Strategies for risk communication:

Evolution, evidence, experience

W. Troy Tucker, Ph.D.
Applied Biomathematics

15-17 May 2006
Montauk Yacht Club Resort & Marina
Montauk, Long Island, New York

Symposium mechanics

- 12 invited speakers
- 2 invited dinner speakers
- 6 organizers giving short presentations
- 5 organizers acting as discussants
- Continuous poster display
- Plenty of time for questions, dialogue, discussion
  - Everyone attending is an expert on some aspect of risk communication
  - Also some time to get out and enjoy Montauk a little

Evolution, evidence, experience

- Evolutionary social science, evolutionary biology
- Neuroscience
- Standard social science model (SSSM)
- Practitioners

- Not "crisis" communication

Questions

- What risk information are we built to understand?
  - Format, counting, delivery, context, numeracy, mental models
- What is ambiguity avoidance?
  - Ellsberg paradox, fMRI studies, risk-sensitive foraging theory, worst-case presumption, precautionary principle
- Why did communication evolve?
  - Transparency, trust, procedural justice
- What kind of "rationality" have humans evolved?
  - Justice, equity, fairness, control, choice, moralistic aggression
- Dual process or modular, and what role for emotion?

Evolved altruism, strong reciprocity, and perception of risk

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Abstract: Humans have a long history of coping with specific risks. We expect natural selection to have resulted in specific physiological and psychological design elements for responding well to these risks. Why then does it seem so difficult to communicate risk in modern technological societies? Although these failures are often blamed on lay ignorance of technical issues or mistrust of industry or government, we suggest that neither ignorance nor mistrust is fundamentally to blame. Instead, humans seem wired by natural selection to use a mental calculus for reckoning uncertainty and making decisions in the face of risk that can be substantially different from probability theory, propositional calculus (logic), or economic rationality (utility maximization). We argue that this is due to the unique armament of strategies humans have evolved to cope with the risks faced during our long history living as hunter-gatherers. In particular, we believe the risk of social contract violation (not contributing a fair share to cooperative endeavors) was an important selective factor because reciprocity, reciprocal altruism, and cooperation are primary adaptations to the most important risks hunter-gatherers faced. Important selective agents include uncertainty in food acquisition timing and quantity, pathogens, and risks from inter-group competition (including warfare).

Hunting-gathering lifestyle

- Deep time
  - Fully modern: 40 kya
  - Anatomically modern: 150 kya
  - Paleolithic: 1.5 mya
  - 1st tools: 2.5 mya

Pueblo Bonito

875 - 1150 B.P.

- Anthropology of risk
  - Subsistence risk coping strategies
    - Behavioral
    - Physiological
    - Social
    - Institutional
  - Other risks
    - Pathogens
    - Inter-group competition (war)
    - Cooperation failure (free riders)

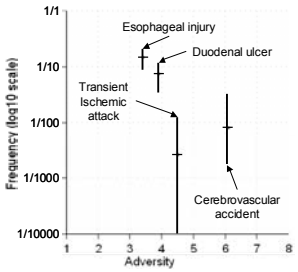
Data from 6 mos. studies

Rofecoxib data from Table 52 6 mos. studies
and from Tables 7 and 14

N	Adverse Reaction	obs	freq	Confidence limits L1	L2	(method)
	Rofecoxib 25					
181	Esophageal injury	18	0.1107	0.0623	0.1591	reported
186	Duodenal ulcer	7	0.0410	0.0112	0.0707	reported
879	Myocardial infarction	2	0.0023	0.0000	0.0052	binomial
879	Coronary artery disease	2	0.0023	0.0000	0.0052	binomial
879	Angina pectoris	3	0.0034	0.0000	0.0052	binomial
879	Transient ischemic attack	3	0.0034	0.0000	0.0052	binomial
	Rofecoxib 50					
176	Esophageal injury	22	0.1416	0.0865	0.1967	reported
178	Duodenal ulcer	12	0.0731	0.0331	0.1130	reported
379	Cerebrovascular accident	3	0.0079	0.0018	0.0317	binomial
379	Transient ischemic attack	1	0.0026	0.0000	0.0121	binomial
	Ibuprofin					
164	Esophageal injury	15	0.1187	0.0613	0.1760	reported
167	Duodenal ulcer	42	0.2769	0.2043	0.3495	reported
377	Angina pectoris	2	0.0053	0.0018	0.0318	binomial
	Placebo					
155	Esophageal injury	10	0.0927	0.0354	0.1500	reported
158	Duodenal ulcer	11	0.0992	0.0412	0.1573	reported
371	Myocardial infarction	2	0.0054	0.0018	0.0321	binomial
371	Unstable angina	1	0.0027	0.0000	0.0124	binomial

These data are from the FDA Vioxx approval web site
http://www.fda.gov/cder/foi/nda/99/021042_52_vioxx.htm
accessed 1/9/2005
Medical reviews parts 7 and 23

