Das Herz hat seine Gründe, die der Verstand nicht kennt.
Blaise Pascal

Bauchentscheidungen:
Intelligenz des Unbewussten

Gerd Gigerenzer

Max-Planck-Institut für Bildungsforschung Berlin

Intuition ist gefühltes Wissen

- das rasch im Bewusstsein auftaucht,
- dessen tiefere Gründe uns nicht bewusst sind und
- das stark genug ist, um danach zu handeln.

April 8, 1779

If you doubt, set down all the Reasons, pro and con, in opposite Columns on a Sheet of Paper, and when you have considered them two or three Days, perform an Operation similar to that in some questions of Algebra; observe what Reasons or Motives in each Column are equal in weight, one to one, one to two, two to three, or the like, and when you have struck out from both Sides all the Equalities, you will see in which column remains the Balance. […]

This kind of *Moral Algebra* I have often practiced in important and dubious Concerns, and tho' it cannot be mathematically exact, I have found it extreamly useful. By the way, if you do not learn it, I apprehend you will never be married.

I am ever your affectionate Uncle,
B. FRANKLIN

She works by intuition and feeling... If she abandons her natural naiveté and takes up the burden of guiding and accounting for her life by consciousness, she is likely to lose more than she gains, according to the old saw that she who deliberates is lost.

Stanley Hall, 1904

Intuitive Judgments = Logical Blunders?

People "display intransitivity; misunderstand statistical independence; mistake random data for patterned data and vice versa; fail to appreciate law of large number effects; fail to recognize statistical dominance; make errors in updating probabilities on the basis of new information; understate the significance of given sample sizes; fail to understand covariation for even the simplest 2x2 contingency tables; make false inferences about causality; ignore relevant information; use irrelevant information (as in sunk cost fallacies); exaggerate the importance of vivid over pallid evidence; exaggerate the importance of fallible predictors; exaggerate the ex ante probability of a random event which has already occurred; display overconfidence in judgment relative to evidence; exaggerate confirming over disconfirming evidence relative to initial beliefs; give answers that are highly sensitive to logically irrelevant changes in questions; do redundant and ambiguous tests to confirm an hypothesis at the expense of decisive tests to disconfirm; make frequent errors in deductive reasoning tasks such as syllogisms; place higher value on an opportunity if an experimenter rigs it to be the 'status quo' opportunity; fail to discount the future consistently; fail to adjust repeated choices to accommodate intertemporal connections; and more."

John Conslik, 1996, *Journal of Economic Literature*

What Is the Process Underlying Intuition?

- Biases due to cognitive limitations
- Optimal weighting of all reasons
- Fast and frugal heuristics

Three Visions of Bounded Rationality

- Optimization under constraints (as-if)

"Boundedly rational procedures are in fact fully optimal procedures when one takes account of the cost of computation in addition to the benefits and costs inherent in the problem as originally posed."

Arrow, 2004, p. 48

- Cognitive illusions (logical rationality)

"Our research attempted to obtain a map of bounded rationality, by exploring the systematic biases that separate the beliefs that people have and the choices they make from the optimal beliefs and choices assumed in rational-agent models."

Kahneman, 2003, p. 1449

- Adaptive heuristics (ecological rationality)

"Models of bounded rationality describe how a judgment or decision is reached (that is, the heuristic processes or proximal mechanisms) rather than merely the outcome of the decision, and they describe the class of environments in which these heuristics will succeed or fail."

Gigerenzer & Selten, 2001, p. 4

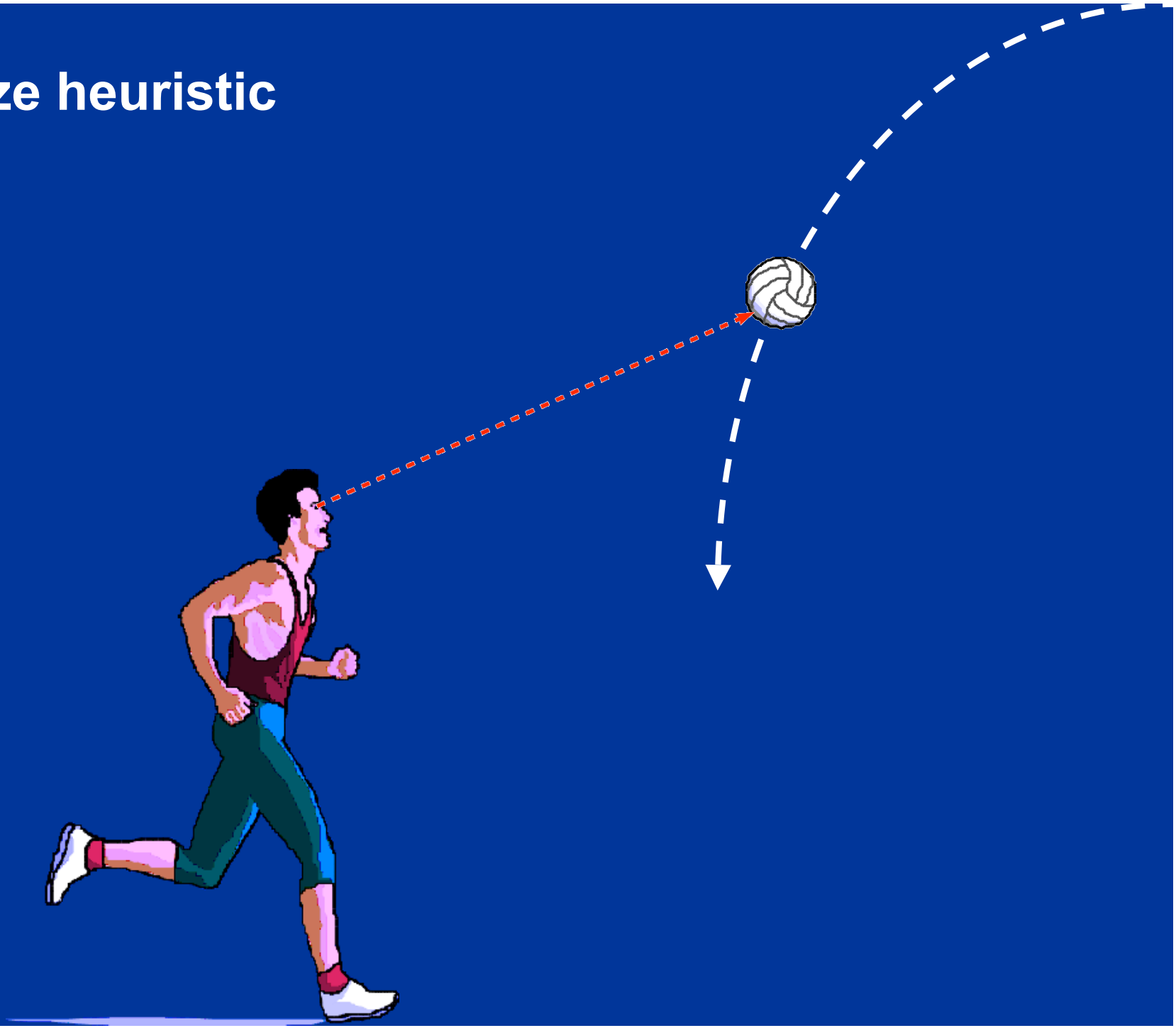
Intuitions in Sports

When a man throws a ball high in the air and catches it again, he behaves as if he had solved a set of differential equations in predicting the trajectory of the ball... At some subconscious level, something functionally equivalent to the mathematical calculation is going on.

