# *Better Decision Making Under Climate Uncertainty:*
# *Lessons from Psychology*

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# "Behavioral science matters"

- Economics and institutional constraints are important design elements for (climate) risk management, but
  - economics, political science, geography not the only useful social sciences
  - risk communication needs to reach human decision makers
  - risk management needs to be embraced and implemented by human decision makers
    - What is special about *human* risk perception and decision making under (climate) risk and uncertainty?
  - *psychology*, *behavioral economics*, and *behavioral game theory* add important insights and risk management process design tools

# Outline

- Uncertainty as barrier to predictability of an action
- Models of how people (actually) deal with uncertainty
  - A. Predicting uncertain events
  - B. Choosing among actions with uncertain outcomes
  - C. Choosing among actions with delayed outcomes
- Multiple processing systems
  - Analytic vs. experiential
- Multiple goals and incentives
- Policy Implication

# Predictability

- Powerful human need and human skill
  - result of evolutionary selection (or intelligent design?)

- Provides control
  - avoid threats to physical and material well-being

- Allows to plan and budget for the future
  - Homo sapiens arguably the most successful species on earth

# Need for Control

- So strong, it can lead to wishful thinking
  - "illusion of control" in situations that are obviously determined by chance
    - superstitious behaviors
    - control, even when illusory, has important health benefits
- Perceived lack of control raises anxiety, individually and socially
  - Inverse u-shaped function for beneficial effect of anxiety
  - Moderate levels motivate behaviors to regain control
    - protective or evasive action
    - mitigation of risk
      - information search, theory building
      - science and technology development
        » Forecast developments for weather, climate, earthquakes, economy, etc.

# Multiple Processing Systems

- Analytic system
  - New evolutionary accomplishment; only available to homo sapiens in full form
  - Effortful, slow, requires conscious awareness, and knowledge of rules
    - e.g., probability calculus, Bayesian updating, formal logic
  - Conscious calculation-based decisions
    - May become habits/rules by virtue of repeated execution

- Experiential system
  - Evolutionarily older, hard-wired, fast, automatic
    - Trial and error learning: Association between behavior and consequences
    - Emphasis on outcomes of decisions (probabilities not explicitly represented)
    - Emotions as a powerful class of associations
      - risk represented as a "feeling" that serves as an "early warning system"
  - Affect-based decisions (fear or worry as motivator for action)
  - Rule-based decisions that get triggered (automatically) by cues in the environment
    - Emergency room procedures, trading floor decisions

# Analytic and Experiential System

- Interact to some extent
  - Emotional reactions as input into analytic processing

- Operate in parallel
  - "Is a whale a fish?"
  - Affective/experiential system is fast, delivers output earlier
  - When output of two systems in conflict, behavior typically determined by experiential processing system

- Discrepancy in output of two systems often accounts for controversies and debates about magnitude and acceptability of risks
  - e.g., nuclear power, genetic engineering
    - Technical experts and academics rely more heavily on analytic processing
    - Politicians, policy makers, end-user stakeholders, and general public rely more heavily on experiential/affective processing

# How do we know about the possible outcomes of different actions?

- In Decisions from Description
  - Outcome distribution fully described
    - possible outcomes and their probabilities provided numerically or graphically
      - seasonal climate forecast for next growing season
      - hurricane warning issued by local TV station
  - Extensive use of analytic processing system
    - rare events are overweighted (Prospect Theory) or ignored

- In Decisions from Experience
  - Outcome distribution initially unknown
    - knowledge of possible outcomes and their likelihood acquired by personal exposure in repeated choices
      - intuitive forecast of climate in next growing season based on years of experience
      - intuitive assessment of likelihood of being affected by hurricane based on past experience with warnings and events
  - Extensive use of experiential processing system
    - recent events get disproportionate weight
    - rare events are underweighted, unless they recently occurred

# A. Predicting uncertain events

- Normative models
  - Probability calculus
  - Bayesian updating and belief revision
- Descriptive reality
  - Phenomena
    - Deterministic/causal/experiential thinking more prevalent than statistical/probabilistic thinking
    - Overconfidence in accuracy of prediction

# Experiential processing to predict uncertain events

- Use of heuristics that utilize stored past experience
  - *Representativeness heuristic*: Similarity to category prototype as indicator of likelihood
    - "What is the probability of having a hot and dry summer?"
    - Answer is based on similarity of current conditions to prototype; base rates get ignored

