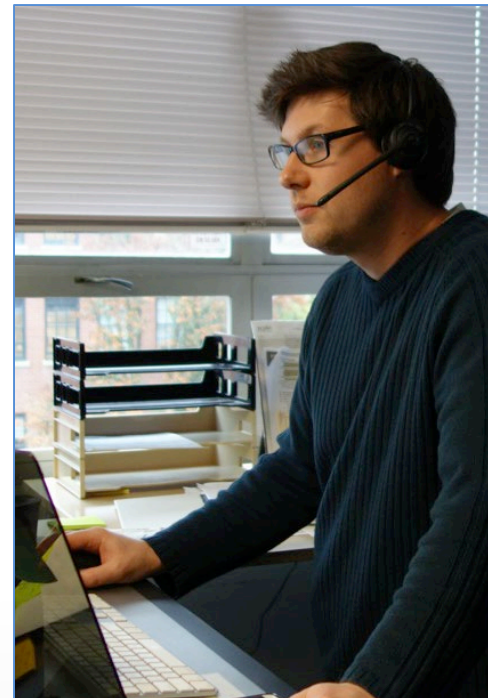
How do people know about NPIC?

- Product labels – About 1/3
- Internet – About 1/3
- Pest Control Companies – About 12%
- Other: health departments, health care providers, university experts, social media, etc.
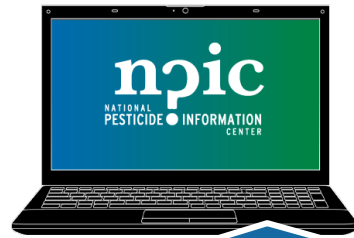
One-on-One

Website

Social Media

Mobile apps

Podcasts

Webinars

Comics

Videos

The Problem(s) with glyphosate

How does it work?

- Disrupts the shikimic acid pathway
- Inhibits EPSP synthase
- Plants cannot produce all of the proteins they need to survive.
- Plants take 4-20 days to die.

- EPSP synthase is not used by animals.
  - It is used by some micro-organisms.

TOXICITY CLASSIFICATION - GLYPHOSATE

	High Toxicity	Moderate Toxicity	Low Toxicity	Very Low Toxicity
Acute Oral LD_{50}	Up to and including 50 mg/kg ($\leq$ 50 mg/kg)	Greater than 50 through 500 mg/kg (>50-500 mg/kg)	Greater than 500 through 5000 mg/kg (>500-5000 mg/kg)	Greater than 5000 mg/kg (>5000 mg/kg)
Inhalation LC_{50}	Up to and including 0.05 mg/L ($\leq$0.05 mg/L)	Greater than 0.05 through 0.5 mg/L (>0.05-0.5 mg/L)	Greater than 0.5 through 2.0 mg/L (>0.5-2.0 mg/L)	Greater than 2.0 mg/L (>2.0 mg/L)
Dermal LD_{50}	Up to and including 200 mg/kg ($\leq$200 mg/kg)	Greater than 200 through 2000 mg/kg (>200-2000 mg/kg)	Greater than 2000 through 5000 mg/kg (>2000-5000 mg/kg)	Greater than 5000 mg/kg (>5000 mg/kg)
Primary Eye Irritation	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8 - 21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or erythema)

The highlighted boxes reflect the values in the "Acute Toxicity" section of this fact sheet.
Modeled after the U.S. Environmental Protection Agency, Office of Pesticide Programs, Label Review Manual, Chapter 7: Precautionary Labeling. http://www.epa.gov/oppfead1/labeling/lrm/chap-07.pdf

http://npic.orst.edu/factsheets/archive/glyphotech.html

- When swallowed, about 1/3 of glyphosate is absorbed.

- About 2% of glyphosate is absorbed through skin.

Cancer

- Animal studies have mixed results, but mostly negative.
- A long-term study with over 50,000 applicators found no association with overall cancer rates or most subtypes.
- Epidemiological data show a <u>suggested association</u> with Non-Hodgkins Lymphoma (NHL).

- EPA classification: "Evidence of non-carcinogenicity"
- IARC classification: "Probable carcinogen"

"Odds Ratios"

4 cancers in the population
      WITH exposure

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4 cancers in the population
      with NO exposure

$$4/4 = 1$$

5 cancers in the population
      WITH exposure
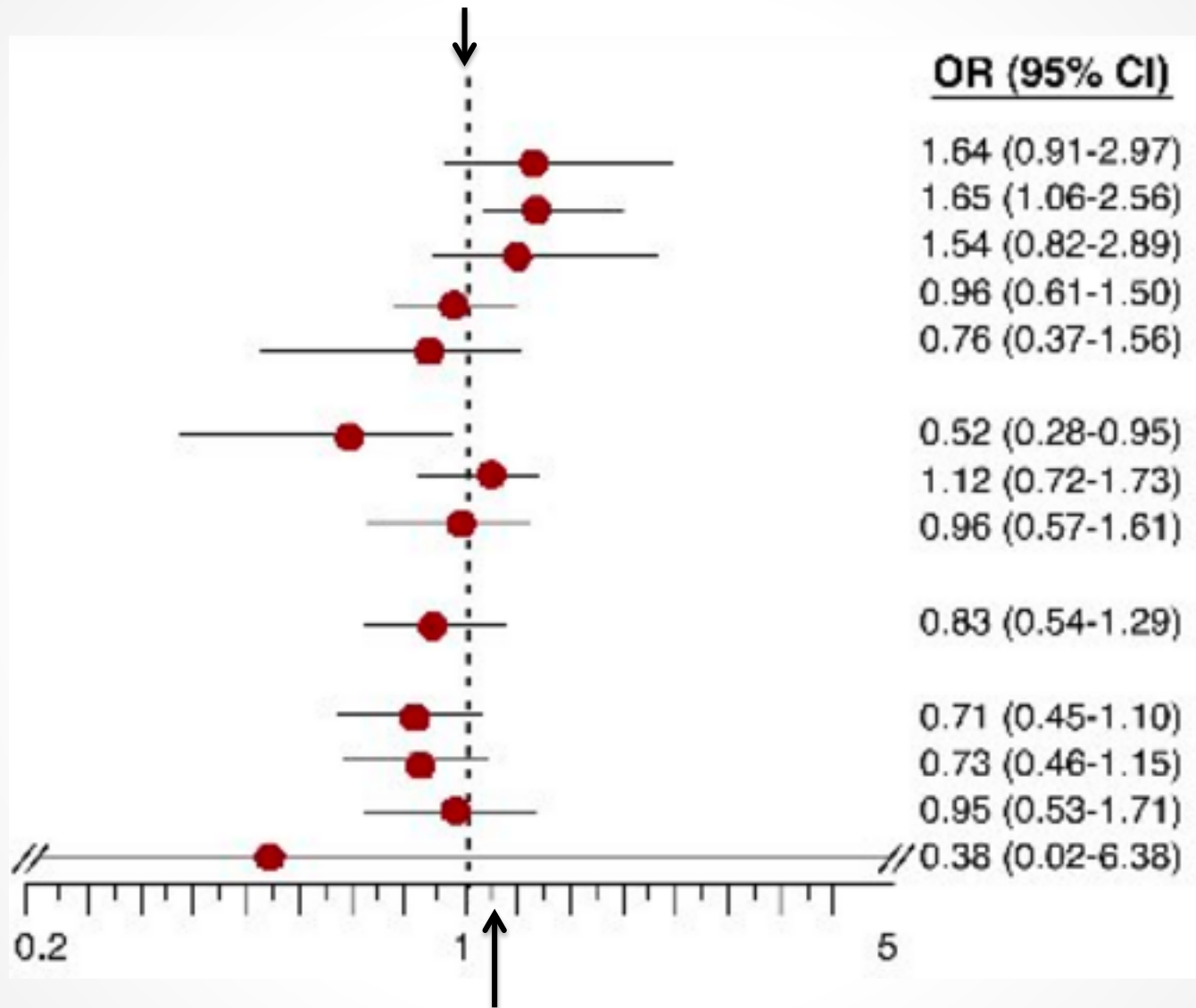
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4 cancers in the population
      with NO exposure

$$5/4 = 1.25$$

*25% higher risk of
cancer with exposure*

Table 2.2 Case–control studies of leukaemia and lymphoma and exposure to glyphosate

