Glyphosate and Communicating Risk

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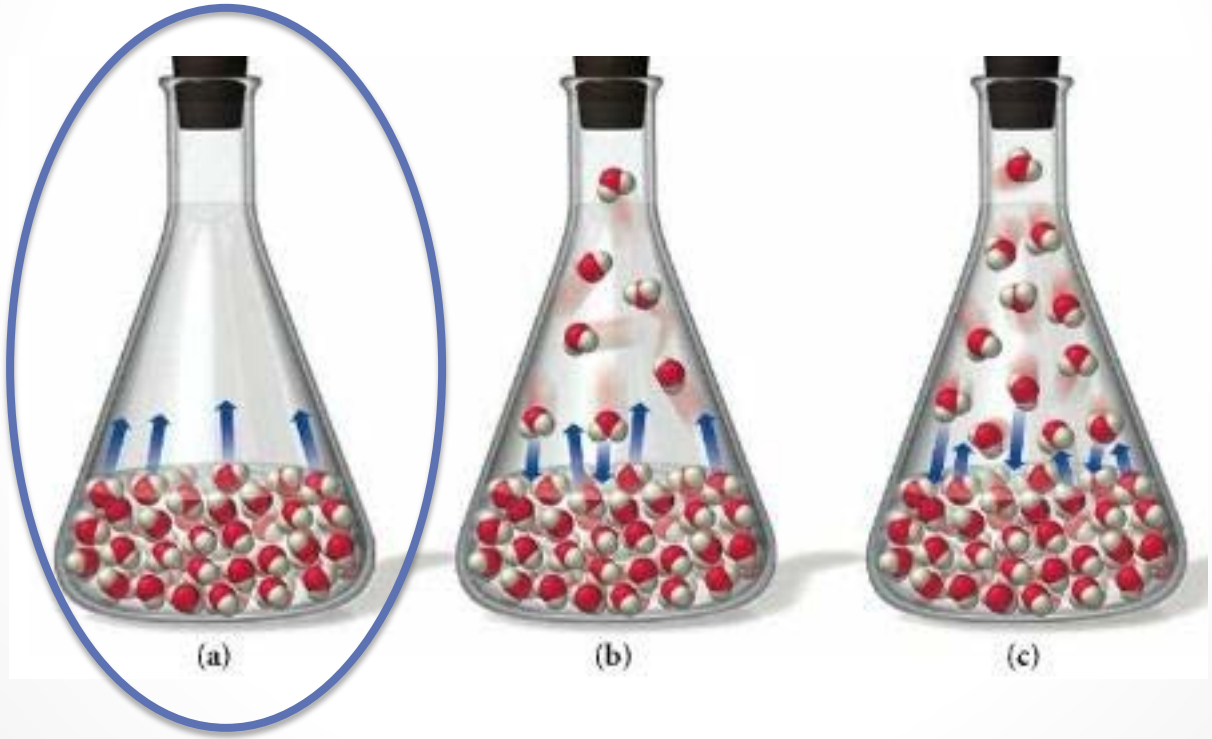
Glyphosate sticks to soil strongly.

Many products registered for application to aquatic areas.

Does glyphosate become vaporous?

No.



- When swallowed, about 1/3 of glyphosate is absorbed.
- About 2% of glyphosate is absorbed through skin.

TOXICITY CLASSIFICATION - GLYPHOSATE

	High Toxicity	Moderate Toxicity	Low Toxicity	Very Low Toxicity
Acute Oral LD_{50}	Up to and including 50 mg/kg (≤ 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 (≤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 (≤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

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 suggested association with Non-Hodgkins Lymphoma (NHL).
- EPA classification: “Evidence of non-carcinogenicity”
- IARC classification: “Probable carcinogen”

Why the difference?

"Odds Ratios"

$$\frac{\text{4 cancers in the population WITH exposure}}{\text{4 cancers in the population with NO exposure}}$$

