According to a possibly apocryphal story, an eminent philosopher of science once encountered a noted decision theorist in a hallway at their university. The decision theorist was pacing up and down, muttering “What shall I do? What shall I do?”

“What’s the matter, Howard?” asked the philosopher.

Replied the decision theorist: “It’s horrible, Ernest - I’ve got an offer from Harvard and I don’t know whether to accept it. “

“Why Howard, “ reacted the philosopher, “you’re one of the world’s great experts on decision making. Why don’t you just work out the decision tree, calculate the probabilities and expected outcomes, and determine which choice maximizes your expected utility?”

With annoyance, the other replied: “Come on, Ernest. This is serious.”

- (Thagard & Millgram, 1997)

1. **VISIONS OF RATIONALITY (TOUT COURT)**

Figure 1 - (from Todd & Gigerenzer, 2001)

n.b: “demons” refer to hyperrational, omniscient agents.

2. **VISIONS OF BOUNDED RATIONALITY**

From Ockham’s razor to Simon’s scissors

*Human rational behavior (...) is shaped by a scissors whose two blades are the structure of task environments and the computational capabilities of the actor. (Simon, 1990, p. 7)*
These two blades – the two sources of bounds on our rationality – must fit together closely for rationality to cut (Todd & Gigerenzer, 2003, p. 144).

The “half-empty” perspective:

1) optimization under constraints
2) human irrationality (Tversky-Kahneman)
   - “people lack the correct programs for many important judgmental tasks” (Slovic et al., 1976, p. 174)

The “half-full” perspective:

3) ecological rationality: the mutual fit of minds and environments

The principle of ‘ecological rationality’ holds that cognitive mechanisms are best understood as fitting the demands and structure of particular environmental niches, as opposed to the classical view of cognition approximating a ‘Laplacean superintelligence’ for achieving “general purpose, optimal performance in any situation” (Bullock & Todd, 1999, p. 3). An implication of ecological rationality is that cognitive mechanisms operating outside of their proper niche may deliver irrational behaviour, in much the same way that a fish out of water is disadvantaged with respect to breathing - (Seth, 2002)

- **Ecological** rationality: mind-environment fit
- **Social** rationality: mind-society (norms, social emotions, rules, custom, etc.).
- **Evolutionary** rationality: adapted mind-EEA (Environment of Evolutionary Adaptation)

Adaptive Behavior and Cognition (ABC) research group: (Chase et al., 1998; Gigerenzer, 2000; Gigerenzer, 2002, 2007; Gigerenzer & Engel, 2006; Gigerenzer & Selten, 2001; Gigerenzer et al., 1999; Kurz-Milcke & Gigerenzer, 2004; Smith, 2003)

**The beginning of Ecological Rationality: frequencies vs. subjective probabilities**

Chase et al. 1998: When problems are presented in (B) frequentist format (how many?), results are better than when problems are presented in (A) subjectivist format (what is the probability that?). Frequencies are more ecological.

| (A) The probability of breast cancer is 1% for a woman at age 40 who participates in routine screening. If a woman has breast cancer, the probability is 80% that she will have a positive mammography. If a woman does not have breast cancer, the probability is 9.6% that she will also have a positive mammography. A woman in this age group had a positive mammography in a routine screening. What is the probability that she actually has breast cancer? (Answer: ___ %) |
| (B) Ten out of every 1000 women at age 40 who participate in routine screening have breast cancer. Eight out of these ten women with breast cancer will get a positive mammography. Of the 990 women without breast cancer, 95 will also get a positive mammography. Here is a new representative sample of women at age 40 who got a positive mammography in routine screening. How many of these women do you expect actually to have breast cancer? (Answer: ___ out of ___) |
3. VISIONS OF ECOLOGICAL RATIONALITY

*In this world, nothing is certain but death and taxes*
- Benjamin Franklin, 1789

**Example (from Todd & Gigerenzer, 2001)**

A man is rushed to a hospital in the throes of a heart attack. Two ways of deciding if he is high-risk or low-risk:

A) look at the results of each of the many measurements that are taken when a heart attack patient is admitted, rank them according to their importance, and combine them somehow into a final conclusion

B) Simple decision tree in (Brieman et al., 1993) to classify heart attack patients according to risk using only a maximum of three variables

B is fast, frugal (3 yes-no questions) and effective ("more accurate in classifying heart attack patients according to risk status than are some rather complex statistical classification methods").
Assumptions

- Ecologically rational = “making good decisions with mental mechanisms whose internal structure can exploit the external information structures available in the environment” (Todd & Gigerenzer, 2003, p. 144)
- Mechanistic approach: algorithmic procedures
- Cognitive mechanisms tailored for environment
- Beyond the “limited” view: external bounds (cost) + internal bounds (computational limits)
- Ideal Rational Agent may not be a good approximation
- Irrationality may come from a maladaptive environment
- New normative project: evaluation of effectiveness of procedures
- “Situated rationality”: the norms are not abstract, a priori, rules, but “fast and frugal heuristics” that work well in certain environments. Environment may be loaded with cues