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled
USA						
Brown et al. (1990) Iowa and Minnesota, USA 1981–1983	Cases: 578 (340 living, 238 deceased) (response rate, 86%); cancer registry or hospital records Controls: 1245 (820 living, 425 deceased) (response rate, 77–79%); random-digit dialling for those aged < 65 years and Medicare for those aged ≥ 65 years Exposure assessment method: questionnaire	Leukaemia	Any glyphosate	15	0.9 (0.5–1.6)	Age, vital status, state, tobacco use, family history lymphopoietic cancer, high-risk occupations, high risk exposures
Cantor et al. (1992) Iowa and Minnesota, USA 1980–1982	Cases: 622 (response rate, 89.0%); Iowa health registry records and Minnesota hospital and pathology records Controls: 1245 (response rate, 76–79%); population-based; no cancer of the lympho-haematopoietic system; frequency-matched to cases by age (5-year group), vital status, state. Random-digit dialling (aged < 65 years); Medicare records (aged ≥ 65 years); state death certificate files (deceased subjects) Exposure assessment method: questionnaire; in-person interview	NHL	Ever handled glyphosate	26	1.1 (0.7–1.9)	Age, vital status, state, smoking status, family history lymphopoietic cancer, high-risk occupations, high-risk exposures

$(0.7 – 1.9)$ ❌

Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled
Brown et al. (1993) Iowa, USA 1981–1984	Cases: 173 (response rate, 84%); Iowa health registry Controls: 650 (response rate, 78%); Random-digit dialling (aged < 65 years) and Medicare (aged > 65 years) Exposure assessment method: questionnaire	Multiple myeloma	Any glyphosate	11	1.7 (0.8–3.6)	Age, vital status
De Roos et al. (2003) Nebraska, Iowa, Minnesota, Kansas, USA 1979–1986	Cases: 650 (response rate, 74.7%); cancer registries and hospital records Controls: 1933 (response rate, 75.2%); random-digit dialling, Medicare, state mortality files Exposure assessment method: questionnaire; interview (direct or next-of-kin)	NHL	Any glyphosate exposure	36	2.1 (1.1–4)	Age, study area, other pesticides

☑ $(1.1 - 4)$

Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled
Lee et al. (2004a) Iowa, Minnesota and Nebraska, USA 1980–1986	Cases: 872 (response rate, NR); diagnosed with NHL from 1980 to 1986 Controls: 2381 (response rate, NR); frequency-matched controls Exposure assessment method: questionnaire; information on use of pesticides and history of asthma was based on interviews	NHL	Exposed to glyphosate – non-asthmatics	53	1.4 (0.98–2.1)	Age, vital status,
			Exposed to glyphosate – asthmatics	6	1.2 (0.4–3.3)	
Canada						
McDuffie et al. (2001) Canada 1991–1994	Cases: 517 (response rate, 67.1%), from cancer registries and hospitals Controls: 1506 (response rate, 48%); random sample from health insurance and voting records Exposure assessment method: questionnaire, some administered by telephone, some by post	NHL	Exposed to glyphosate	51	1.2 (0.83–1.74)	Age, province of residence
			Unexposed	464	1	
			> 0 and ≤ 2 days	28	1.0 (0.63–1.57)	
			> 2 days	23	2.12 (1.2–3.73)	

Table 2.2 (continued)

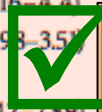| Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled
Hardell & Eriksson (1999) Northern and middle Sweden 1987–1990	Cases: 404 (192 deceased) (response rate, 91%); regional cancer registries Controls: 741 (response rate, 84%); live controls matched for age and county were recruited from the national population registry, and deceased cases matched for age and year of death were identified from the national registry for causes of death Exposure assessment method: questionnaire	NHL (ICD-9 200 and 202)	Ever glyphosate – univariate Ever glyphosate – multivariate	4 NR	2.3 (0.4–13) 5.8 (0.6–54)	Not specified in the multivariable analysis
Hardell et al. (2002) Sweden; four Northern counties and three counties in mid Sweden 1987–1992	Cases: 515 (response rate, 91% in both studies); Swedish cancer registry Controls: 1141 (response rates, 84% and 83%%); national population registry Exposure assessment method: questionnaire	NHL and HCL	Ever glyphosate exposure (univariate) Ever glyphosate exposure (multivariate)	8 8	3.04 (1.08–8.5) 1.85 (0.55–6.2)	Age, county, study ... ...s in ...te analysis

(0.6 – 54) ✗

(1.08 – 8.5) ✓

(0.55 – 6.2) ✗

Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled
Eriksson et al. (2008) Sweden. Four health service areas (Lund, Linkoping, Orebro and Umea) 1999–2002	Cases: 910 (response rate, 91%); incident NHL cases were enrolled from university hospitals Controls: 1016 (response rate, 92%); national population registry Exposure assessment method: questionnaire	NHL	Any glyphosate	29	2.02 (1.1–3.71)	
			Any glyphosate*	29	1.51 (0.77–2.94)	
			≤ 10 days per year use	12	1.69 (0.7–4.07)	
			> 10 days per year use	17	2.36 (1.0–5.37)	
		NHL	1–10 yrs	NR	1.11 (0.24–5.08)	
			> 10 yrs	NR	2.26 (1.16–4.4)	
		B-cell lymphoma	Exposure to glyphosate	NR	1.87 (0.998–3.55)	
		Lymphocytic lymphoma/B-CLL	Exposure to glyphosate	NR	3.35 (1.42–7.89)	
		Diffuse large B-cell lymphoma	Exposure to glyphosate	NR	1.22 (0.44–3.35)	
		Follicular, grade I–III	Exposure to glyphosate	NR	1.89 (0.62–5.79)	
		Other specified B-cell lymphoma	Exposure to glyphosate	NR	1.63 (0.53–4.96)	
		Unspecified B-cell lymphoma	Exposure to glyphosate	NR	1.47 (0.33–6.61)	
		T-cell lymphoma	Exposure to glyphosate	NR	2.29 (0.51–10.4)	
		Unspecified NHL	Exposure to glyphosate	NR	5.63 (1.44–22)	

(1.1 – 3.71)

(0.77 – 2.94)

(0.24 – 5.08)

(1.16 – 4.4)

(1.44 – 22)

6.1 Cancer in humans

There is *limited evidence* in humans for the carcinogenicity of glyphosate. A positive association has been observed for non-Hodgkin lymphoma.

6.2 Cancer in experimental animals

There is *sufficient evidence* in experimental animals for the carcinogenicity of glyphosate.

6.3 Overall evaluation

Glyphosate is *probably carcinogenic to humans (Group 2A).*

IARC CARCINOGENIC CLASSIFICATION GROUPS

Processed meats have been given Group 1 classification

INCLUDES

Salami

Bacon

Sausages and hot dogs

Red meats have been given Group 2A classification

Pork   Beef   Lamb

(Does not include chicken or fish)

GROUP 1 — Causes cancer

GROUP 2A — Probably causes cancer

GROUP 2B — Possibly causes cancer

GROUP 3 — Not classifiable as a cause of cancer

GROUP 4 — Probably not a cause of cancer

These categories represent how likely something is to cause cancer in humans, not how many cancers it causes.

glyphosate

2,4-D

GROUP 1 — Causes accidents

GROUP 2A — Probably causes accidents

GROUP 2B — Possibly causes accidents

GROUP 3 — Not classifiable

GROUP 4 — Probably doesn't cause accidents

International Agency for Research on Cancer

World Health Organization

Can it cause cancer?