  - *Availability heuristic:* Ease of recall as indicator of likelihood
    - "How likely will New York City experience a terrorist attack before the 2008 election?"
    - More likely events generally easier to recall, but not all easily-recalled events are very likely
      - emotional impact (psychological risk dimensions of Slovic et al.)
      - recency effects
      - media distortions, overreporting of catastrophic rather than chronic risks

# *Overconfidence in judgments or decisions*

**"There is no likelihood man can ever tap the power of the atom."**
Robert Milikan, Nobel Prize in Physics, 1923

**"Heavier than air  flying machines are impossible."**
Lord Kelvin, President of Royal Science Society, 1895

- Confidence ratings
  - Poor calibration found in most cases
    - Proportion of time a prediction of answer is correct ought to equal the confidence assigned to that estimate
    - Only weather forecasters, bookies, and expert bridge players are well calibrated
      - Due to availability of quick and frequent corrective feedback

- Confidence intervals (CIs) tend to be too narrow
  - 95% CIs are closer to 50% CIs
    - E.g., for general knowledge questions
      - Length of Nile river?
  - engineering discount/safety factors are social acknowledgment of systemic overconfidence

# Overconfidence in Science
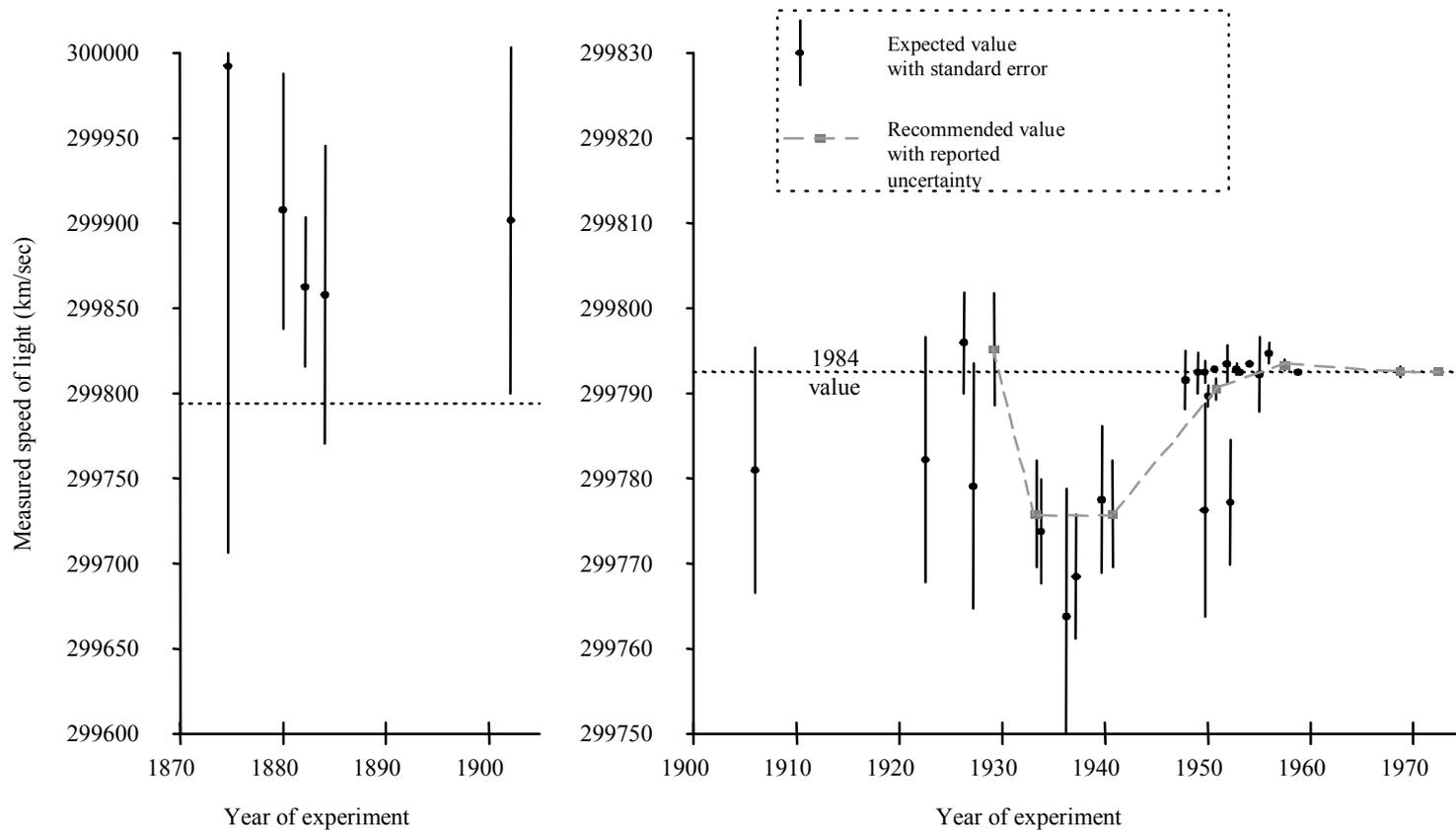


Henrion & Fischhoff (1986)

# Reasons for Overconfidence

- **Attentional**
  - Selective information and memory search
    - Difficult to know what we don't know
    - Confirmation bias
    - Implications for veridicality of personal recollections of climate information
- **Motivational**
  - Need to appear competent and confident to others and oneself
  - Confidence and optimism help to get the job done

# B. Choosing among actions with uncertain outcomes

- Normative models
  - Expected utility theory
    - Outcomes of actions as random variables
    - Outcomes transformed into subjective value/utility
    - Shape of utility function as measure of risk aversion/seeking

  - Risk-return models
    - Using moments of outcome distributions
      - EV and Variance
    - Decision as tradeoff between greed and fear
      - Capital Asset Pricing Model
        - WTP(X) = EV(X)-bVar(X)
        - Willingness to Pay for Option X involves a tradeoff between Return (EV) and Risk (Var)

- **Descriptive Modifications**
  - Expected utility theory → Prospect theory
    - Psychological extension of expected utility theory
      - by Kahneman and Tversky (1979)
    - Value Function:
      - Defined over gains and losses on deviations from reference point
      - Concave for gains (risk-averse), convex for losses (risk-seeking)
      - Steeper for losses than for gains ("losses loom larger")

  - Variance-EV models→ Psychological Risk-Return Models