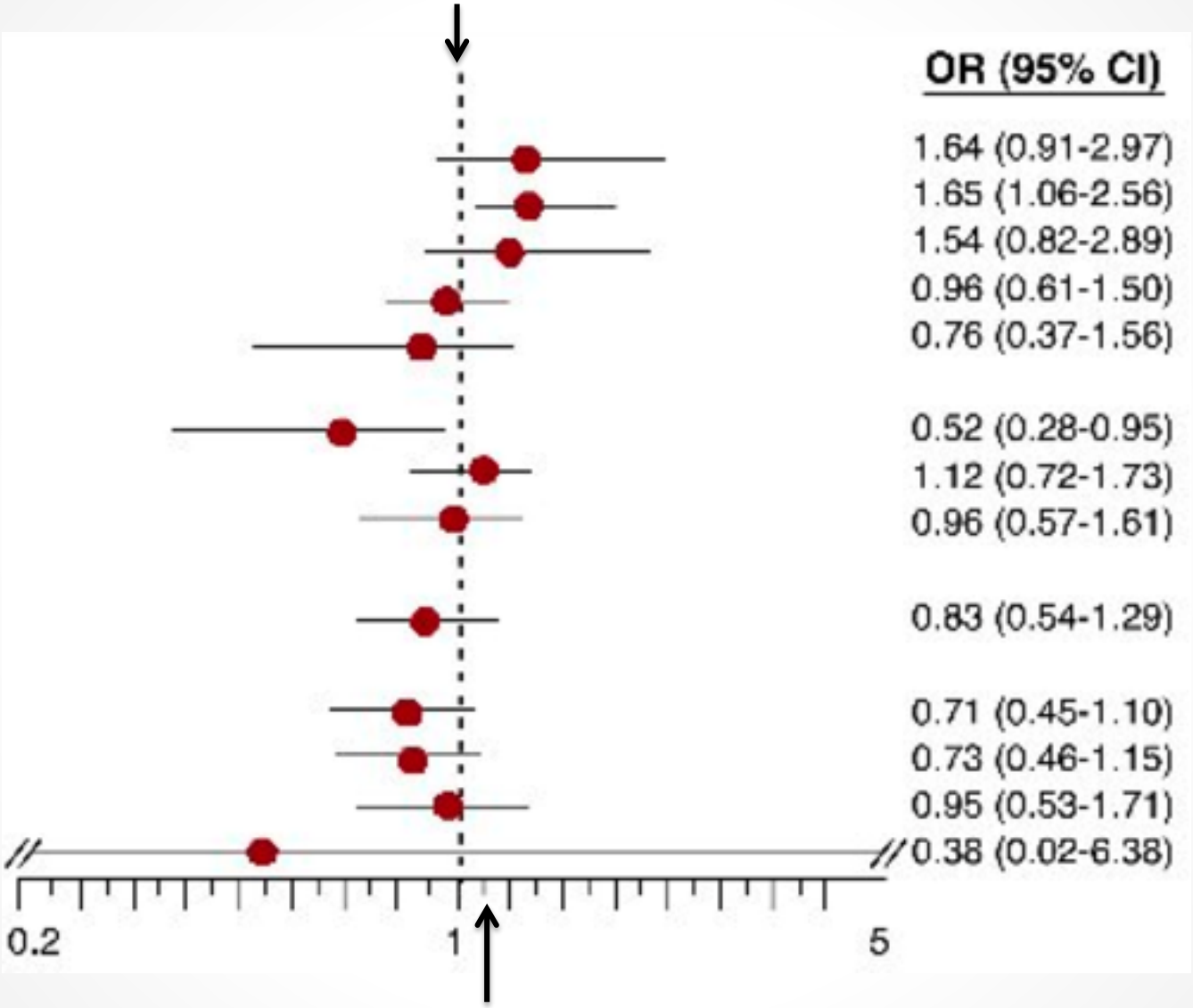
4/4 = 1

$$\frac{\text{5 cancers in the population WITH exposure}}{\text{4 cancers in the population with NO exposure}}$$

5/4 = 1.25

25% higher risk of cancer with exposure

4/4 = 1


OR (95% CI)
1.64 (0.91-2.97)
1.65 (1.06-2.56)
1.54 (0.82-2.89)
0.96 (0.61-1.50)
0.76 (0.37-1.56)
0.52 (0.28-0.95)
1.12 (0.72-1.73)
0.96 (0.57-1.61)
0.83 (0.54-1.29)
0.71 (0.45-1.10)
0.73 (0.46-1.15)
0.95 (0.53-1.71)
0.38 (0.02-6.38)
0.2
1
5

5/4 = 1.25

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)	

(0.98 – 2.1)

(0.4 – 3.3)

(0.83 – 1.74)

(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	4	2.3 (0.4–13)	Not specified in the multivariable analysis
			Ever glyphosate – multivariate	NR	5.8 (0.6–54)	
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)	8	3.04 (1.08–8.5)	Age, county, study [illegible] s, [illegible] s in [illegible] te analysis
			Ever glyphosate exposure (multivariate)	8	1.85 (0.55–6.2)	

(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[illegible]–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 (0.99–3.5[illegible])	
		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	N[illegible]	5[illegible] (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

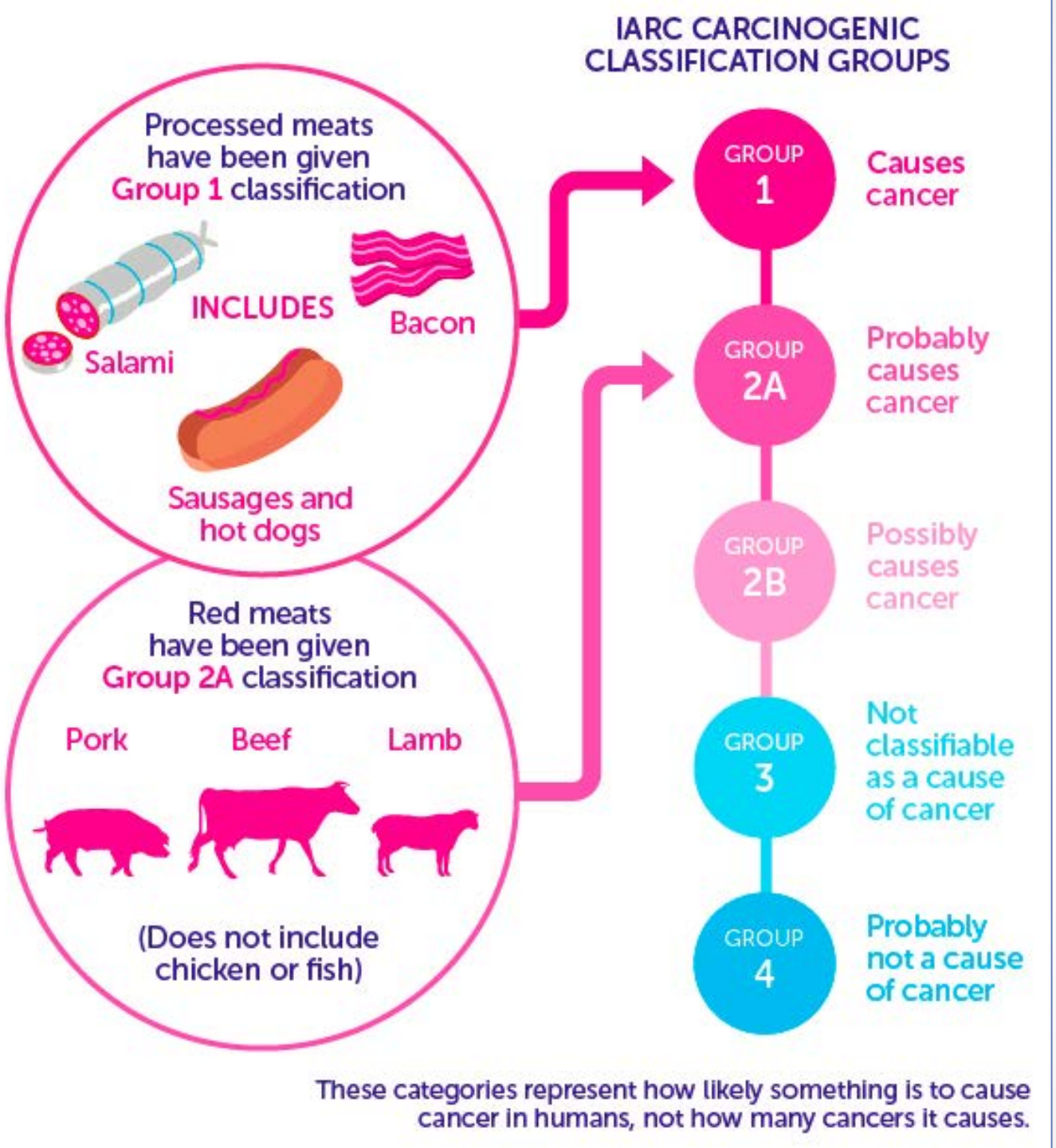
There is *limited evidence* in humans for the carcinogenicity of glyphosate. A positive association has been observed for non-Hodgkin lymphoma.