United States Environmental Protection Agency
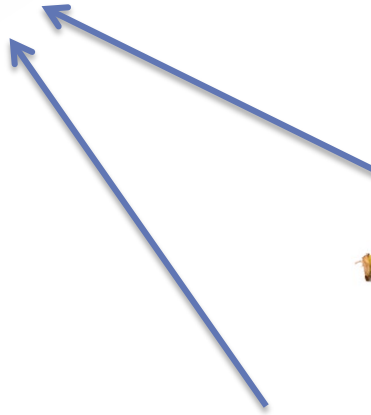
Can it cause cancer? + What level of exposure is expected? = Is that exposure level likely to result in cancer?

Glyphosate Issue Paper:
Evaluation of Carcinogenic Potential

EPA's Office of Pesticide Programs
September 12, 2016

For cancer descriptors, the available data and weight-of-evidence clearly do not support the descriptors "carcinogenic to humans", "likely to be carcinogenic to humans", or "inadequate information to assess carcinogenic potential". For the "suggestive evidence of carcinogenic potential" descriptor, considerations could be looked at in isolation; however, following a thorough integrative weight-of-evidence evaluation of the available data, the database would not support this cancer descriptor. The strongest support is for "not likely to be carcinogenic to humans" at doses relevant to human health risk assessment.

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http://bit.ly/glypho-cancer-2016

EFSA Finds Glyphosate 'Unlikely to Cause Cancer in Humans'

BY DAN FLYNN | NOVEMBER 13, 2015

Europe's gardeners and farmers probably won't have their Monsanto Roundup weed killer or other similar herbicides taken away from them now that the influential European Food Safety Authority (EFSA) has found that the ingredient glyphosate is unlikely to cause cancer in humans.

Glyphosate, which has been around since the 1970s, is used in herbicides around the world, including Monsanto's popular Roundup.

EFSA's research findings appear to trump the conclusion this past March by the International Agency for Research on Cancer (IARC), which listed glyphosate as "probably carcinogenic to humans."

EFSA's assessment will be used by the European Commission in deciding whether to keep glyphosate on the EU list of approved active substances. Currently, glyphosate is widely used in both Roundup and in generic brands of herbicides for home gardening and agriculture.

The Science of Risk Perception

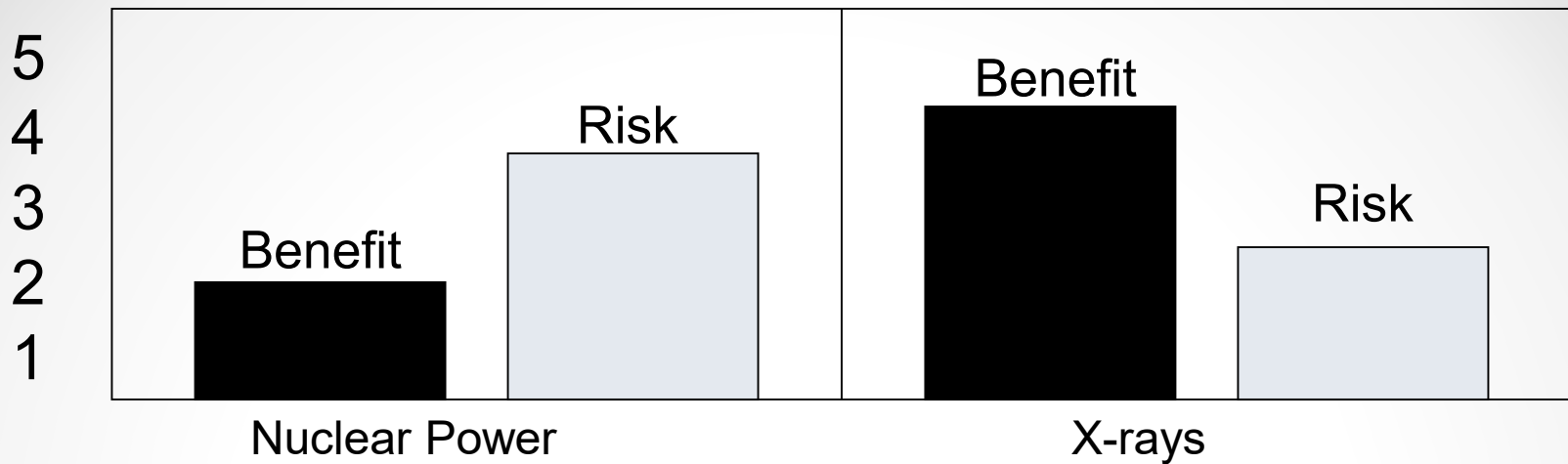Every hazard is unique
Every person is unique

Risk

- Human beings made up the concept of risk.
- It cannot be objectively measured.
- Assumptions and subjective judgments are used.
- Most risk perception is determined by *fast* intuitive feelings.
- The **risk(s)** cannot be separated from the **benefit(s)**
- Understanding risk perception is critical for effective communication.

Risks are less likely to be acceptable if the benefits are hidden from view, or if they are not fairly distributed among those who bear the risks.


Benefits of Pesticides
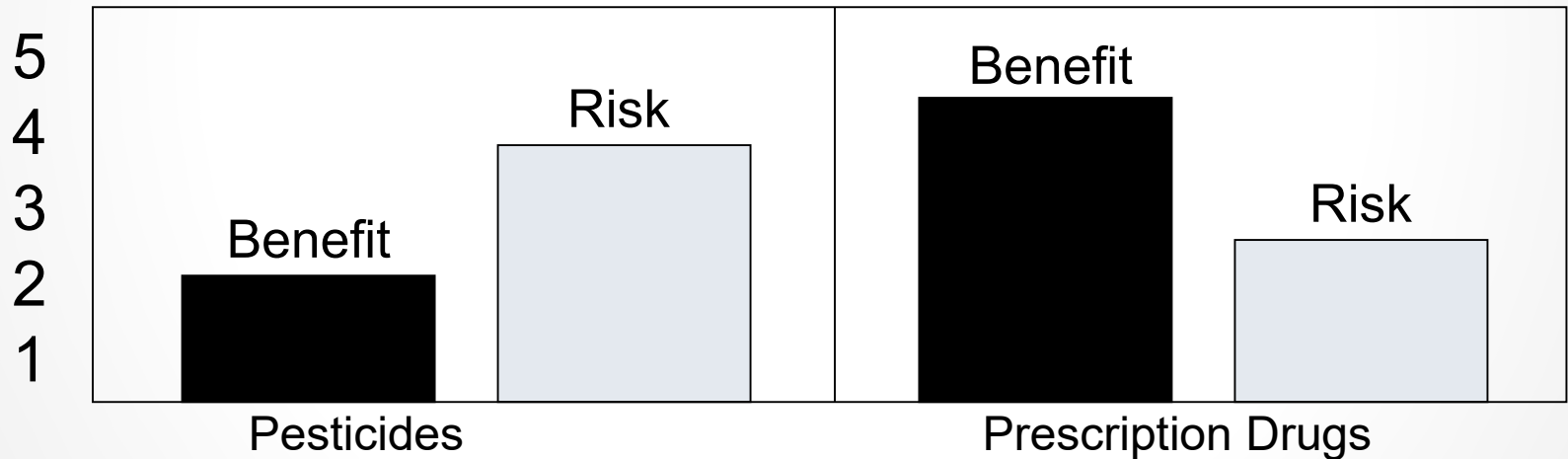
Figure 3. Mean perceived risk and perceived benefit for medical and nonmedical sources of exposure to radiation and chemicals. Each item was rated on a scale of perceived risk ranging from 1 (very low risk) to 7 (very high risk) and a scale of perceived benefit ranging from 1 (very low benefit) to 7 (very high benefit). Data are from a national survey in Canada by Slovic et al., 1991.
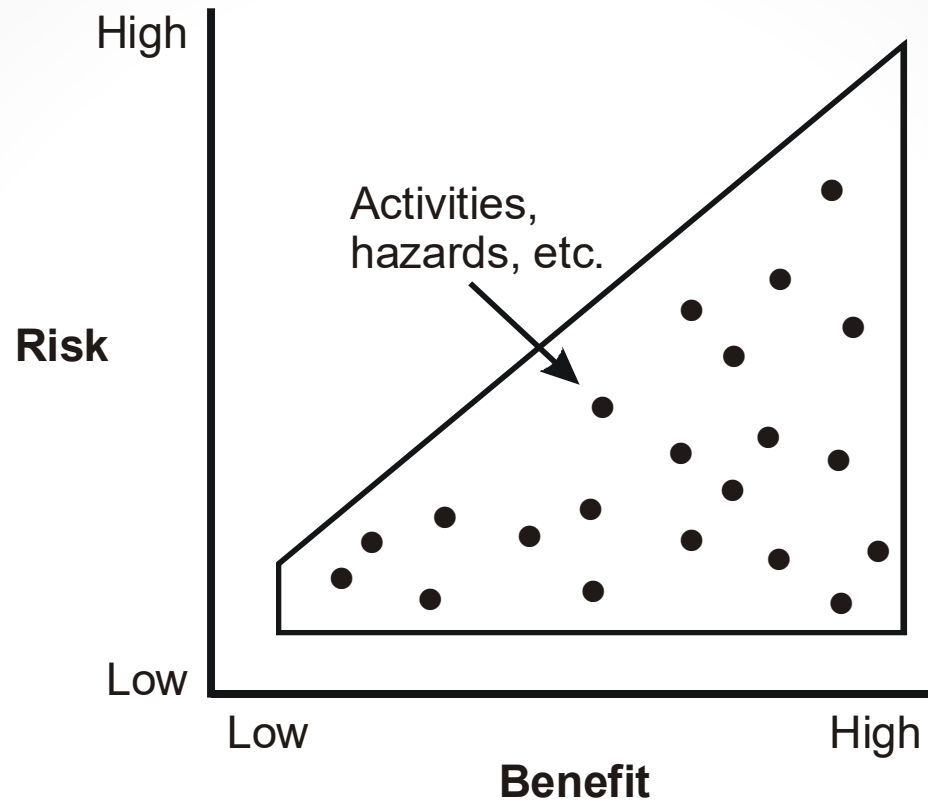
In the world, risk and benefit are **positively** correlated.