    - WTP(X) = a Perceived Benefits(X) – b Perceived Risk(X)
    - Variance of outcomes does not describe how people perceive the risk of risky options
      - Upside and downside variability do not enter symmetrically; downside gets greater weight
    - Variability and risk often perceived in a relative fashion
      - in very basic psychophysical judgments like perceived loudness or brightness (Weber's law, 1834)
      - *coefficient of variation* (CV) a measure of relative risk: risk per unit of return
        - » defined as standard deviation / expected value

# C. Choosing among actions with delayed outcomes

- Same framework as for decisions under risk
  - Integrate/aggregate over all possible outcomes of a choice option, but also discount outcomes based on their time delay

- Normative models
  - Discounted utility theory
    - Utility of outcome x (u(x)) is discounted as a function of its time delay
    - Constant discount rate for all time periods (exponential discounting)
    - Interest rate on financial deposits a reasonable standard

# Intertemporal Choice Stylized Facts

- People are impatient
  - Discount "too much"
  - Implicit discount rate far greater than interest rate
- Discount rates are inconsistent over time
  - People especially dislike delays that prevent immediate consumption
  - Delays on existing delays less consequential
    - Captured by hyperbolic discounting, where initially very high discount rate levels off with time delay

# Multiple Goals and Incentives

- Multiattribute utility theory is normative model
  - allows decision makers to make tradeoffs between multiple outcome dimensions in ways that can satisfy multiple goals

- Deviations from normative model
  - People dislike tradeoffs (we "want it all")
  - Use noncompensatory choice processes
    - Decision rules used that avoid the realization of goal conflict
    - Editing out of elements that remind us of goal conflicts
  - Goal space broader than assumed by traditional economic view of human nature
    - Includes social goals not just selfish goals of homo economicus
    - Includes process goals as well as material goals

# Economic and Other Incentives

- Common-pool resource dilemmas ("tragedy of the commons") are serious, but situation not as hopeless as envisioned by Hardin
  - Communication and trust play a major role
    - Most interactions seen as repeated games
    - Communication is seen as binding and not just "cheap talk"
  - Cooperation can be facilitated by appealing to social identity of people
    - Social affiliation and social approval are powerful human needs
    - Priming of social goals by the way situations are described or "framed" often more effective, "cheaper," and more feasible than the modification of economic incentives