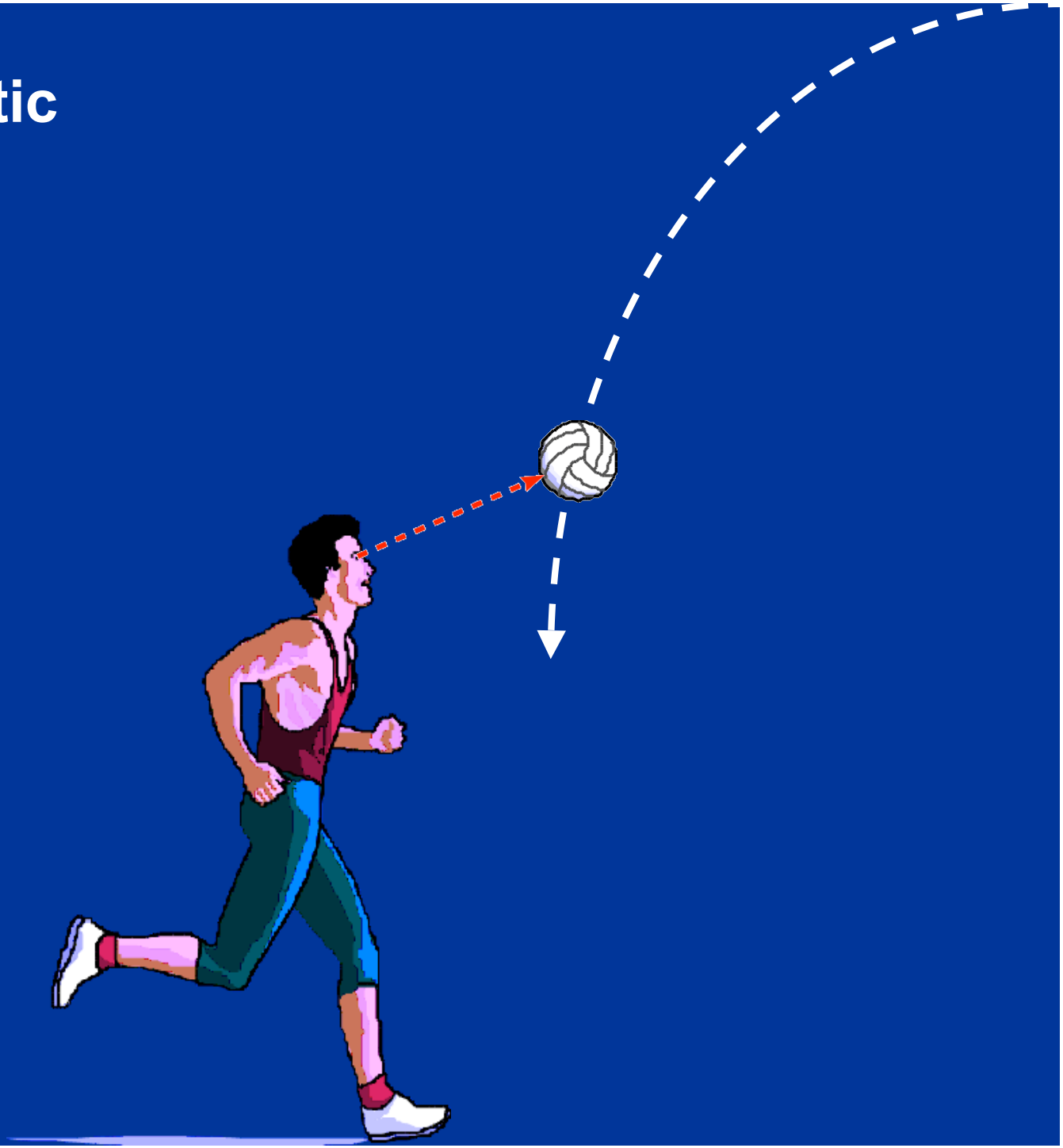
Richard Dawkins, The Selfish Gene

Gaze heuristic

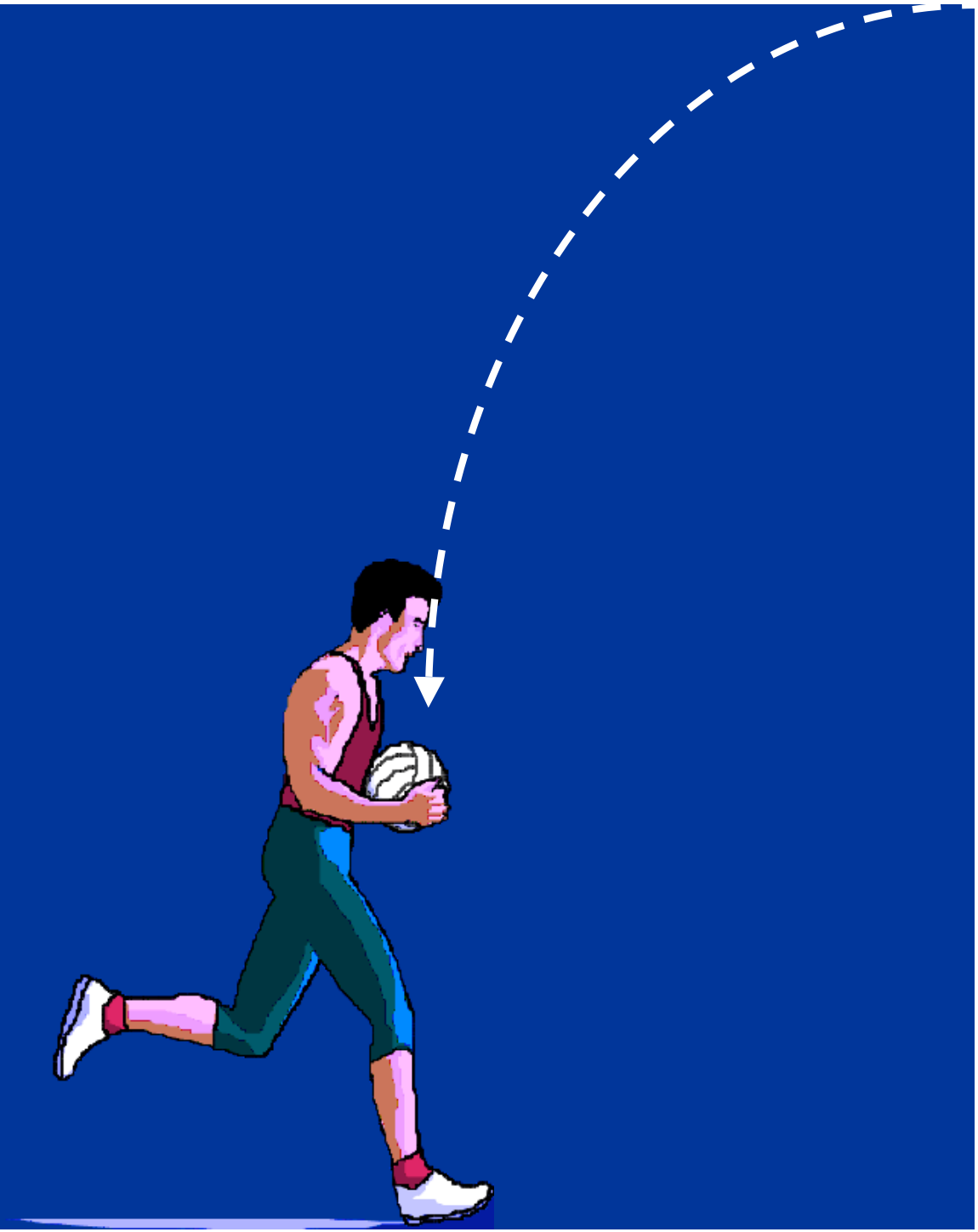
Gaze heuristic



Gaze heuristic



Gaze heuristic



Gaze Heuristic

- How to intercept a potential pray or mate?