In people's minds, they are **negatively** correlated.
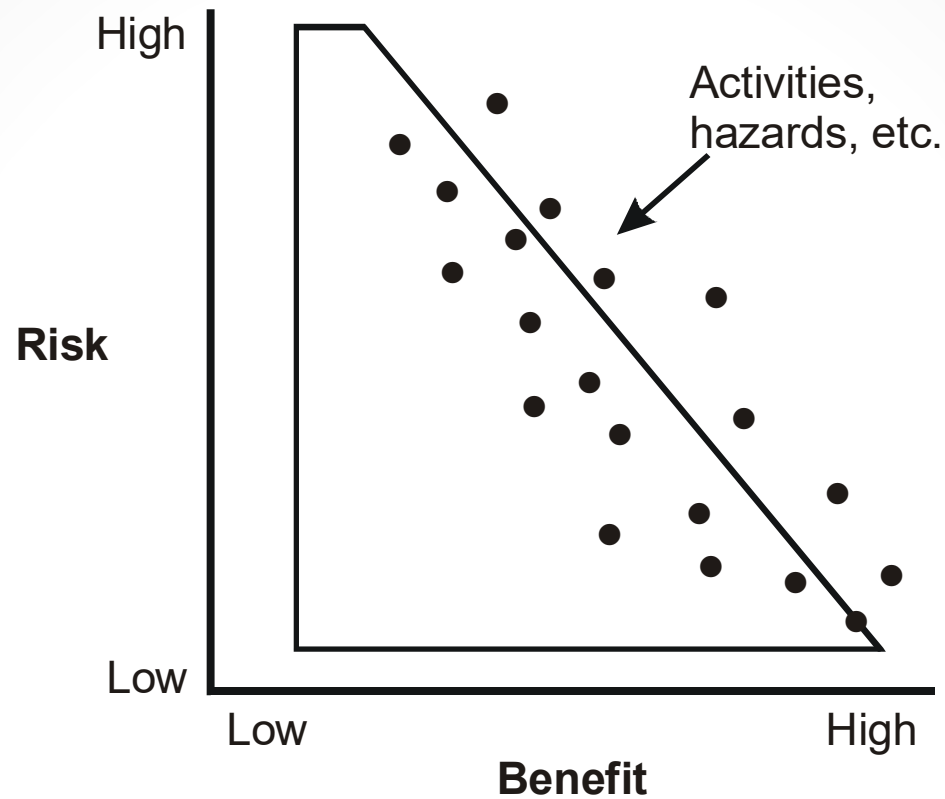
According to social science research, the relationship between risk and benefit in people's minds is negatively correlated.
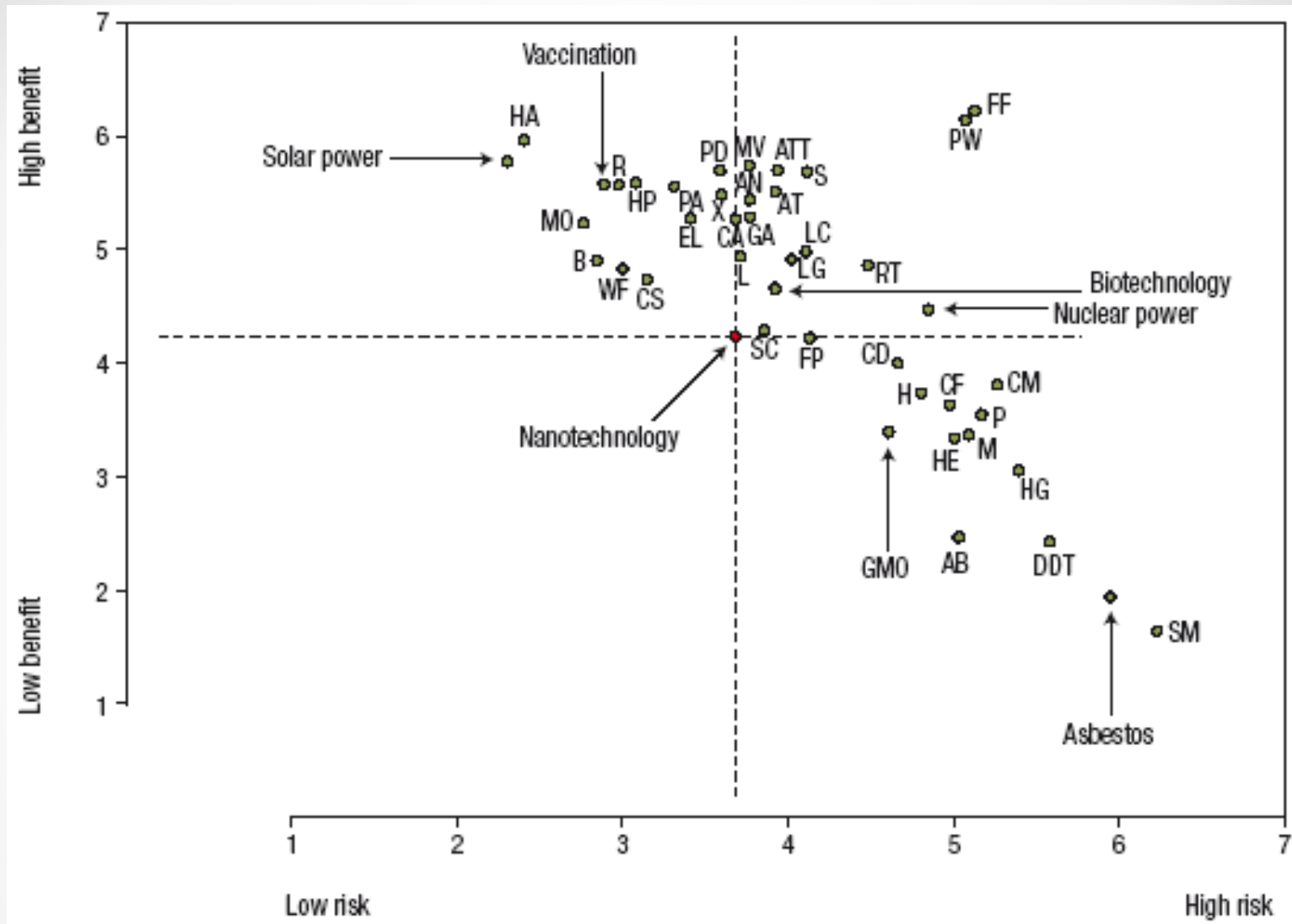
Figure 1 Perceived risks and benefits of nanotechnology and 43 other technologies, based on 503 responses to a national telephone survey. Source: Currall et al. 2006