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).*



glyphosate

2,4-D

Causes accidents

Probably causes accidents

Possibly causes accidents

Not classifiable

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

Food Safety News
Breaking news for everyone's consumption

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.

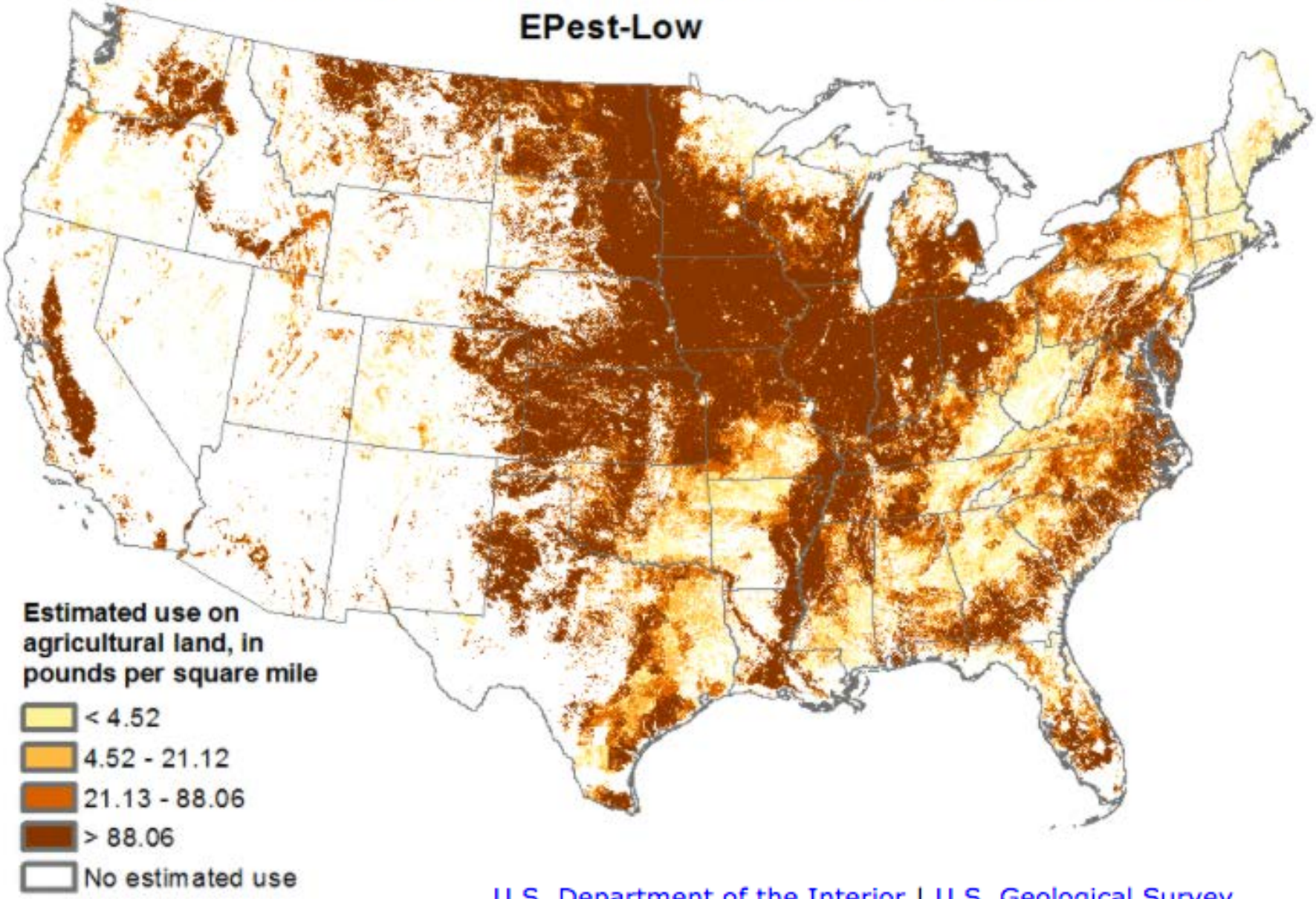
Glyphosate, which has been around since the 1970s, is used in herbicides around the world, including Monsanto's popular Roundup.

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.

Estimated Agricultural Use for Glyphosate , 2014 (Preliminary)