  bats, birds, dragonflies, hoverflies, teleost fish, houseflies

- How to avoid collisions?

  sailors, aircraft pilots

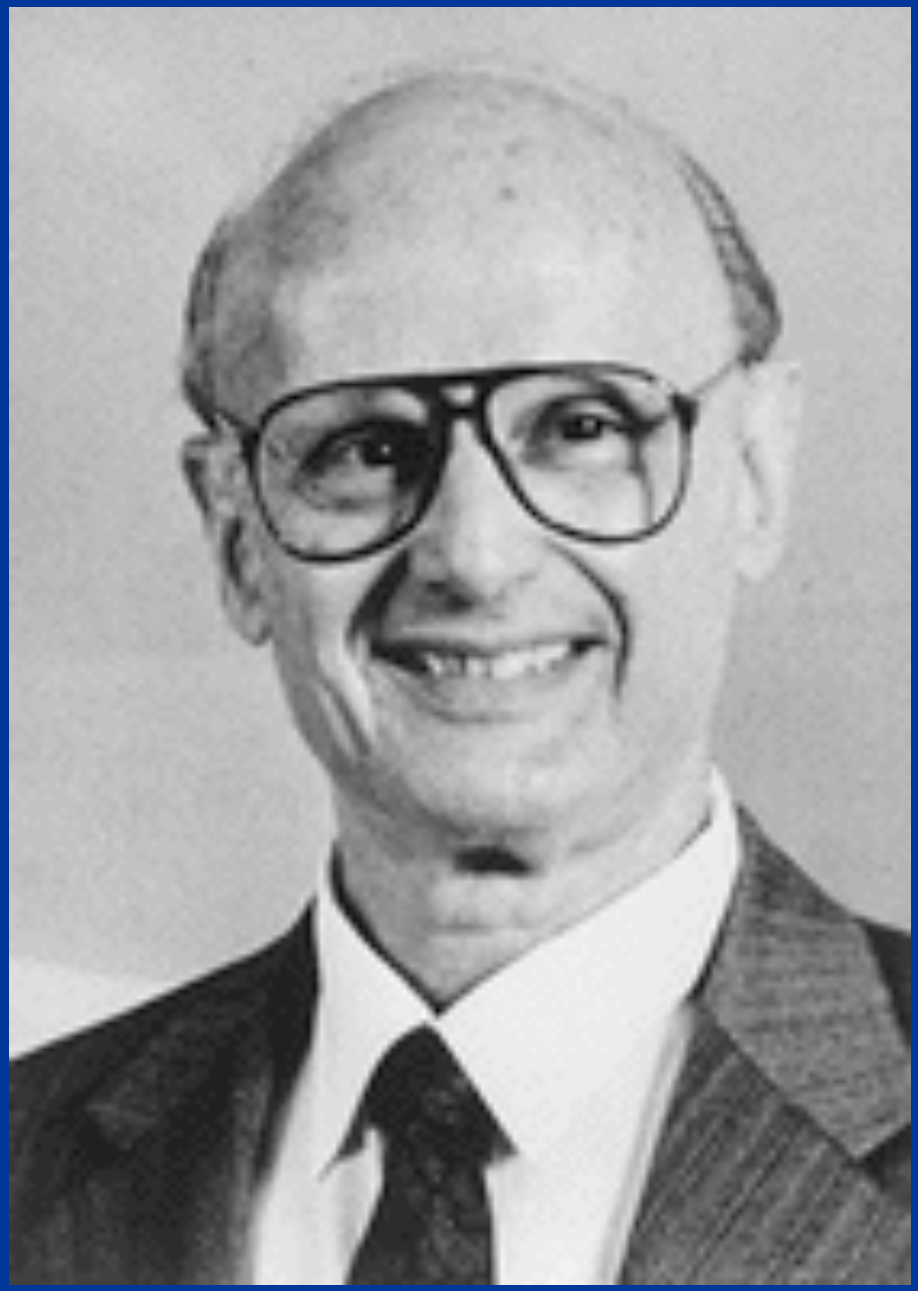
- Where to run to catch a ball?

  Shaffer et al., 2004, *Psychological Science;* McLeod et al., 2003, *Nature*

- How to infer intention from gaze?