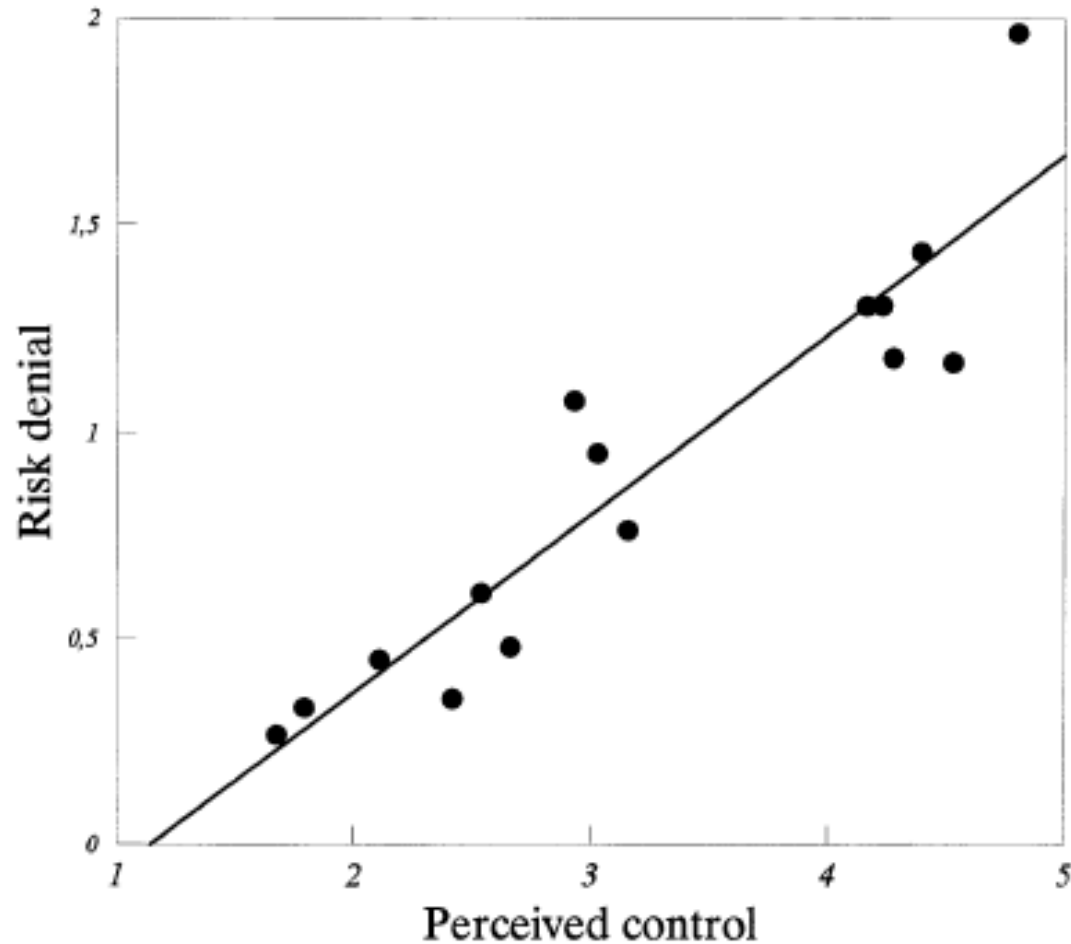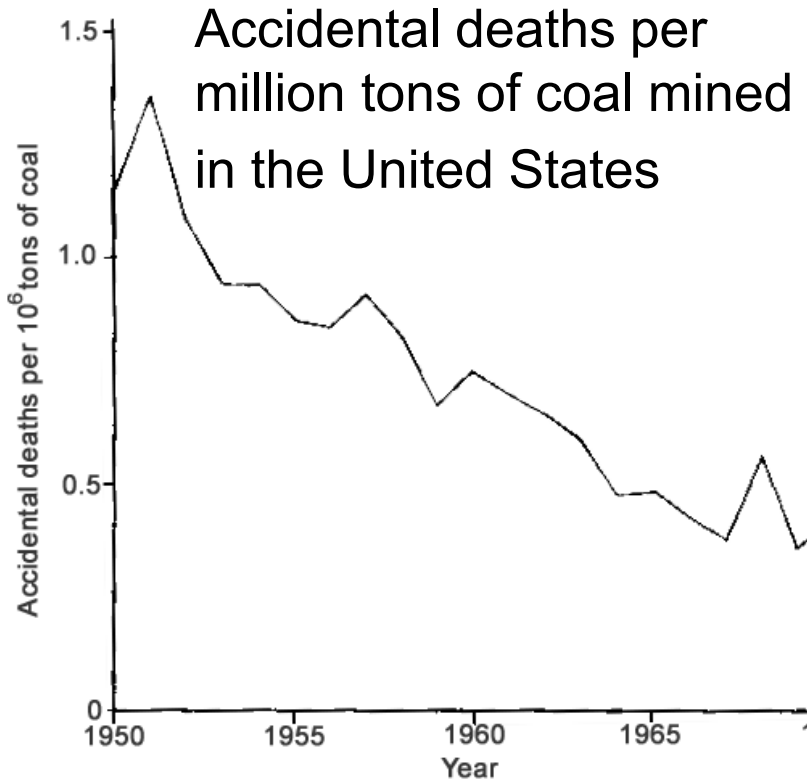# Risk denial increases with perceived control

Fig. 2. Risk denial (general minus personal risk) plotted against perceived control over risks. Each point corresponds to one hazard; mean ratings are plotted.

Sjoberg, L. Factors in Risk Perception. 2000. *Risk Analysis* 20:1 (pp1-11)

How is Risk Defined? Who Decides?

Is coal mining getting safer?

Accidental deaths per million tons of coal mined in the United States

Accidental deaths per thousand coal mine employees in the United States

Counting fatalities gives equal weight to:

- Young and old
- Painful and painless deaths
- Voluntary and involuntary exposure(s)
- Fair (beneficial) and unfair (no benefit)

Whoever controls the definition of risk is in control.

Defining Risk is an Act of *Power*

Probability – Proba-shmility

- Feelings about **probabilities** and feelings about **outcomes** are often confused.

- When <u>strong emotions</u> are involved, there is 'probability neglect.'

Many people lack dose-response sensitivity for exposure to chemicals that can produce effects that are dreaded, such as cancer.

