

Explanations as Indicators of Expertise

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Global Cognition


Assessing Expertise

- ▶ Often want to know which of several experts to trust (most)
 - Select for consultation
 - Weighting opinions
- ▶ Can we use explanations to assess the cognitive competence or expertise of a judge for a particular forecast problem?

Explanations and Expertise

- ▶ Approach requires us to determine explanation quality

What is a good explanation?

- ▶ Review cognitive science literature addressing the issue
 - ▶ Attempt to determine components to incorporate in scoring rules
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Physical Domain: Internet Inquiry Study

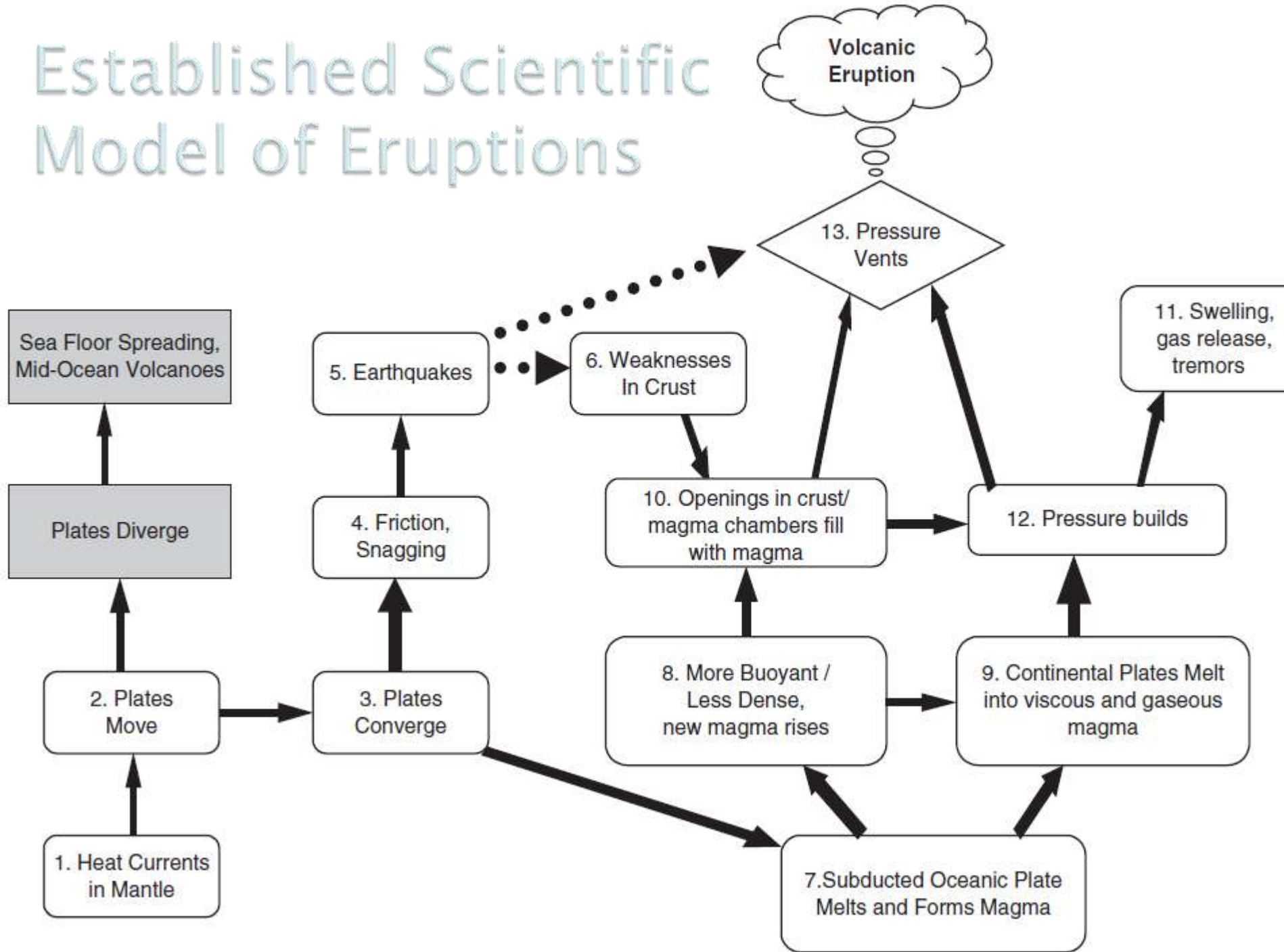
- ▶ Cognitive science of instruction
- ▶ Students given 1 hour to read Internet sources about volcanoes
- ▶ Aim to write report on what caused the eruption of Mt. St. Helens
- ▶ Coding and scoring of essays indicator of (acquired) knowledge on the topic