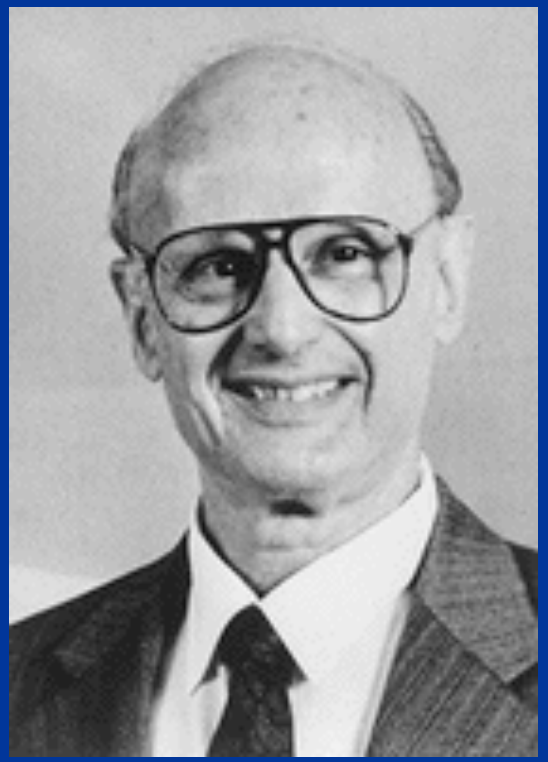
  Baron-Cohen 1995; Blythe et al., 1999; in Gigerenzer et al., 1999,*Simple Heuristics That Make us Smart*

Intuitions About Investments



How to make investment decisions?

Optimal Asset Allocation Policy
"Mean-Variance-Model"

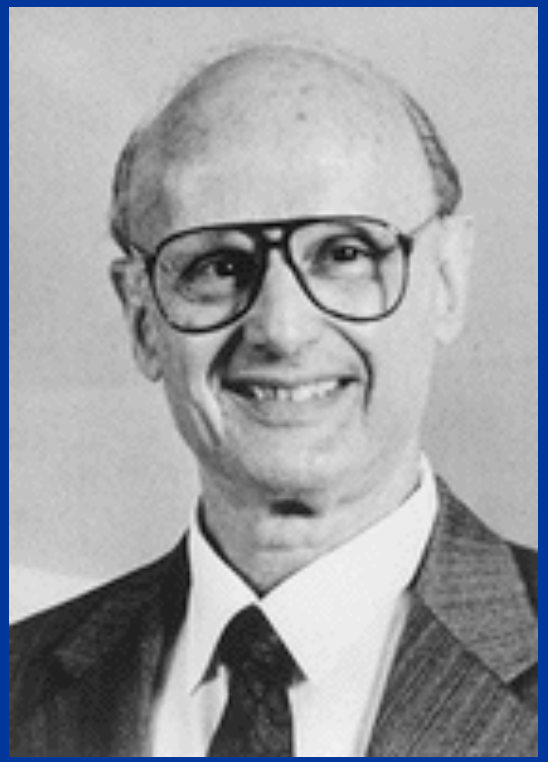


Harry Markowitz

Optimization or Heuristic?

~~*Optimal Asset Allocation Policy*~~
~~*"Mean-Variance-Model"*~~

1/N
Allocate your money equally to each of N funds

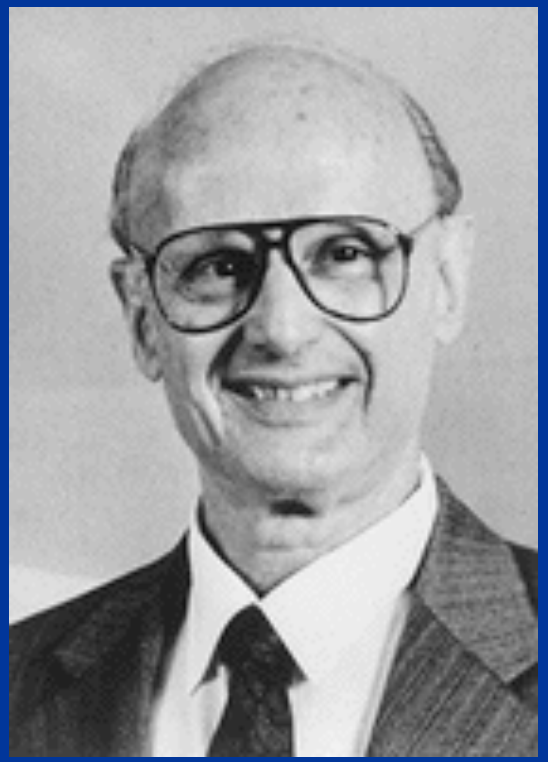


Harry Markowitz

When Are Heuristics Better Than Optimization?

1/N

Allocate your money equally to each of N funds



Harry Markowitz

Ecological rationality of 1/N:

1. **Predictive uncertainty: *large***
2. **N: *large***
3. **Learning sample: *small***

DeMiguel, Garlappi & Uppal 2007

1/N

- How do parents divide investment between their children?
  Hertwig et al., Psychological Bulletin 2002
- How do children divide resources in the Ultimatum game?
  Takezawa et al., J of Economic Psychology 2006
- How do people allocate financial resources?
  Hubermann & Jiang, Journal of Finance 2006
- How to weight reasons to make good predictions?
  Dawes' Rule; see Hogarth & Karelaia, Psychological Review 2007

Four Misconceptions

1. Heuristics produce second-best results; optimization is always better.

2. Intuition relies on heuristics only because of cognitive limitations.

3. People use heuristics only in routine decisions of little importance.

4. More information, time, and computation is always better.

No Speed-Accuracy Trade-off

Expert handball players make better decisions with less time (Johnson & Raab, 2003 *OBHDP)*

Expert golfers perform better with limited time and without paying attention (Beilock et al. 2002 *JEP:Applied*)

No Knowledge-Accuracy Trade-off

Small memory and forgetting is beneficial for language learning (Elman 1993, *Cognition*)

Forgetting is beneficial for heuristics use (Gigerenzer & Goldstein 2002, *Psychological Review*; Schooler & Hertwig 2005, *Psychological Review*)

Research Questions

What Are the Mechanisms of Intuition?

The Study of the Adaptive Toolbox

When Are Intuitions Successful?

The Study of Ecological Rationality

How to Design Intuitive Decision Systems?

Gigerenzer et al. 1999. *Simple Heuristics That Make Us Smart*. OUP

Gigerenzer & Selten 2001, Eds. *Bounded Rationality: The Adaptive Toolbox*. MIT Press

Gigerenzer 2007. *Gut Feelings: The Intelligence of the Unconscious.* NY: Viking

I.

What Are the Mechanisms of Intuition?