If large exposures are bad, small exposures are also bad.
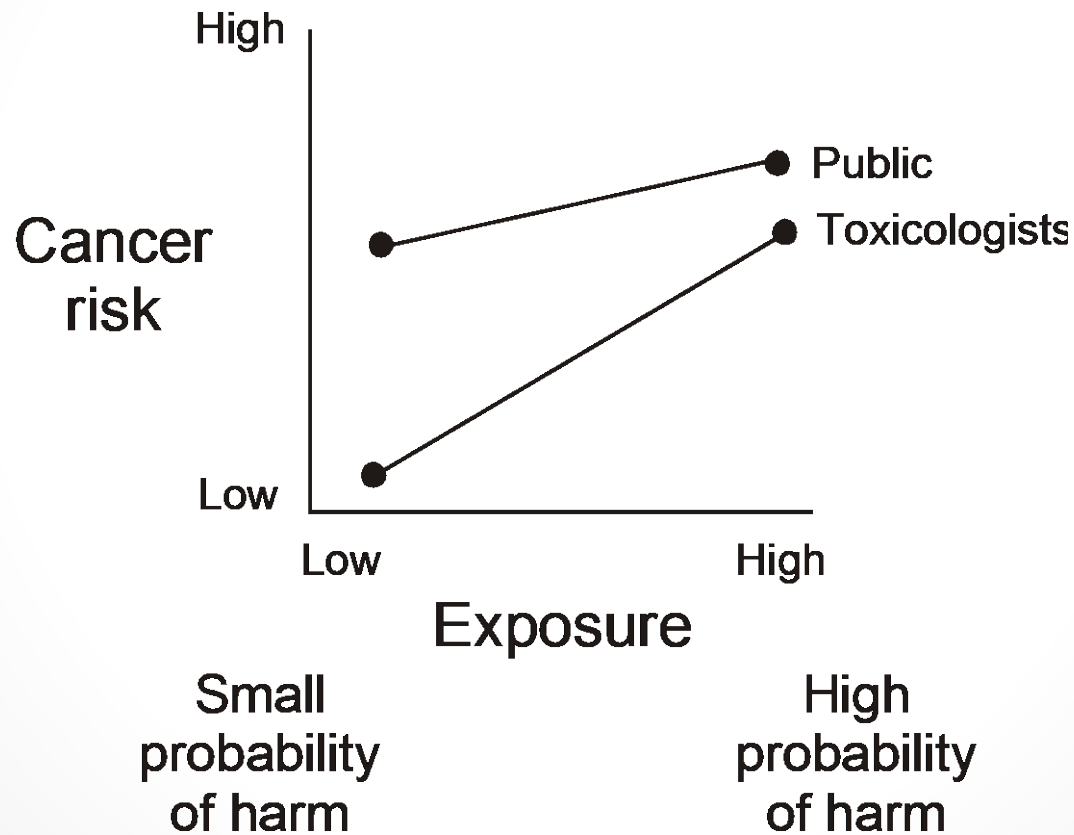
Worldview affects risk perception

The government should stop telling people how to live their lives (Individualism)

The government should do more to advance society's goals, even if that limits the freedom of individuals (Communitarian)

Our society would be better off if the distribution of wealth was more equal (Egalitarianism)

We should let the experts make all the risk decisions for society (Hierarchism)

People with different worldviews were asked about their attitudes towards nanotechnology, before and after being given information about nanotechnology.
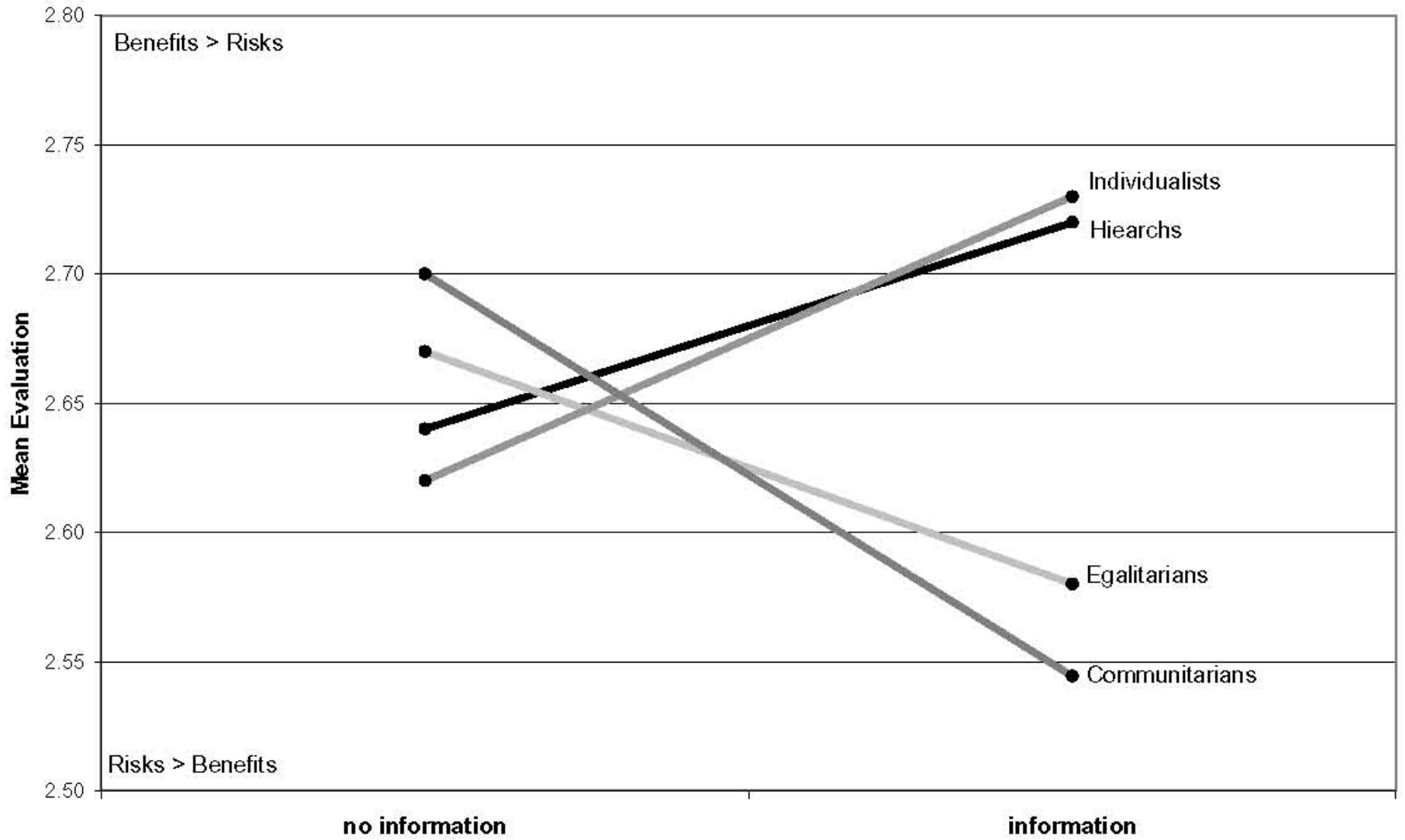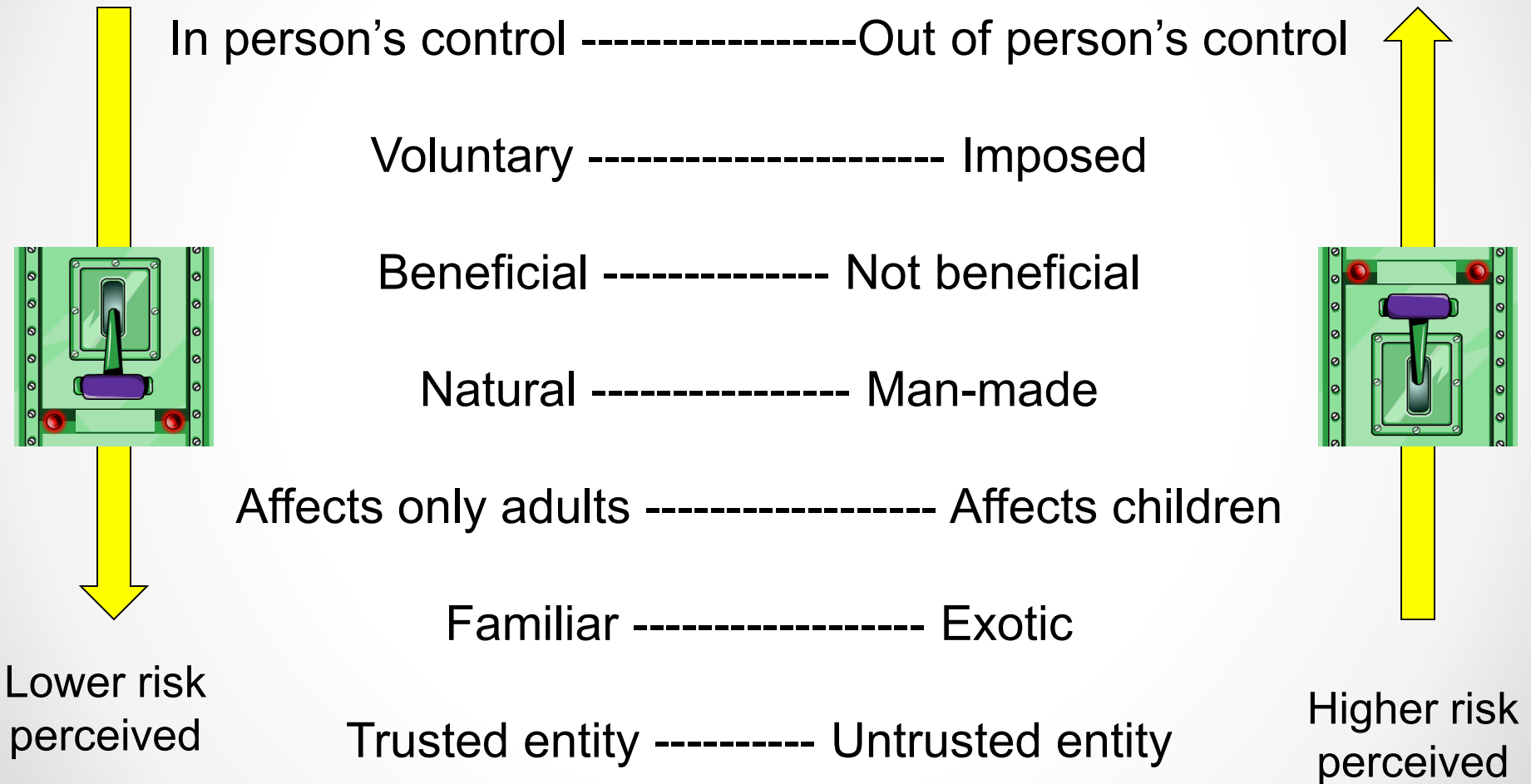
Figure 4. Impact of Information Across Condition by Dimension of Cultural Worldview