Wiley, J. et al (2009). Source evaluation, comprehension, and learning in internet science inquiry tasks. *Am Ed Res Journal*

Scoring Explanations of Volcano Eruptions

- ▶ *Type 0: Incorrect, superficial models*
 - Explanations of the cause of volcanoes that were related to irrelevant surface features of the earth
 - Did not include any of the major known causal agents: heat, movement, or pressure
- ▶ *Type 1: Local models*
 - Explanations mentioned one (and only one) of three local causes
- ▶ *Type 2: Mixed models*
 - multiple correct factors were mentioned but not causally related to one another
- ▶ *Type 3: Integrated models*
 - An explanation that involved both the notions of heat or pressure and plate movement and the causal relation between them

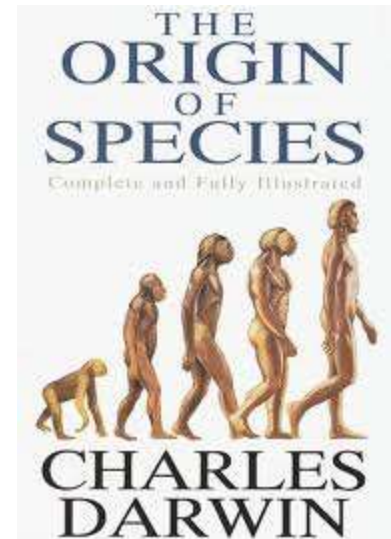
Established Scientific Model of Eruptions



Lessons from the Advancement of Scientific Theories

- ▶ Philosophy of science
- ▶ Which scientific hypothesis, or theory provides the best explanation?

It can hardly be supposed that a false theory would explain, in so satisfactory a manner as does the theory of natural selection, the several large classes of facts above specified. It has recently been objected that this is an unsafe method of arguing; but it is a method used in judging of the common events of life, and has often been used by the greatest natural philosophers.
(Darwin)



Explanatory Coherence

- ▶ What are the criteria scientists use to determine the best scientific explanation? (Thagard, 1978; 1989)
- ▶ **Consilience** : How much a theory explains; use to tell whether one theory explains *more* of the evidence than another.
- ▶ **Simplicity**: Simplicity puts a constraint on consilience; a *simple* consilient theory not only must explain a range of facts; it must explain those facts without making a host of assumptions with narrow application.
- **Analogy**: The explanations afforded by a theory are better if it introduces mechanisms, entities, or concepts that are used in established explanations.

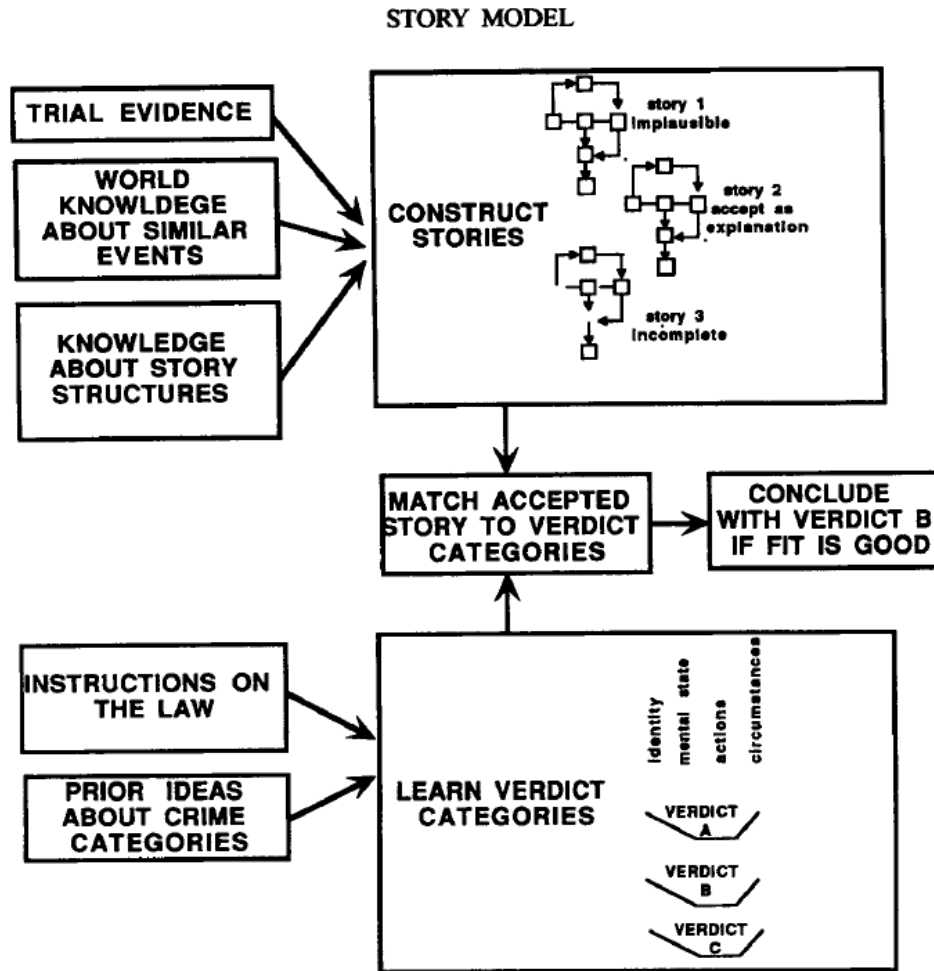
Thagard, P. (1989). Explanatory Coherence. *Beh & Brain Sci.*