Principles of Intuition

1. Gaze heuristic

2. 1/N

3. Recognition

Recognition heuristic: *Goldstein & Gigerenzer 2002 Psychological Review*
Fluency heuristic: *Schooler & Hertwig 2005 Psychological Review*

4. One-good-reason

Take-the-best: *Gigerenzer & Goldstein 1996 Psychological Review*
Fast & frugal trees: *Martignon et al. 2003*
Priority heuristic: *Brandstätter, Gigerenzer & Hertwig 2006 Psychological Review*

5. Default

Johnson & Goldstein 2003 Science

6. Satisficing

Simon 1955 Quarterly J of Economics

7. Imitation

Boyd & Richerson 2005 The Origin and Evolution of Cultures

II.

When Are Intuitions Successful?

Sequential Search Heuristics

no trade-off

Take The Best

Search rule: Look up the cue with the highest validity

Stopping rule: If cue values differ (+/-), stop search. If not, look up next cue.

Decision rule: Predict that the alternative with the positive cue value has the higher criterion value.

don't add

trade-off

Tallying (1/N)

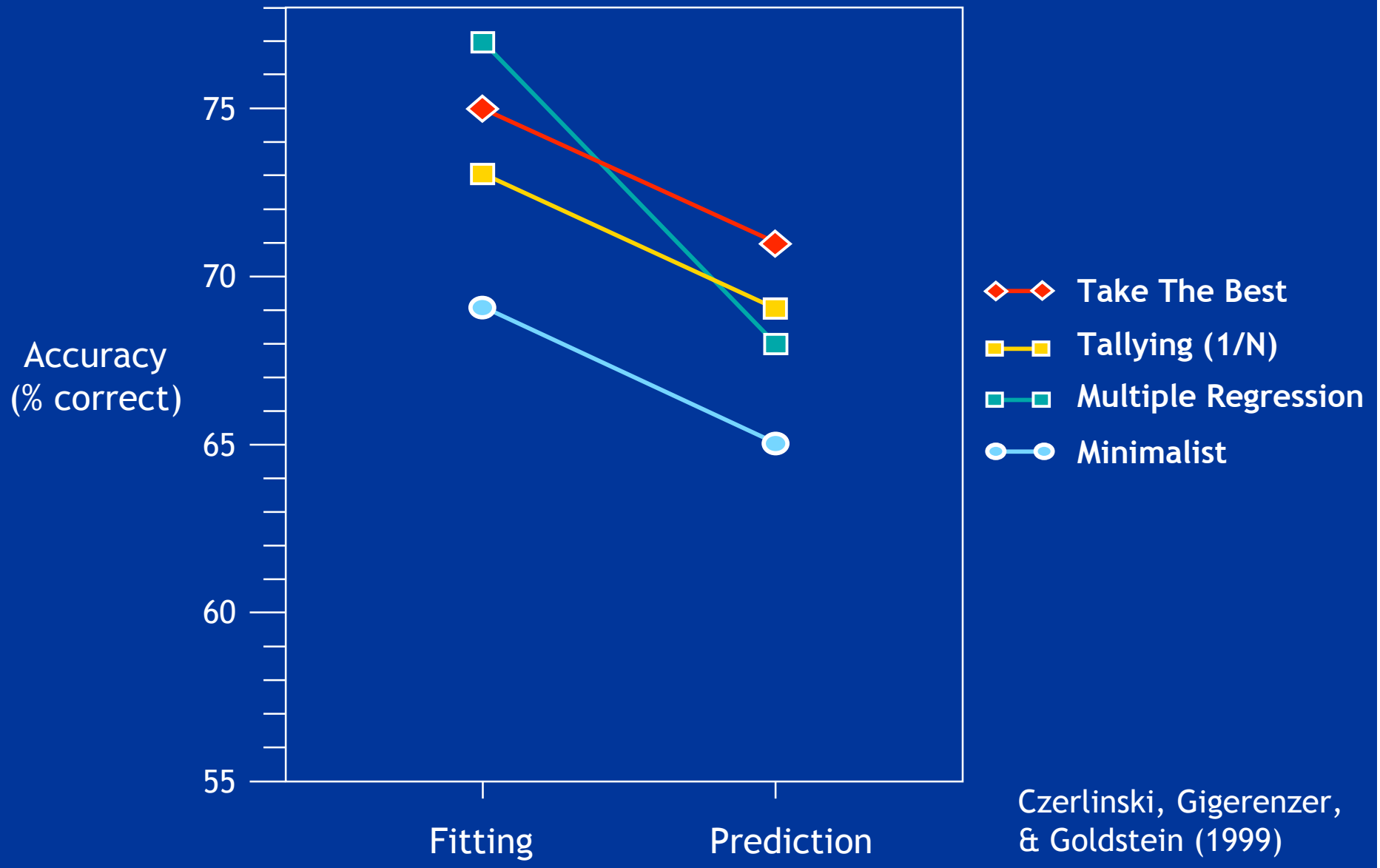
Search rule: Look up a cue randomly.

Stopping rule: After m ($1<m\leq M$) cues, stop search.

Decision rule: Predict that the alternative with the higher number of positive cue values has the higher criterion value.