EPest-Low



U.S. Department of the Interior | U.S. Geological Survey
URL: http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.
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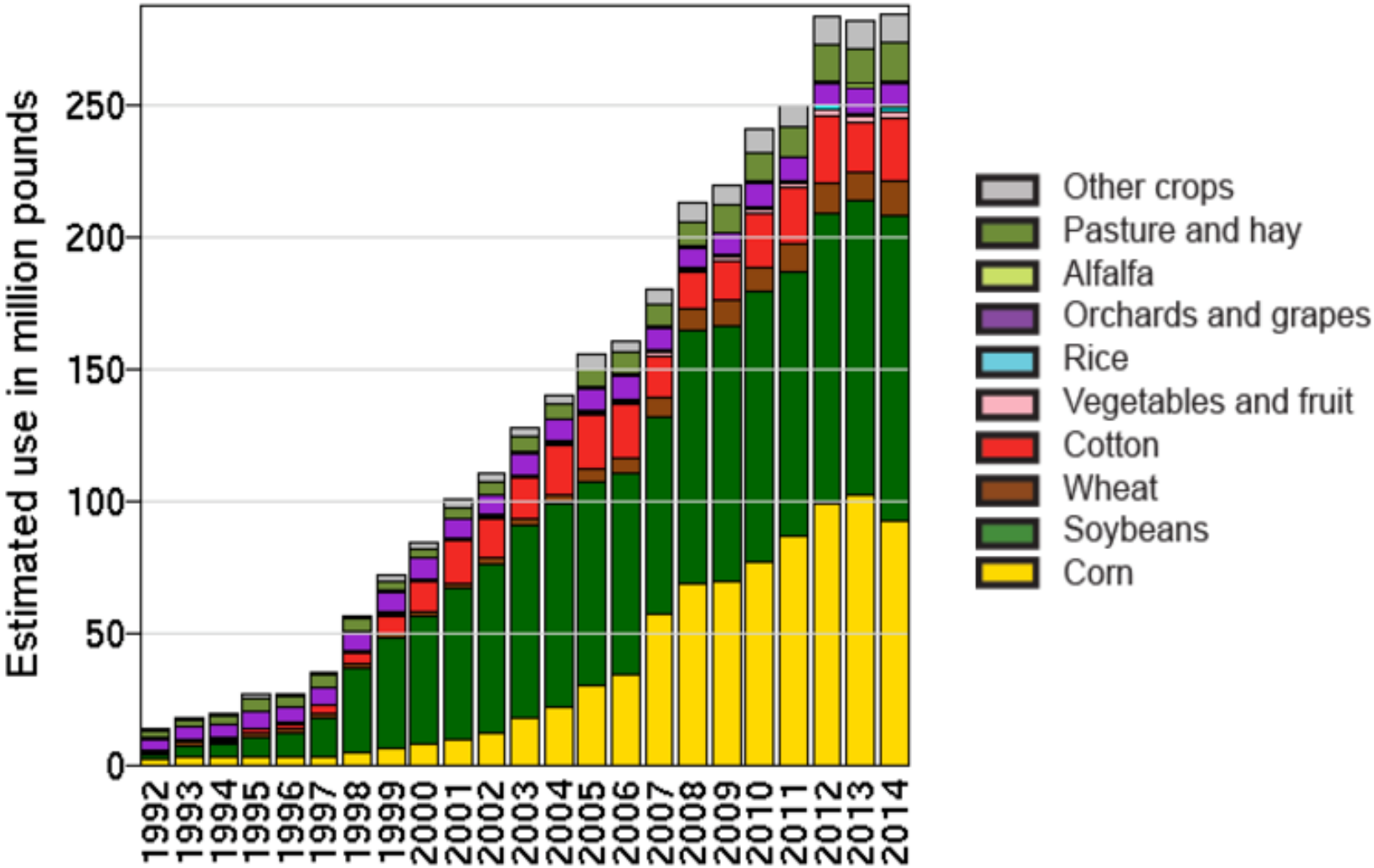
Page Last Modified: January 17 2017 09:55:22.

Use by Year and Crop



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Page Last Modified: March 18 2015 13:44:16.

The Science of Risk Perception

Every hazard is unique

Every person is unique

Acknowledgement: Dr. Paul Slovic, University of Oregon

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.

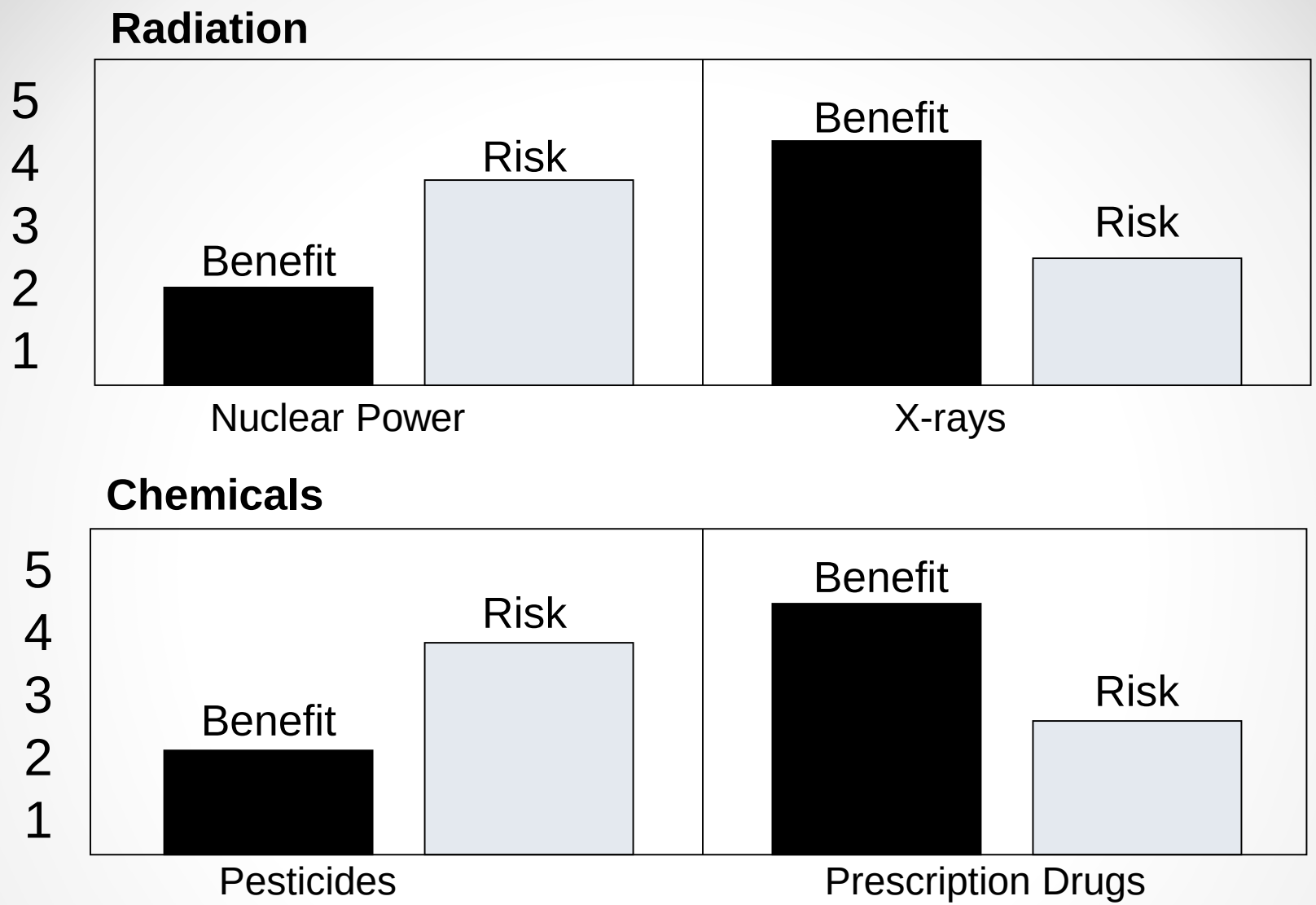


Figure 3. Mean perceived risk and perceived benefit for medical and nonmedical sources of exposure to radiation and chemicals. Each item was rated on a scale of perceived risk ranging from 1 (very low risk) to 7 (very high risk) and a scale of perceived benefit ranging from 1 (very low benefit) to 7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