Visual display rofecoxib 50mg

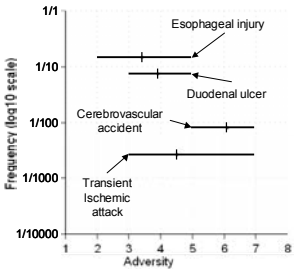


Adversity survey

Adverse Reaction	min	mean	max
Esophageal injury	2.00	3.43	5.00
Duodenal ulcer	3.00	3.86	5.00
Ischemic heart disease	4.00	4.36	5.00
Coronary artery disease	4.00	4.43	6.00
Transient ischemic attack	3.00	4.46	7.00
Angina pectoris	3.00	4.50	6.00
Unstable angina	3.00	5.14	7.00
Coronary artery occulusion	4.00	5.54	7.00
Cerebrovascular accident	5.00	6.07	7.00
Myocardial infarction	5.00	6.07	7.00
Cardiac arrest	6.00	6.64	7.00

Informal poll, n=14, mostly MDs and RNs

Visual display rofecoxib 50mg



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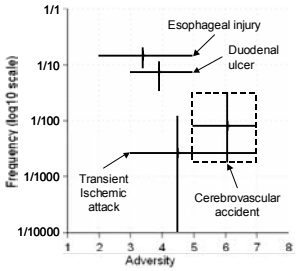

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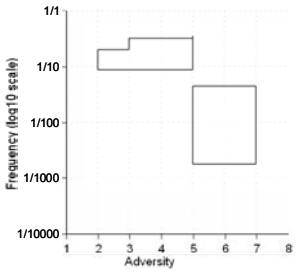

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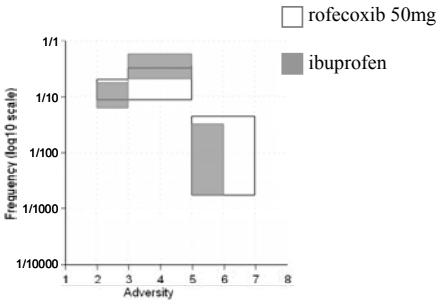


Why is risk communication hard?

Experts often say that lay response to risk is irrational

But sometimes (often) people are good risk calculators

What are people *evolved* to comprehend?

People are *good* risk calculators

When provided with natural frequencies
- 76-92% correct Bayesian reasoning
  (Cosmides & Tooby 1996; Gigerenzer 1991)

When faced with short-term variability
- Foraging, maximizing rewards or minimizing costs
  (Hawkes et al. 1982; Bechara et al. 1997)

When engaged with multiple actors
- Cheater detection, ultimatum game
  (e.g. Cosmides 1989; Guth 1995)

People are *bad* risk calculators

… or often *seem* bad when

1. Presented with percentages, large numbers, or single-event probabilities
2. Experts tell them the risk
3. Presented with incertitude (versus variability)
4. Risk is seen to be imposed
5. Risk is out of personal control
6. Rare events are observed - representativeness
7. When children are at risk
8. etc.

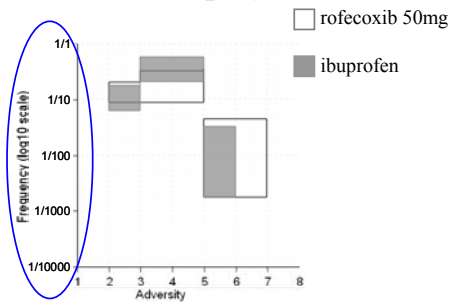
1. Percentages, large numbers, or single-event probabilities

No calculator evolved to take these as inputs

Natural frequencies are the preferred input
- Makes reference class clear
  (Cosmides and Tooby 1996; Gigerenzer 2002)

Mental calculators are frequentist
- Probability of single event is uninterpretable
  (Cosmides and Tooby 1996)

Visual display



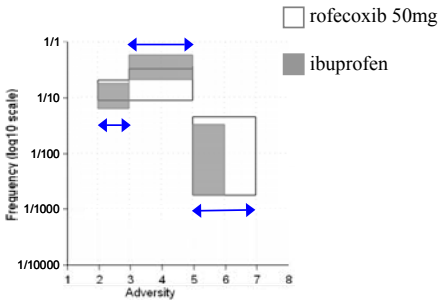
2. When experts tell the risk

Communication: A signal or display meant to produce behavior in the recipient that is beneficial to the sender (Krebs & Davies 1981)

The messenger is more important than the message

- Trust in motive: what's in it for the expert?
- Is the expert on my side? (Earle 2004)
- Trust in competence: are experts wrong?