Explanation Relevance

- ▶ Are novices more easily swayed by “seductive details”?
- ▶ Study examined extent to which irrelevant neuroscience information in an explanation of a psychological phenomenon interferes with people’s abilities to critically consider the underlying logic of this explanation.
- ▶ Result:
 - Nonexpert participants judged that explanations with logically irrelevant neuroscience information were more satisfying than explanations without.
 - Experts spotted the irrelevance


Weisberg et al (2009). Seductive allure of neuroscience explanations. *Journal of Cognitive Neuroscience*.

Explanation-Based Decisions



Pennington & Hastie (1988). Explanation-based decision making. JEP:LMC.

EBD: Explanation Properties

- ▶ Coverage: extent to which story accounts for evidence
 - ▶ Coherence has 3 components:
 1. Completeness – extent to which story has all its parts
 2. Consistency – extent to which contradictions are absent
 3. Plausibility – extent to which story sequences match known or imagined events in real world
 - ▶ Uniqueness: the only coherent story
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Explanations, Culture, and Confidence

- ▶ Test proposals for cultural differences in overconfidence
 - Americans, Chinese, Japanese
 - Do distinct reasoning styles account for the differences in observed overconfidence?
- ▶ Think-aloud method: Attempt to get a direct look at reasoning (explanation) process

Yates, J. F. et al. (2010). Indecisiveness and culture: Incidence, values, and thoroughness. *Journal of Cross-Cultural Psychology*

General Knowledge Question

For which is the average gestation period longer?

(a) Humans, or

(b) Chimpanzees

Choice (circle one): (a) (b)

What is the probability (50%–100%) that your chosen answer is correct?:_____ %

Overconfidence (OC)

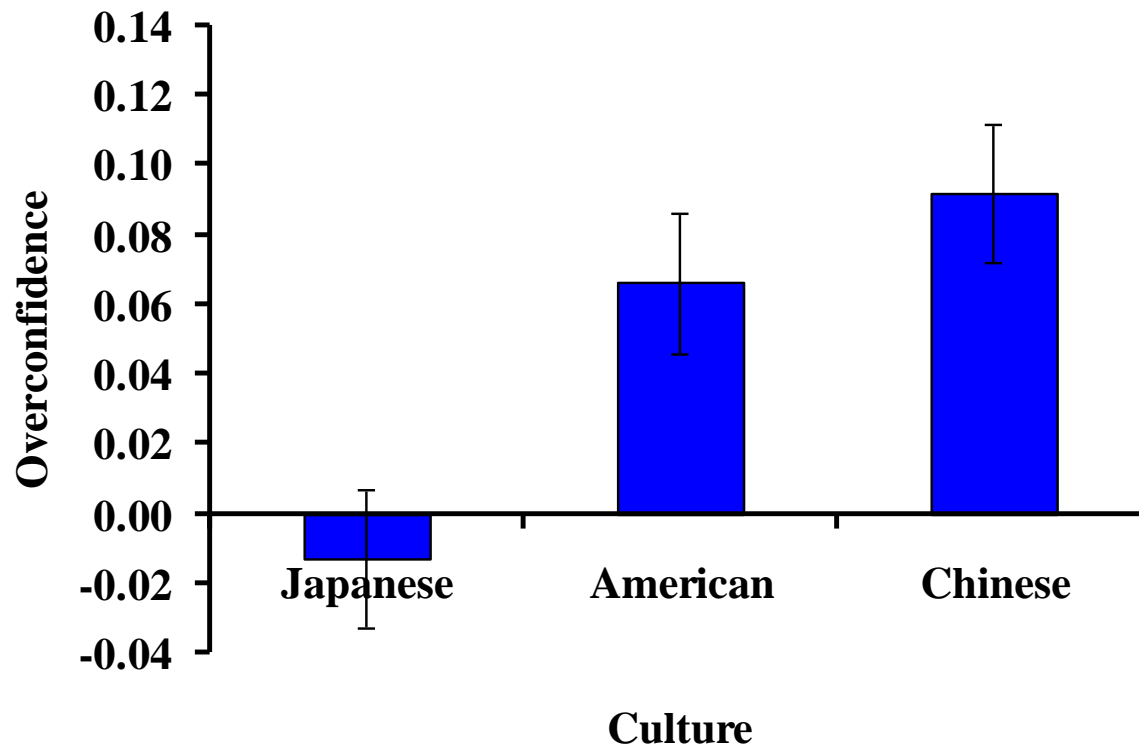
Mean $P'(\text{Correct}) > \text{Prop}(\text{Actually Correct})$