Risk denial increases with perceived control

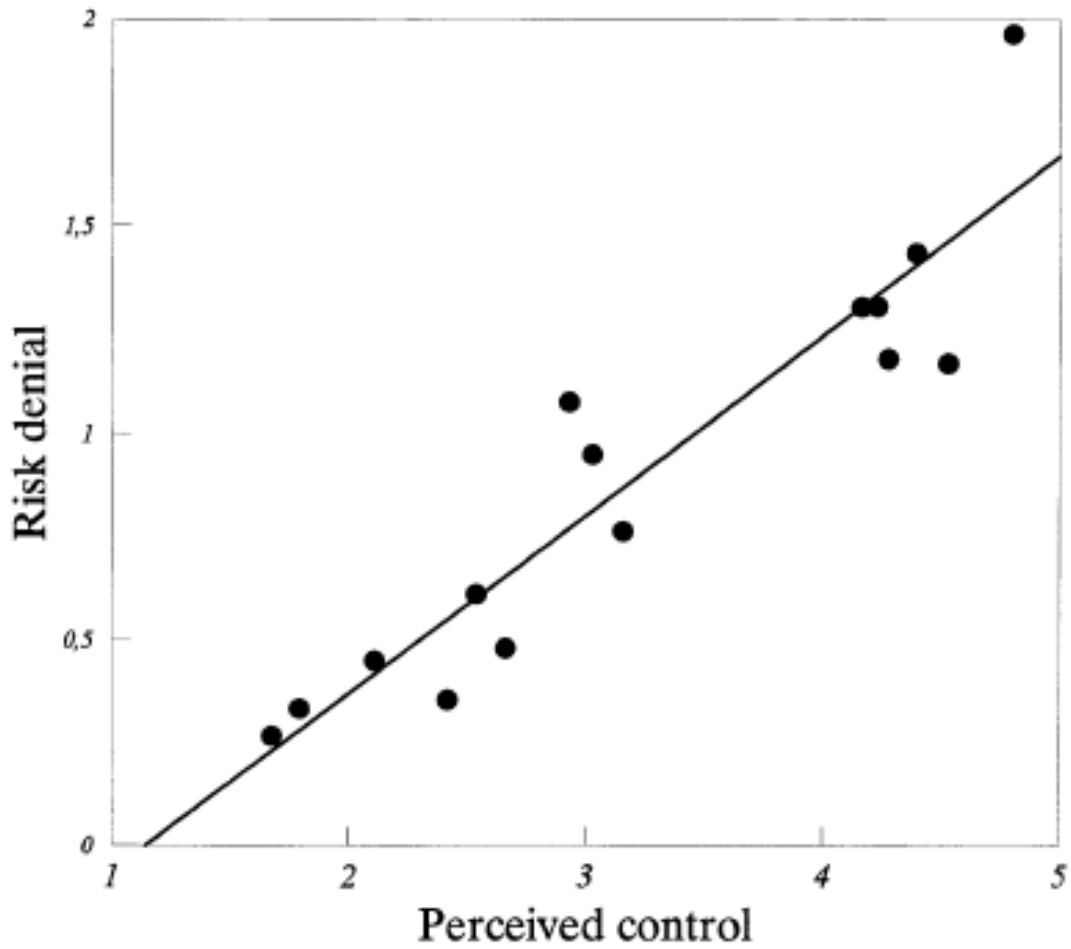
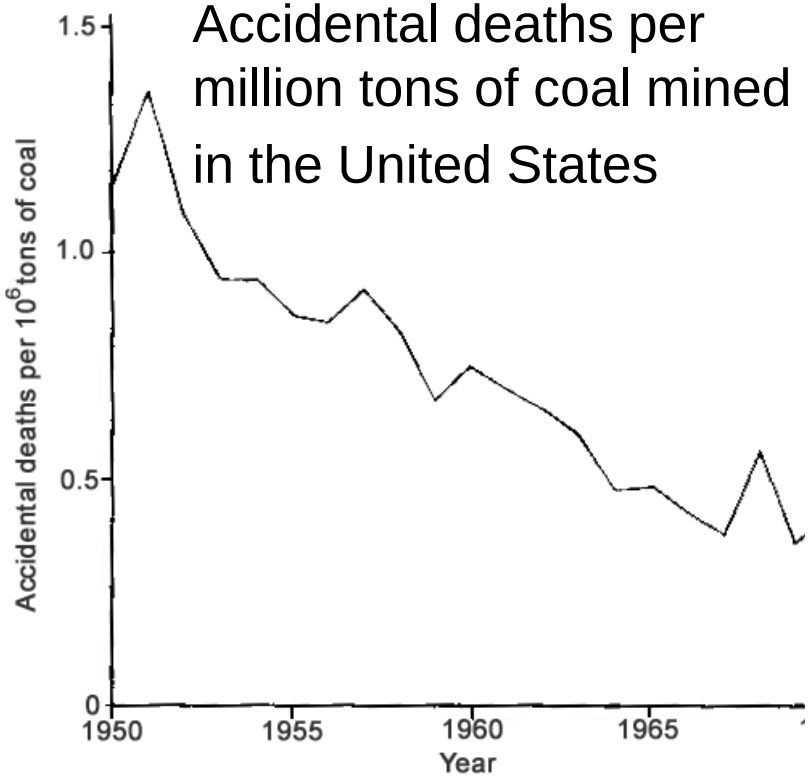


Fig. 2. Risk denial (general minus personal risk) plotted against perceived control over risks. Each point corresponds to one hazard; mean ratings are plotted.

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

How is Risk Defined? Who Decides?

Is coal mining getting safer?



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.