don't weight

Robust Inference with Cognitive Heuristics

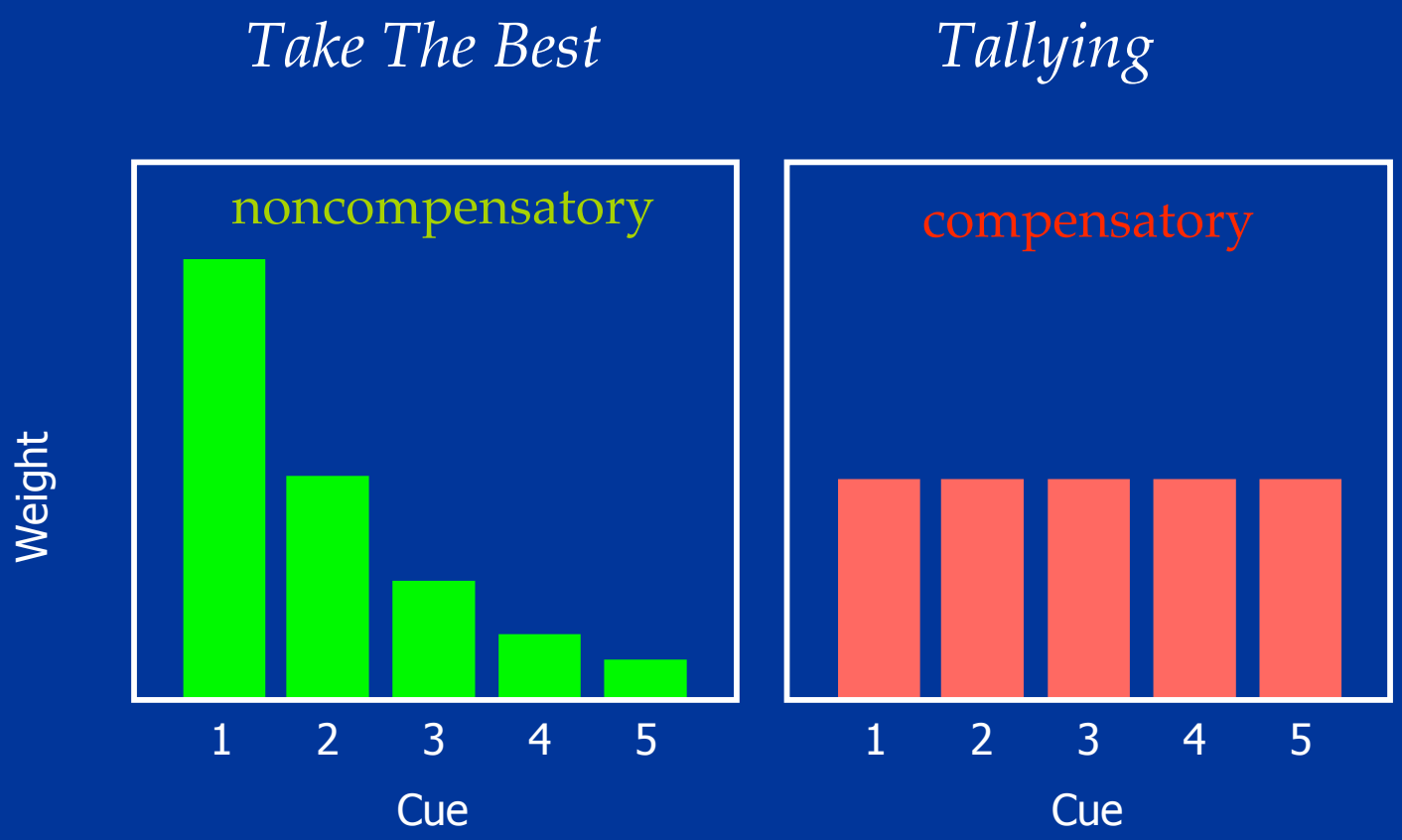


Czerlinski, Gigerenzer,
& Goldstein (1999)

Ecological Rationality of Take-The-Best

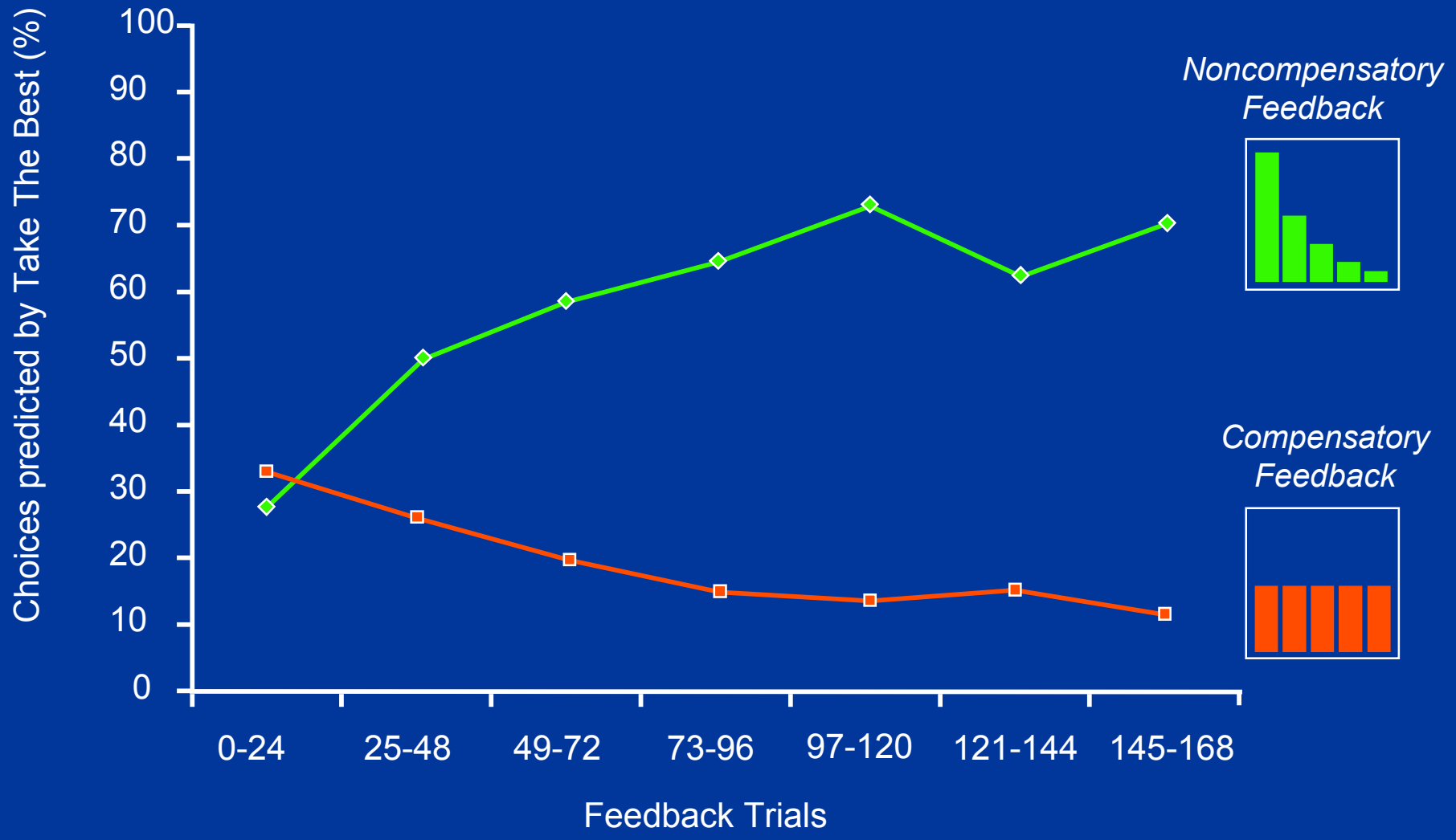
Study and Assumptions	**Concept**	Result
Martignon & Hoffrage (*Theory & Decision* 2002) no environment model; no assumptions for cues	Noncompensatory cue weights: $w_i \geq \Sigma_{k>i} w_k$	Lexicographic rule is as accurate as linear rule with noncompensatory cue weights
Katsikopoulos & Martignon (*J of Mathematical Psychology* 2006) no environment model; conditionally independent cues	Noncompensatory cue validities: $v_i / (1 - v_i) \geq \Pi_{k>i} v_k / (1 - v_k)$	Lexicographic rule is optimal if and only if cue validities are noncompensatory
Hogarth & Karelaia (*Psychological Review* 2007) linear environment model; normally distributed cues	Linear cognitive ability GR: how well the person uses a linear rule, in terms of using the "right" cue weights (G) and using weights consistently (R).	Lexicographic rule is more accurate than linear rule unless linear cognitive ability is high
Baucells et al (*Operations Research* in press) linear environment model	Cumulative dominance: object A cumulatively dominates an object B if $\Sigma_{k \leq i} c_k(A) \geq \Sigma_{k \leq i} c_k(B)$, and the inequality holds strictly for at least one i.	Lexicographic rule is optimal if cumulative dominance holds