# Policy Implications

- How to get stakeholders (public officials, members of the general public) to pay attention to climate change and variability?
  - Analytic appeals not very effective
    - Contrary to personal experience of climate change in many regions of the worlds
    - Mitigative and adaptive actions often require immediate costs/sacrifices/losses to achieve time-delayed benefits/gains
      - Both hyperbolic discounting and loss aversion argue against taking such actions
  - Is there wisdom in designing more emotional appeals, i.e., in inducing people to worry more about climate change and variability?
    - Could be done by
      - visualization or graphic description of catastrophic climate change
      - concretizing future changes in simulations of conditions in local environments

# Caveats

- Finite Pool of Worry
  - Increases in worry about one hazard may result in decrease in worry about other hazards
    - Found in Argentine farmers with climate risks and political risks (Hansen, Marx, Weber, 2004)

- Single Action Bias
  - Tendency to engage in only a single corrective action to remove perceived threat of a hazard (single action removes "hazard flag"), even when portfolio of responses is clearly advantageous
    - Radiologist: detect single abnormality, miss others
    - US Midwestern farmers: engaged in single adaptation to climate change (*either* production practice, pricing practice, or endorsement of government intervention) (Weber, 1997)
    - Argentina Pampas farmers: less likely to use irrigation or use crop insurance if they had capacity to store grain on their farms (Hansen, Marx, Weber, 2004)
  - Reactions on multiple fronts may require more analytic response to situation

# Risk Communication and Management Challenges and Implications

- How to use people's experiential and affective processing and their aversion to uncertainty constructively?
  - Help people plan for uncertainties
    - Scenario analysis provides good match to nonprobabilistic information processing of experiential system
      - Worst case, best case, most likely case scenarios
    - Contingency plans, especially for worrisome worst and bad case scenarios
      - Real benefits
        - » Increased response speed; better responses
      - Psychological benefits
        - » Perceived preparedness reduces anxiety

# Conclusions

- Probabilistic nature of climate (change) forecasts
  - Liability
    - In the absence of clear action implications (that allow a feeling of control), awareness of climate risk may arouse too much anxiety
      - Gets edited out, i.e., treated as being effectively zero, resulting in procrastination and decision avoidance
    - Strategic use of uncertainty to justify decisions that are desired for other reasons (hidden agendas)
  - Opportunity
    - "Uncertainty is not the enemy"
    - Range of outcomes as natural impetus for contingency planning
    - Development of forecast formats that take into consideration human information processing modes and constraints can minimize liabilities and maximize opportunities

# Conclusions – cont'd

- Consider the combination of analytic and experiential/emotional processes
  - to facilitate correct interpretation of climate forecasts
  - to motivate forecast usage and adaptive risk management actions
- Tailor forecast formats and risk management process to different segments of users
  - Amount and sophistication of analytic processing a key variable, but time horizon and incentives/goals also differ
  - For most users, it will pay to
    - Elicit optimal level of worry/concern
      - Development of envisioning tools to concretize the (temporally and spatially distant) impacts of climate change
    - Concretize statistical uncertainty measures
      - Localize forecasts
      - Provide analogies to previously experienced situations
      - Discretize the distribution of different futures
        - » Best case, most likely case, worst case, likelihood of extreme events
    - Provide accurate degree of confidence in forecasts

# Conclusions – cont'd

- Actions and choices can be influenced by strategic use of "framing"
  - Description of situation in ways that prime cross-group commonalities, social goals, and cooperation vs. differences, selfish goals, and competition
  - Choice of reference points that depict alternatives as involving gains or losses, depending on desired response
    - Risk seeking in the domain of losses, risk aversion for gains
    - Protective or mitigative actions can be seen as either involving costs and losses or benefits and opportunities
      - Both perceptions are true, but attentional focus induced by problem description often determines responses

# "Social science matters"

- In addition to economic and institutional constraints, constraints on human cognition and motivation need to be considered to design of effective risk communication and risk management processes

- Knowledge about human capabilities and constraints can provide useful tools

- Ignoring such knowledge leaves many problems seemingly more intractable than they have to be