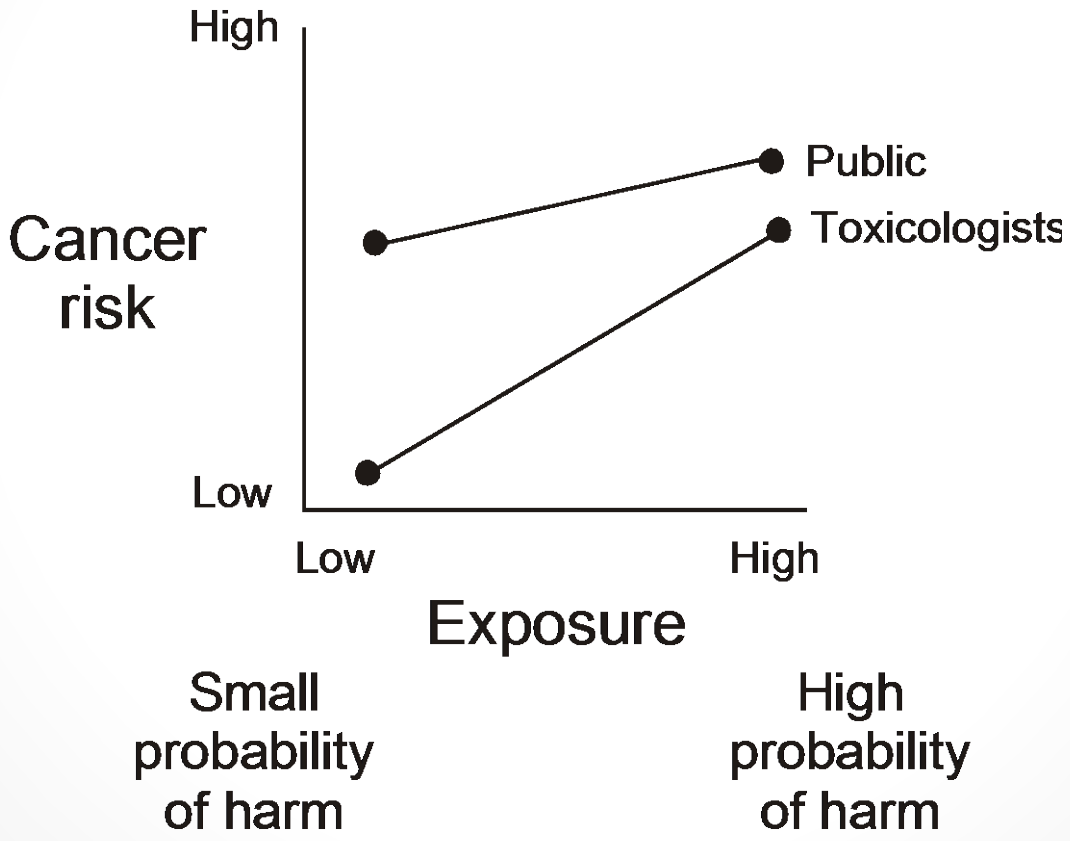
Defining Risk is an Act of *Power*

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.

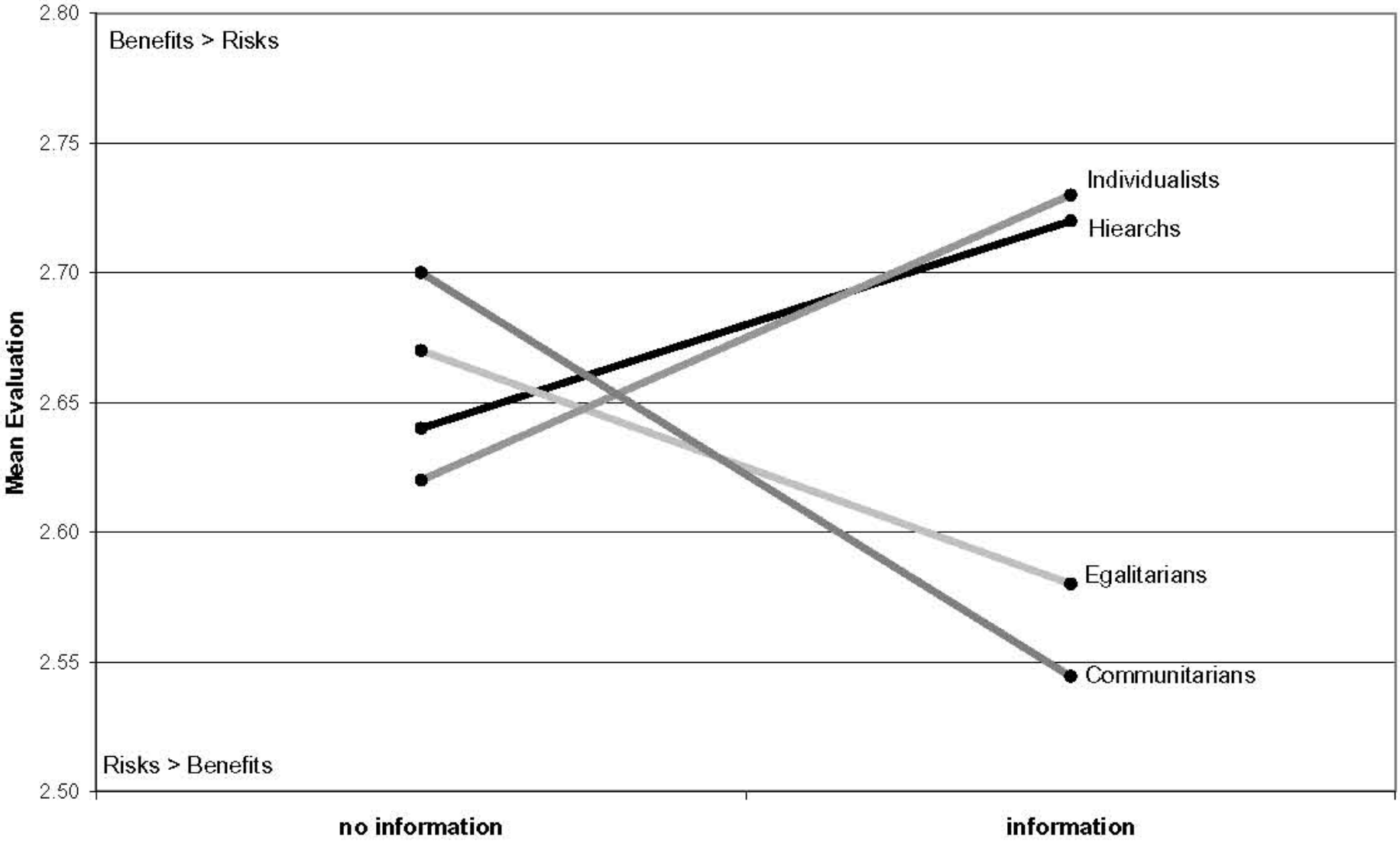
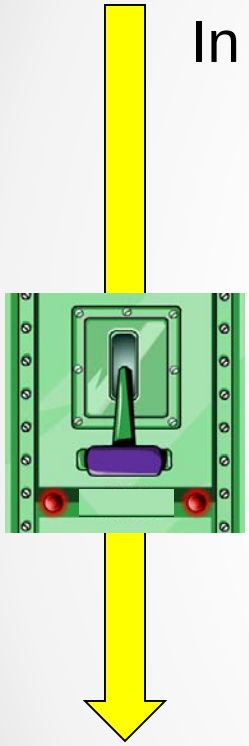