Ecological Rationality



Martignon & Hoffrage (1999), In Gigerenzer et al., *Simple heuristics that make us smart*. Oxford University Press

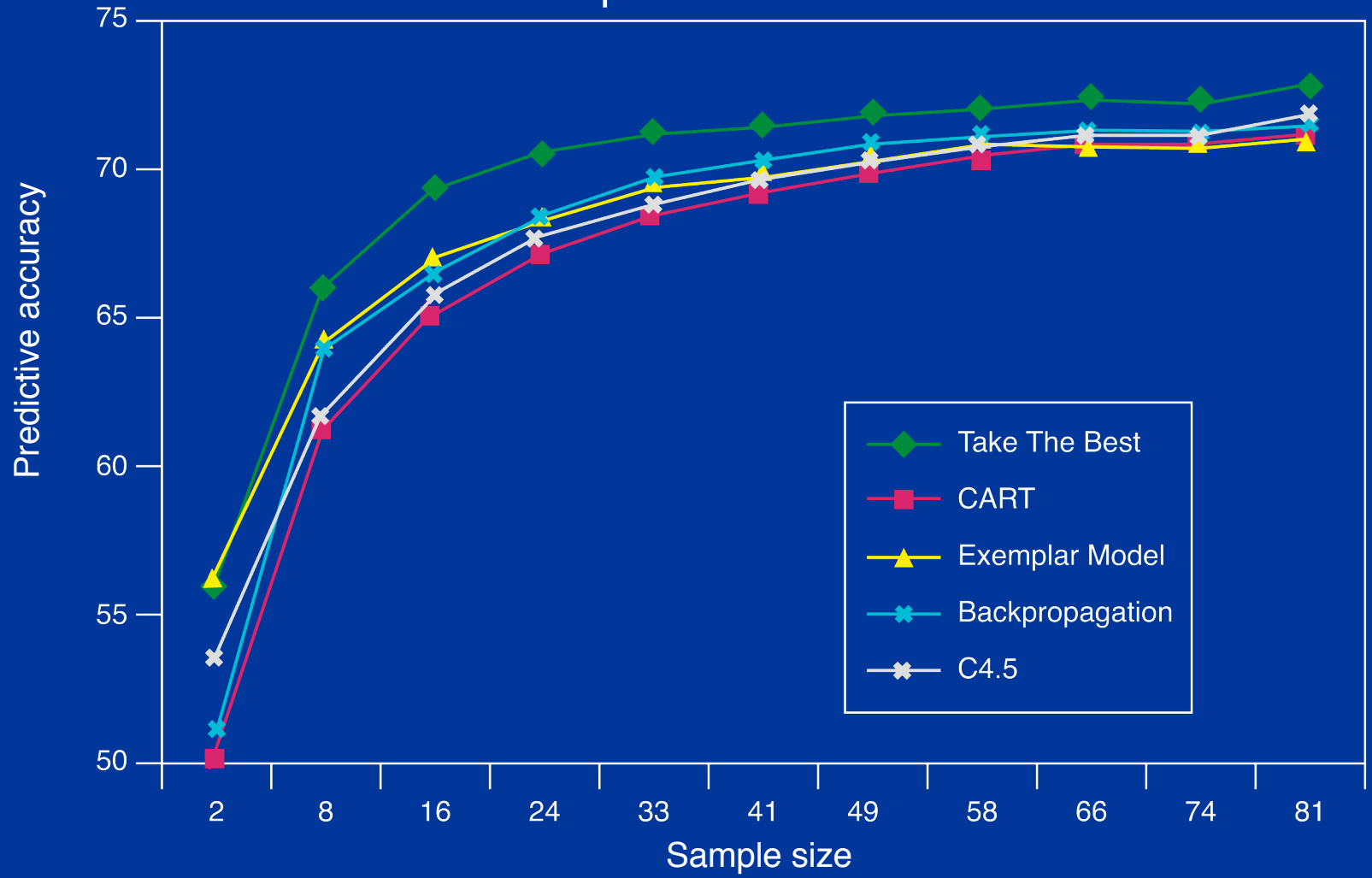
Selection of heuristics



Rieskamp & Otto 2006 *JEP:General*

City Population

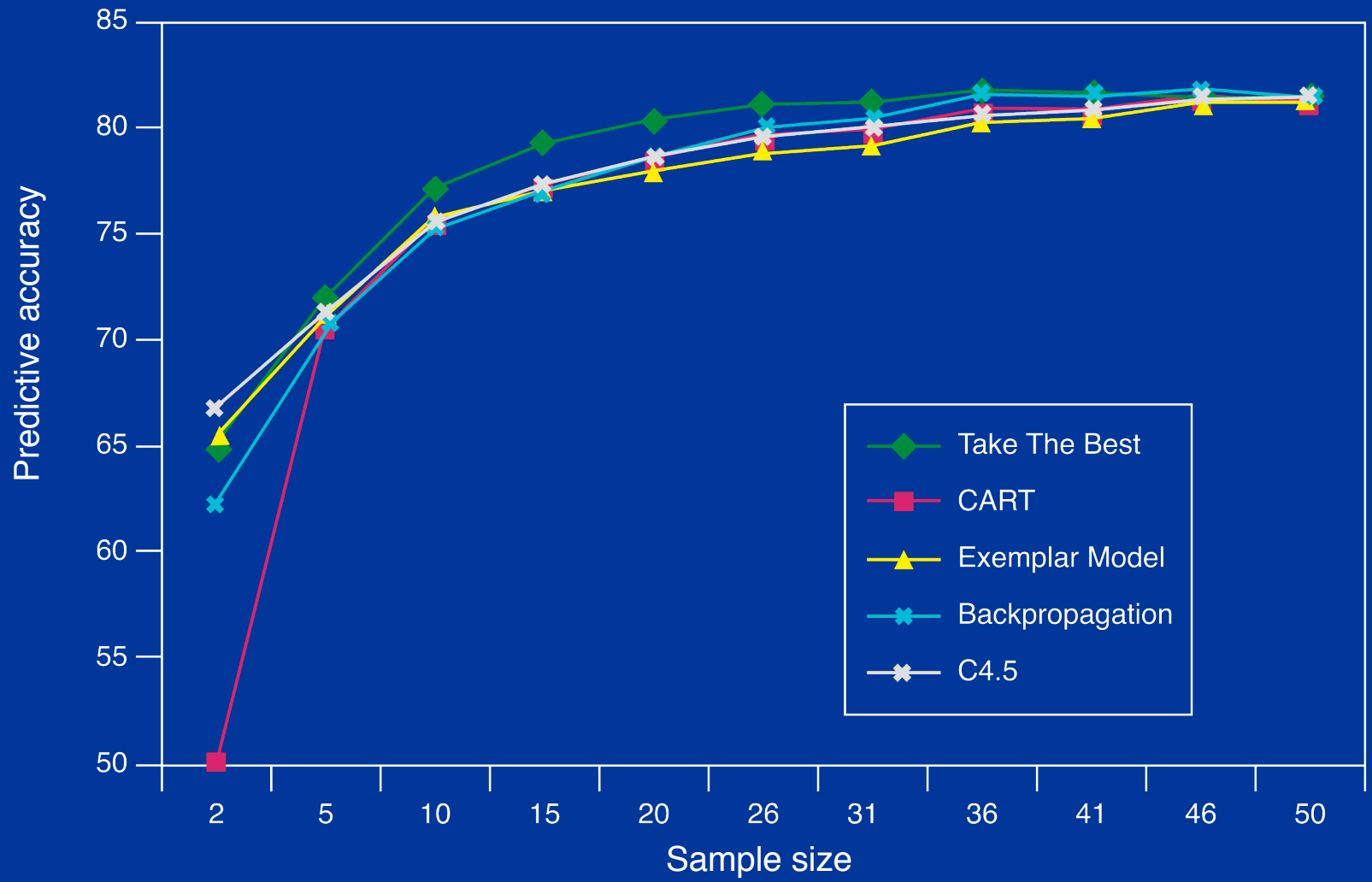