Building blocks: what F&F heuristics are made of

Search – stop – decision

Search: gather information about the problem and its solution(s)

Stop: information gathering must stop in order to be effective (Simon’s aspiration levels)

Decision: simple decision strategies

Adaptive toolbox: “specialized cognitive mechanisms that evolution and learning has built into the human mind” (149)

Mechanistic explanation

Building blocks → Heuristics → Adaptive toolbox

Figure 4 - CBE (Categorization By Elimination, (Berretty et al., 1997)
4. **4 CLASSES OF HEURISTICS**

1) **Ignorance-based decision-making**

*Recognition heuristics* “If one of two objects is recognized and the other is not, then infer that the recognized object has the higher value with respect to the criterion” (Goldstein & Gigerenzer, 2002, p. 76)

Ex: which one is larger: Munich or Dortmund? San Diego or San Antonio?

The size of a city is correlated with its exposition in media (Goldstein & Gigerenzer 2002). Thus guessing that the know is larger than the unkow is ecologically rational.

2) **One-reason decision-making**

*TakeTheBest*: decision is based on the first criterion that discriminates between the alternatives. → see market experiments (Borges et al., 1999): http://www.sciencenews.org/pages/sn_arc99/5_29_99/bob2.htm

In 1996–1997, « the simple ignorance-driven recognition heuristic beat highly trained fund managers using all the information available to them »

3) **Elimination heuristics**

Narrowing down the possibilities with cues (see CBE)

4) **Satisficing heuristics**

Fix an aspiration level, and stop when you reach it

5. **F&F HEURISTICS AGAINST LOGIC AND PROBABILITY**

- Multiple *coherence* criteria vs multiple *correspondence* criteria (real-world decision performance): the models are *empirically*, not *formally* tested.
- F&F algorithms have been tested on data sets and either outperforms standard algorithms or equals them.
- “less-is-more”: limited working memory capacity forces people to rely on small samples of information drawn from real-world environments or long-term memory. advantage: they can increase the chance of detecting a correlation in population;
constraints of the developing brain are a necessary hindrance for a first language to be learned fluently.

- Thus bounded rationality may have evolve not as a by-product of limited cognitive capacities, but as an adaptive strategy.

Other examples: (Gigerenzer, 2004)

| Is a phenomenon due to a biased mind . . . | . . . or to an environmental structure plus an unbiased mind?
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Overconfidence bias (defined as miscalibration)</td>
<td>“Miscalibration” can be deduced from a unbiased mind in an environment with substantial unsystematic error, causing regression toward the mean (Dawes &amp; Mulsford 1996; Erev et al. 1994)</td>
</tr>
<tr>
<td>Overconfidence bias (defined as mean confidence minus proportion correct)</td>
<td>“Overconfidence bias” can be deduced from an unbiased mind in an environment with unrepresentative sampling of questions; this disappears largely with random sampling (Juslin et al. 2000)</td>
</tr>
<tr>
<td>Hard–easy effect</td>
<td>“Hard–easy effect” can be deduced from an unbiased mind in an environment with unsystematic error, causing regression toward the mean (Juslin et al. 2000)</td>
</tr>
<tr>
<td>Overestimation of low risks and underestimation of high risks</td>
<td>This classical phenomenon can be deduced from an unbiased mind in an environment with unsystematic error, causing regression toward the mean (Gigerenzer &amp; Fiedler 2003)</td>
</tr>
<tr>
<td>Contingency illusion (based on prior beliefs or prejudices)</td>
<td>“Contingency illusion” can be deduced from an unbiased mind performing significance tests on samples with unequal sizes, such as minorities and majorities (Fischler et al. 1999)</td>
</tr>
<tr>
<td>Most drivers say they drive more safely than average</td>
<td>The distribution of the actual numbers of accidents is highly skewed, which results in the fact that most drivers (in one study, 80%) have less accidents than the average number of accidents (Gigerenzer 2002; Lopes 1992)</td>
</tr>
<tr>
<td>Availability bias (letter ”L” study)</td>
<td>“Availability bias” largely disappears when the stimuli (letters) are representative sampled rather than selected (Sedlmeier et al. 1998)</td>
</tr>
<tr>
<td>Preference reversals</td>
<td>Consistent social values (e.g., don’t take the largest slice; don’t be the first to cross a picket line) can create what look like preference reversals (Sen 1993; 2002)</td>
</tr>
<tr>
<td>Probability matching</td>
<td>Social environments with N &gt; 1 individuals competing over resources can make probability matching a more successful strategy than maximizing, whereas this would not be the case for an individual studied in isolation (Gallistel 1990)</td>
</tr>
<tr>
<td>Conjunction fallacy</td>
<td>“Conjunction fallacy” can be deduced from the human ability for pragmatic inference about the meaning of natural language sentences—an ability no computer program has so far (Hertwig &amp; Gigerenzer 1999)</td>
</tr>
<tr>
<td>False consensus effect</td>
<td>This “egocentric bias” can be deduced from Bayes’s rule for problems of which a person is ignorant, that is, where a person has no knowledge about prior probabilities (Dawes &amp; Mulsford 1995)</td>
</tr>
<tr>
<td>Violations of logical reasoning</td>
<td>A number of apparent “logical fallacies” can be deduced from Bayesian statistics for environments in which the distribution of events (e.g., P Q, and their negation) is highly skewed (McKenzie &amp; Amlin 2002; Oaksford &amp; Chater 1994), and from the logic of social contracts (Cosmides &amp; Tooby 1992; Gigerenzer &amp; Hug 1992)</td>
</tr>
</tbody>
</table>