Equivalently:

$OC > 0$, where

$OC = \text{Mean } P'(\text{Correct}) -$
 $\text{Prop}(\text{Actually Correct})$

Results: Overconfidence



Think Aloud: Protocols

- ▶ Representative Chinese protocols
 - Participant 5: *“Question: For which of the following is the gestation period longer? It’s (a) humans. That’s what I learned from my biology class. The probability is about 90%.”*
 - Participant 8: *“For which is the average gestation period longer, (a) humans or (b) chimpanzees? I choose (b) chimpanzees, and the probability is 50%. I am guessing.”*

Think Aloud: Protocols

- ▶ Representative American protocol:
 - Participant 1: *“For which is the average gestation period longer, humans or chimpanzees? Well, relatively, I know humans have a long gestation period compared to most animals, but I don’t know what, what it is for chimpanzees, but for some reason I think it’s longer than humans, but wait, now I don’t know. I know I’ve read it somewhere, but I can’t remember where. Um, I guess I’ll go with chimpanzees, I guess. Just because I have a feeling that I read it or something, so I’ll put sixty percent.”*

Think Aloud: Protocols

- ▶ Representative Japanese protocol:
 - Participant 1: *“For which is the average gestation period longer?: (a) humans, (b) chimpanzees. In the case of humans, I have heard that it takes ten months and ten days. It is about 300 days. I don’t know what to say about chimpanzees. I feel that the gestation period of the two alternatives will be roughly the same because humans and chimpanzees are similar.”* (Continued)

Think Aloud: Protocols

- ▶ Representative Japanese protocol, cont'd:
 - Participant 1, cont'd: *“The mammals stand on the last stage of evolution from reptiles or amphibians, and I think it is because they chose a safer way of rearing their babies in their bodies, not in eggs. Humans seem to be higher animals than chimpanzees, so I feel the gestation period of humans is longer than chimpanzees. As humans and chimpanzees are similar species, there may be a slight possibility that ‘chimpanzees’ is the correct answer. So the probability is 50%.”*

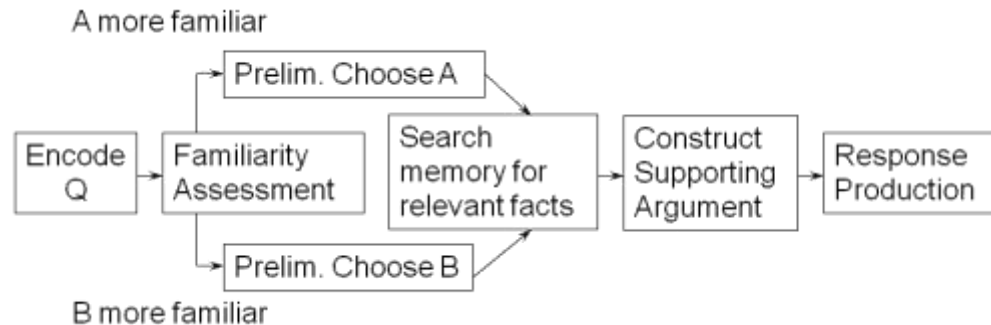
Coding Explanations in Protocols

- ▶ Concept of good explanations:
Thoroughness
 - large amounts of diverse information required before choosing particular decision alternatives
- ▶ Measures:
 - Number of “idea units”: distinct propositions
 - Balance of reasons for/against each option
 - Proportion of arguments for chosen alternative