Personal 'Outrage Factors'

In person's control -----------------Out of person's control

Voluntary -------------------- Imposed

Beneficial -------------- Not beneficial

Natural ---------------- Man-made

Affects only adults ----------------- Affects children

Familiar ----------------- Exotic

Trusted entity ---------- Untrusted entity

Lower risk perceived

Higher risk perceived

RISK PERCEPTION
IT'S PERSONAL

In the face of contradictory information, people must rely on their instincts as much as the facts to size up potential threats. © Corbis

We just covered…

Factors in risk perception

- Who benefits? How much?
- Who defines the way we measure the risk?
- Gut feelings, 'probability neglect'
- Worldview
- Other 'outrage factors' (dread, voluntary, etc.)?

A Framework for Risk Communication

Why "risk",
... when people ask about "safety?"

Safety
Yes or No
No precautions necessary
Safe is safe for everyone
Easy to explain

Risk
More risky----------------Less risky
Precautions reduce risk
Risk is higher for certain people
Harder to explain

The impression of safety → Careless behaviors, lack of vigilance → Increased risk
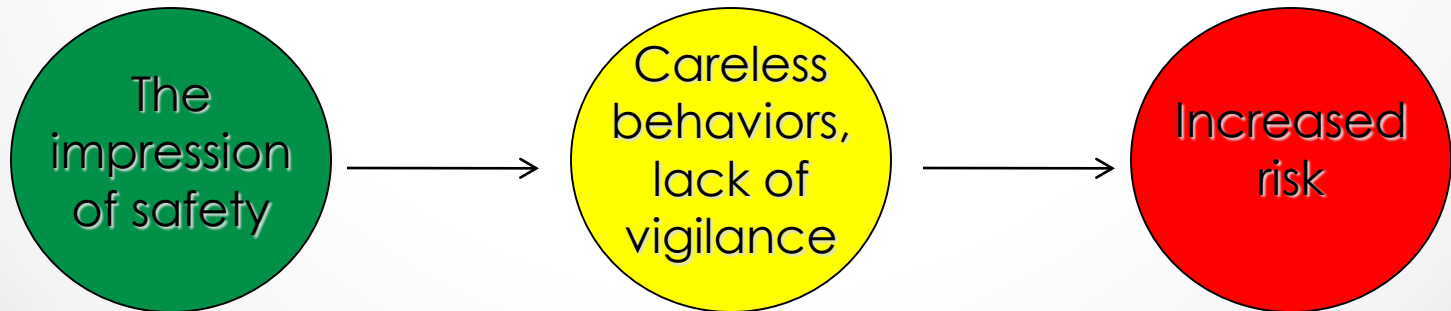
Re-framing the 'safe' question

Talking about toxicity and exposure

Risk　=　Toxicity　X　Exposure

- Toxicology of active ingredient
- Product signal word
- Dose estimate
- Effects (signs, symptoms) reported in the literature
- Onset, duration and resolution of symptoms

- Distance to application site
- Route of potential exposure
- Physical/chemical properties of active ingredient
- Duration/frequency of exposure
- Bioavailability by the route in question

The risk equation as scaffolding

Risk Communication Checklist:

Listen, ask questions, paraphrase: _____

Frame as risk rather than safety: _____

Toxicity information: _____

Exposure information: _____

Benefit(s) of the application: _____

Action items in person's control: _____

Where to get more info: _____

When people experience social pain, their IQ is decreased by up to 20%.

- Embarrassment, shame
- Disappointment, anger

Communicating Liklihood

A patient – Mr. Jones – was evaluated for discharge from a mental health facility. A psychologist whose professional opinion you respect has evaluated Mr. Jones. Her conclusions, stated differently:
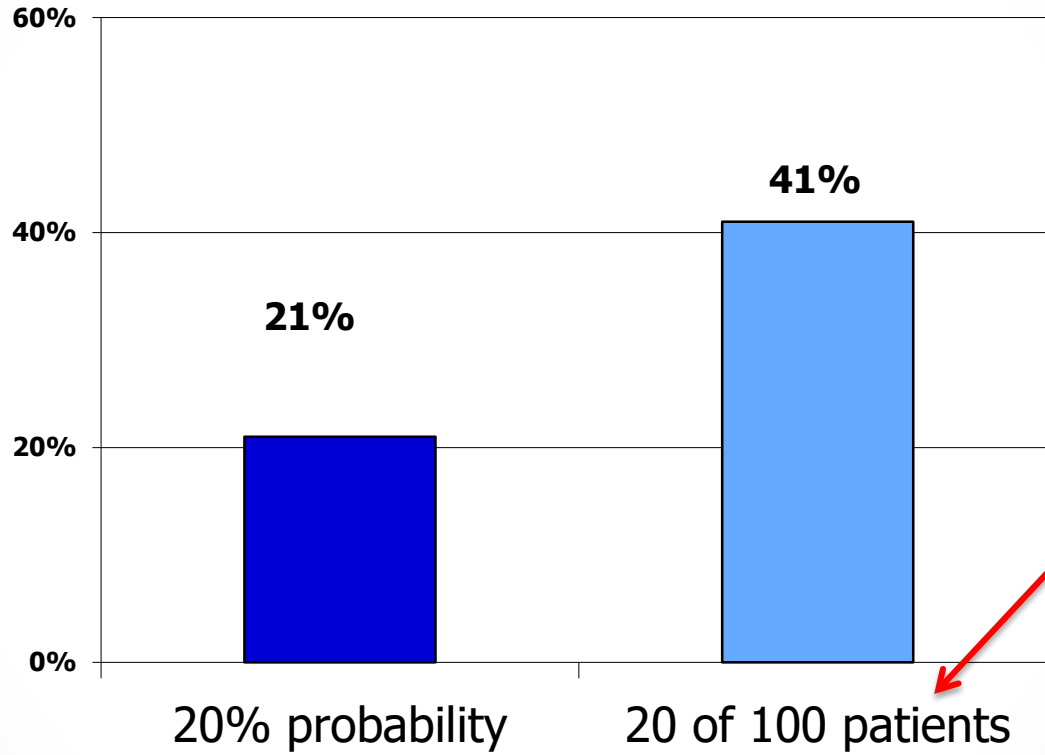
EITHER:

"Patients similar to Mr. Jones have a 20% probability of committing an act of violence during the first several months after discharge."