Normative project

- Changing the presentation of medical/legal/others statistics in order to avoid confusion
- Changing the environment instead of making people better at following traditional norms
- Ex: (Gigerenzer & Edwards, 2003)
<table>
<thead>
<tr>
<th><strong>TYPE OF INFORMATION</strong></th>
<th><strong>EXAMPLES</strong></th>
<th><strong>HOW TO FOSTER INSIGHT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single event probabilities</td>
<td>&quot;You have a 30% chance of a side effect from this drug&quot;</td>
<td>Use frequency statements: &quot;Three out of every 10 patients have a side effect from this drug&quot;</td>
</tr>
<tr>
<td>Conditional probabilities</td>
<td>The probability of a positive test result if the patient has the disease (sensitivity)</td>
<td>Use natural frequencies, alone or together with conditional probabilities</td>
</tr>
<tr>
<td></td>
<td>The probability of a negative test result if the patient does not have the disease (specificity)</td>
<td></td>
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<tr>
<td></td>
<td>The probability of the disease if the patient has a positive test result (positive predictive value)</td>
<td></td>
</tr>
<tr>
<td>Relative risks</td>
<td>If four out of every 1000 women (age 40 or older) who do not undergo mammography screening die of breast cancer, compared with three out of every 1000 who are screened, the benefit is often presented as a relative risk, &quot;Mammography reduces breast cancer mortality by 25%.&quot;</td>
<td>Use absolute risks, alone or together with relative risks: &quot;In every 1000 women who undergo screening one will be saved from dying of breast cancer.&quot; Use the number needed to treat or harm: &quot;To prevent one death from breast cancer, 1000 women need to undergo screening for 10 years.&quot;</td>
</tr>
</tbody>
</table>

**Criticisms of ecological rationality**

(Boyd, 2001; Newell, 2005; Stanovich, 2003; Stanovich & West, 2003)

- Boyd: Replication of the market experiments: unconclusive
- Newell: no indication of the degree of empirical deviation permissible from the deterministic search, stopping and decision rules. No solid proofs of F&F superiority
- Stanovich & West:
  - a slippery concept (confusion between EEA and modern world, between fitness and utility, inconsistent use)
  - Ecological rationally may be highly suboptimal (not comparing prices)
  - The portfolio experiment is a “pure artifact of an extraordinary short period in the 1990s when large capitalization stocks outperformed small capitalization stocks”
  - A dual process model (system 1- system 2) is a better account of human performance.
  - Life is getting like the lab: in the contemporary world, we need to be able to apply normative theories
  - “Smarter people” (higher on the SAT test) are more rational (in the classical sense)
The Rationality war: Heuristics and biases vs ecological rationality:

1- (Gigerenzer, 1991) argue that “biases are not biases” and “heuristics are meant to explain what does not exist” (102). Errors of judgments can be “made to disappear” by two simple manipulations: asking questions in terms of frequencies rather than in terms of probabilities and emphasizing the role of random sampling.

2- (Kahneman & Tversky, 1996) replied that Gigerenzer “misrepresents the authors’ theoretical position and ignores critical evidence (...) judgments of frequency—not only subjective probabilities—are susceptible to large and systematic biases.”

3- (Gigerenzer, 1996) “The issue is not whether or not, or how often, cognitive illusions disappear. The focus should be rather the construction of detailed models of cognitive processes that explain when and why they disappear.”

4- Postscript in (Kahneman & Tversky, 1996): “Gigerenzer rejects our approach for not fully specifying the conditions under which different heuristics control judgment. Much good psychology would fail this criterion (...)We believe that progress is more likely to come by building on the notions of representativeness, availability, and anchoring than by denying their reality.”

5- Postscript in (Gigerenzer, 1996): “Twenty-five years ago (...) Kahneman and Tversky opened up a fertile field. Now it is time to plant theories”

6- According to (Samuels et al., 2002), the dispute is more apparent than real: (...) contrary to appearances, there is no substantial disagreement between [both]. (...) neither research program denies the core claims of the other and, in many cases, it is clear that they should and do endorse each other’s core claims. (...) there is also a surprising degree of consensus. Moreover, and this has been our central theme, they do not really have any deep disagreement over the extent of human rationality.

Links

http://www.mpib-berlin.mpg.de/en/forschung/abc ABC site

References