Figure 4. Impact of Information Across Condition by Dimension of Cultural Worldview

Personal 'Outrage Factors'



Lower risk perceived

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

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

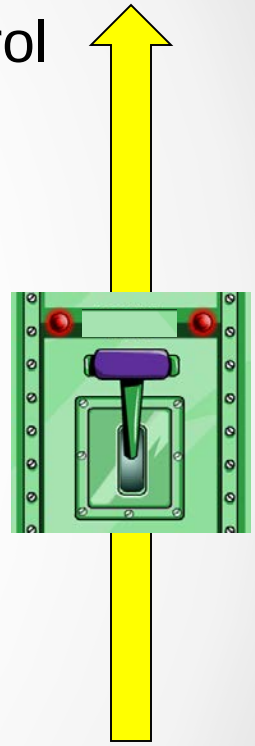
Beneficial ---------- Not beneficial

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

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

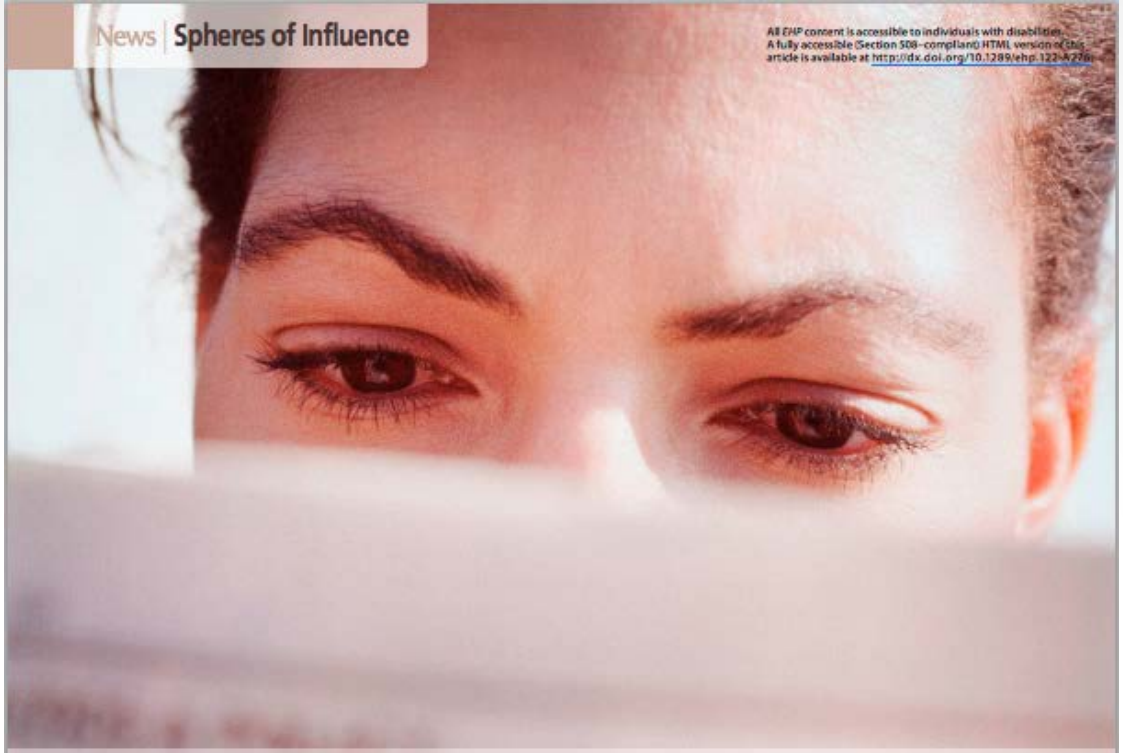
Familiar ---------- Exotic

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



Higher risk perceived

All EHP content is accessible to individuals with disabilities.
A fully accessible (Section 508–compliant) HTML version of this article is available at http://dx.doi.org/10.1289/ehp.122-A276.



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

A Framework for Risk Communication

Why “risk”,

… when people ask about “safety?”

Safety	Risk
Yes or No	More risky----------Less risky
No precautions necessary	Precautions reduce risk
Safe is safe for everyone	Risk is higher for certain people
Easy to explain	Harder to explain

Re-framing the ‘safe’ question

- Listen
- Consider tailored approaches
- Quickly explain why “safe” isn’t the right word or mindset
- Discuss the level of risk and things that affect it

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: _____

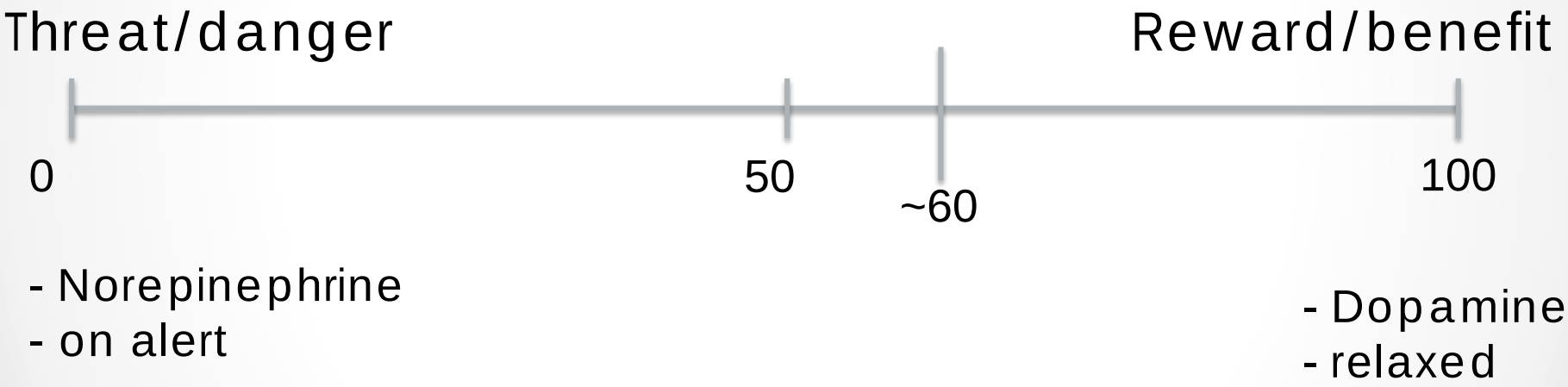
Action items in person's control: _____

Where to get more info: _____

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

- Embarrassment, shame
- Disappointment, anger

Finding the Sweet Spot



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).