OR:

"Of every 100 patients similar to Mr. Jones, 20 may commit an act of violence during the first several months after discharge."
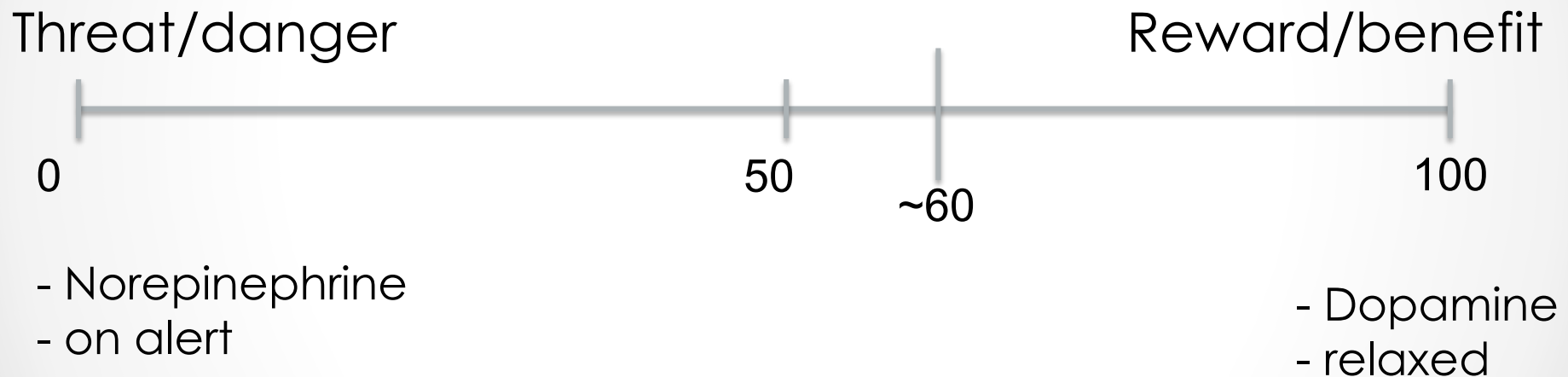
Do not discharge

20%

20% is pretty low.
He probably won't hurt anyone.

20 out of 100

He could be one of those 20.
Now I'm thinking about 100 mental patients
on the loose.

Finding the Sweet Spot

Threat/danger   Reward/benefit

0   50   ~60   100

- Norepinephrine
- on alert

- Dopamine
- relaxed

If the focus is too much on 'threat', learning shuts down.

What else can neuroscience tell us?

- The brain wanders about 30% of the time.

- People tend to internalize the most dominant emotion in the room.

- Reading trumps listening, even if you try to do both.

- People learn best in 20-minute chunks.

- To maximize learning, use stories that are tangible, relatable, and emotional. This strategy turns information into a life experience.

One approach to relatable stories…

Feel: Acknowledge the person's feelings (i.e. fear).

Felt: Share how you felt about something similar.

Found: Share some information you found that
              may have influenced your thinking on the topic.

We just covered…

Framework for Risk Communication

- Frame as 'risk' rather than 'safety'
- The risk equation as scaffolding for risk communication
- A proposed checklist
- Tips from neuroscience
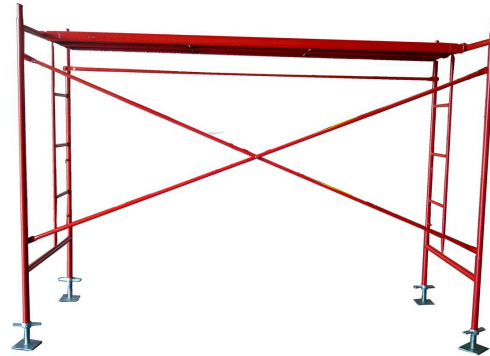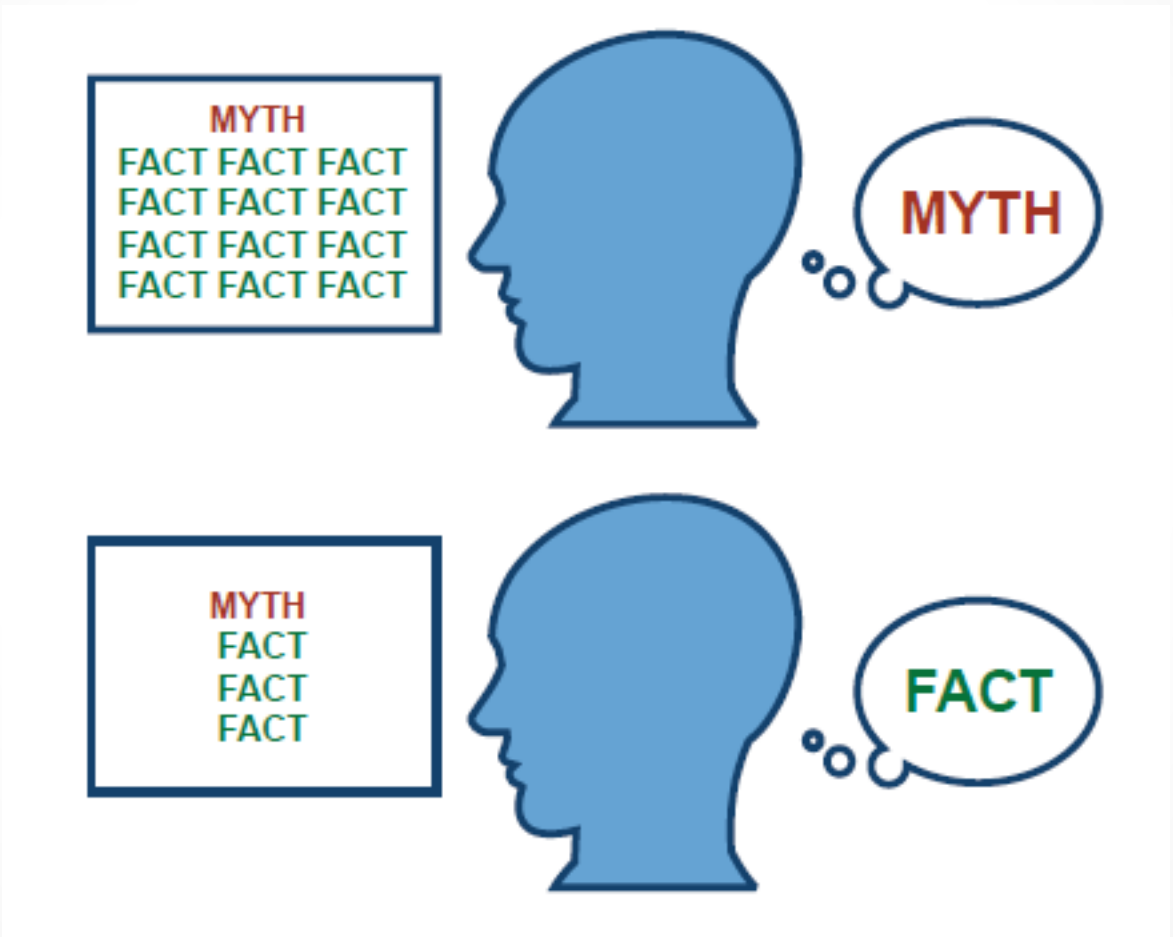
"One day I will find the right words, and they will be simple."

Jack Kerouac

Wednesday - Oct 24, 2012(4:53 pm)

Risk Communication Checklist:

Listen, ask questions, paraphrase: _____

Frame as risk rather than safety: _____

Toxicity information: _____

Exposure information: _____

Benefit(s) of the application: _____

Action items in person's control: _____

Where to get more info: _____