Results: Process measures

<i>Measure (per item)</i>	<i>Nationality</i>		
	<i>Japanese</i>	<i>American</i>	<i>Chinese</i>
<i># Idea Units</i>	7.53	4.47	3.33
<i>Time (sec)</i>	91.7	25.5	26.8
<i>Pr(Args for alternative)</i>	0.11	0.04	0

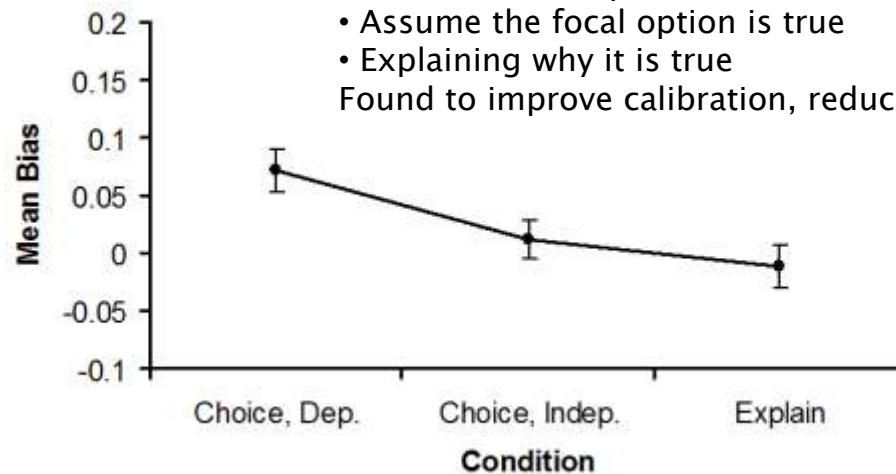
Assess, Search, and Construct (ASC) Model



Choice based on fast familiarity leads to **option fixation**.
 Subjective probability depends on **success of memory search** and **coherence of argument** for why the preliminary choice is true

“Independent Explanations” Procedure:

- Consider each option alone
 - Assume the focal option is true
 - Explaining why it is true
- Found to improve calibration, reduce bias



Sieck, et al. (2007).
 Option fixation: A cognitive contributor to overconfidence.
OBHDP

Foxes vs. Hedgehogs

- ▶ Tetlock on thinking styles: Fox vs. Hedgehog
 - Thinking styles rather than content of beliefs
 - *Hedgehog*: knows one big thing and tries to explain as much as possible within that conceptual framework
 - *Fox*: knows many small things, and improvises explanations on a case-by-case basis
- ▶ Tetlock had forecasters explain their predictions:
 - Used as indicator of Fox or Hedgehog thinking style
 - Why are you, on balance, optimistic, pessimistic, or mixed in your assessment of the future of x ?

Tetlock, P. (2005). *Expert Political Judgment*. Princeton University Press.

Fox/Hedgehog Explanations

- ▶ Analyzed the explanations in terms of two properties:
 - Evaluative differentiation:
 - Extent to which thoughts are in tension with one another
 - How often people use qualifying conjunctions such as “however,” “but,” etc.
 - Conceptual integration:
 - Extent to which people attempt to resolve the tensions
 - How often people grapple with trade-offs, acknowledge different views of same problem, etc.
- ▶ Two measures combined into “integrative complexity”

Fox/Hedgehog Results

- ▶ Hedgehogs and foxes
 - Do not differ in the total number of thoughts they generate; suggests similar knowledge-levels
 - Evaluative differentiation and cognitive integration more associated with fox thinking style
- ▶ Integrative complexity correlated with forecasting accuracy:
 - Correlation with Calibration = .34
 - Correlation with Discrimination = .24

Education	Philosophy	DM	Confidence	Forecasting
Number of correct factors		Completeness Plausibility	Number of ideas, reasons	
Number of causal relations		Completeness Plausibility		
		Consistency: (-) internal contradictions Uniqueness	Balance: (+) internal contradictions	Integrative complexity
	Consilience	Coverage		
	Simplicity			
	Analogy			

Possible Scheme for Scoring Expert Explanations for Forecasts

- ▶ **Completeness:**
 - ↑ Supporting factors, causal relations, analogies
- ▶ **Balance:**
 - ↑ Inconsistent (“minority”) factors
- ▶ **Simplicity in assumptions:**
 - ↓ Necessary contingencies (“ifs”)
- ▶ **Plausibility:**
 - ↓ Known false facts → *external checks required*
 - ↓ Explicit statements of lack of knowledge (“guessing”)

Conclusions

- ▶ Gauging the quality of explanations for social and political forecasts may help select experts or assign weights to judgments
 - ▶ It may be possible to determine the relative quality of expert thinking by examining structural characteristics of their explanations
 - ▶ The candidate explanation scoring rules described here require testing
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