Visual display



3. When risk is uncertain

…People concentrate on the worst case

- But ignore how unlikely the bad outcome is
  - Precautionary principle

Uncertainty triggers a specific calculator(s)

- ventromedial prefrontal cortex
  - (Glimcher & Rustichini 2004; O'Doherty et al. 2001; c.f. Loewenstein et al. 2003)

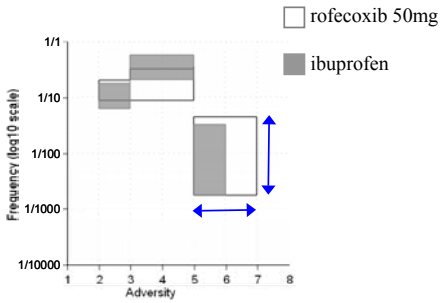
Evolution favors caution in the face of ambiguity

- Death is an absorbing state

Or is "ambiguity" interpreted as high variability?

- Risk-sensitive foraging theory

Visual display



4. When risk is imposed

…People perceive **more** risk

Even when the risk is smaller than voluntary risks

Multiple mental risk calculators perceive risk

Some perceive risk of disease, death, economic cost

Some perceive risk of social contract violation
(e.g. Cosmides 1989, Guth 1995)

Bilateral anterior insula: disgust (e.g. Sanfey et al. 2003)

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    - **Social**
    - Institutional
  - Other risks
    - Pathogens
    - Inter-group competition (war)
    - **Cooperation failure (free riders)**

The problem of altruism

- Hamilton 1964, Haldane – kin-directed altruism
  - Explains social insects, parenting, nepotism
- Trivers 1971, Axelrod & Hamilton 1981
  - How can non-relatives cooperate?
    - Reciprocal altruism
      - 2 problems: how to evolve, how to maintain
      - Evolve is still not well understood
      - Prisoner's dilemma: Tragedy of the commons
      - Maintain - Tit for tat - requires 5 emotions (at least)
        - » Friendship, moralistic aggression, forgiveness, guilt/shame, sympathy/gratitude

Risk of being cheated

- Social contract violation
  - Wason selection task and logic
    - Evidence of cheater detection module: patterned violation of logical deduction
      - Cosmides & Tooby, Gigerenzer & Hug
    - Cheaters looked at longer, remembered better
      - Chiappe, Brown, Dow, Koontz, Rodriguez, & McCulloch 2004; Mealey, Daood, & Krage, 1996; Oda, 1997
    - Neuropsychology - Bilateral limbic system damage to temporal pole and amygdala impairs detection
      - Stone, Cosmides, Tooby, Kroll, & Knight 2002

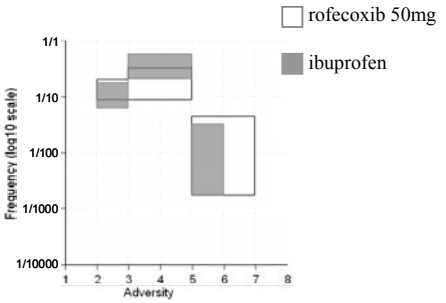
Strong Reciprocity

- Ernst Fehr and Simon Gächter
  - team earns money when all cooperate
  - Punishers (moralistic aggression)
    - Spend money to ensure freeloaders don't prosper
    - Note – this is "irrational".
  - People do pursue own self interest
    - But, definition of "self interest" includes fairness, equity, justice, prudence, generosity, etc.

Strong reciprocity (2)

- Human emotional constitution embraces prosocial and altruistic notions of in-group and out-group identification, and reciprocity
  - A direct result of evolutionary history
    - Gintis 2005, Bowles and Gintis 2003
  - Moral principles are evolved facts in the world
    - Evolved and transformed according to natural laws

Visual display



Visual display

What is justice?

- Socrates' question
  - What is justice?
  - "All of western philosophy a footnote to Plato"
  - Evolutionary theory answers Socrates' question
    - And it's not a part of the footnote - it's truly new
    - Not derivable with armchair 1st principles
      - Easy to show inductively – e.g. strong reciprocity
      - Derives deductively from evolutionary theory

W. Troy Tucker is a human ecologist and anthropologist at Applied Biomathematics. He received a B.A. from the University of Utah and an M.S. and Ph.D. from the University of New Mexico. His research includes a quantitative statistical study of the demography of New Mexican men (supported by a National Science Foundation Graduate Fellowship) and quantitative demographic and ethnographic studies among a hunter-gatherer population in Venezuela, an agricultural village in Tanzania, and swidden agriculturalists in Madagascar. At Applied Biomathematics he has conducted research in risk perception and communication, case studies and methods to test probabilistic deconvolution and probability bounds, and developing and testing methods for the incorporation of human demography into ecological risk analyses. He has several years experience conducting probabilistic human health and ecological risk assessments for a Superfund site in Massachusetts and Connecticut. He is currently studying methods for analyzing epistemic and aleatory uncertainty during the early phases of spacecraft design.