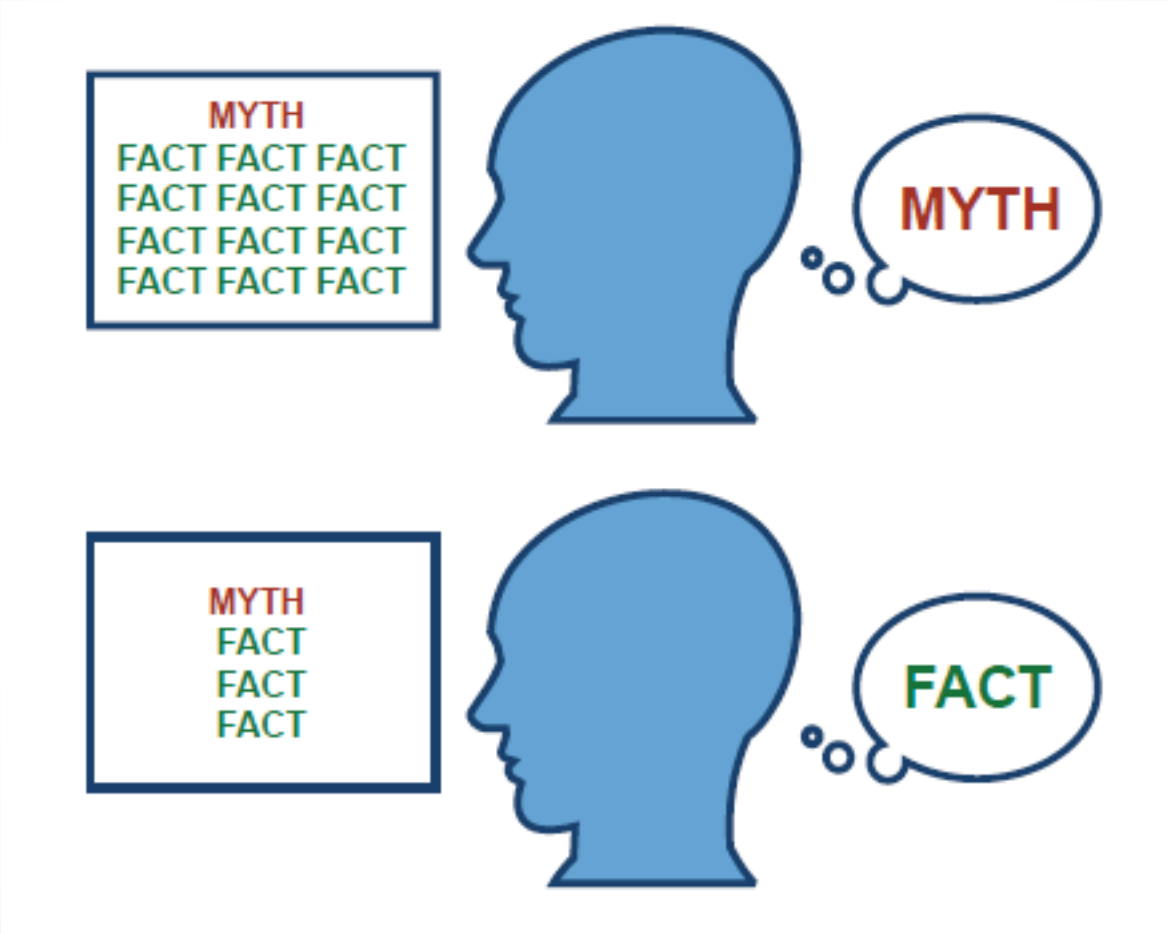
Felt: Share how you felt about something similar.

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

"… Here are some unnecessarily long or ugly words (and replacement words) that many people use a lot:"

utilize – use
currently – now
possess – have
however – but
for the purpose of – for
initiate – start

terminate – end
facilitate – help
interface – meet? Talk to?
relocate – move
retain – keep

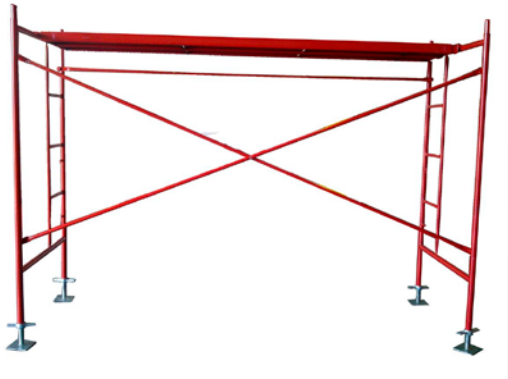


Cook, J., Lewandowsky, S. (2011), *The Debunking Handbook*. St. Lucia, Australia: University of Queensland. November 5. ISBN 978-0-646-56812-6. [http://sks.to/debunk]

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



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: _____

Resources

- National Pesticide Information Center
  - http://npic.orst.edu 1-800-858-7378
- Glyphosate Technical Fact Sheet
  - http://npic.orst.edu/factsheets/archive/glyphotech.html
- Glyphosate General Fact Sheet
  - http://npic.orst.edu/factsheets/glyphogen.html
- PlainLanguage.gov
  - http://www.plainlanguage.gov/
- Debunking Handbook
  - https://www.skepticalscience.com/docs/Debunking_Handbook.pdf
- Book: Risk Communication: A Handbook for Communicating Environmental, Safety, & Health Risks by Regina Lundgren & Andrea McMakin

Glyphosate and Communicating Risk

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