Cues: soccer team, university, state capital, intercity train line, exposition site etc



Brighton 2007

Professors' Salaries

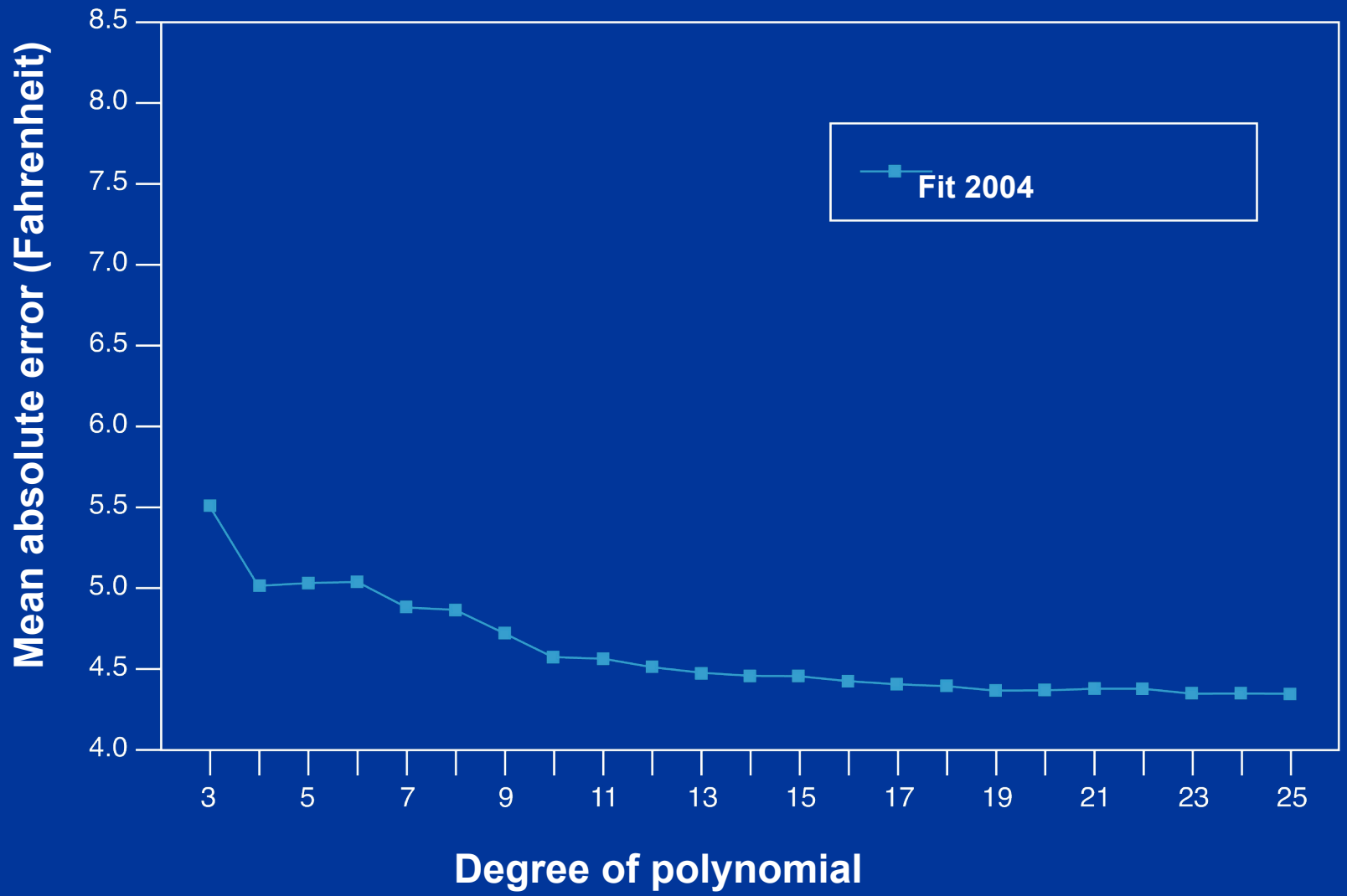
Cues: rank, gender, years in current rank, highest degree earned, years since highest degree earned



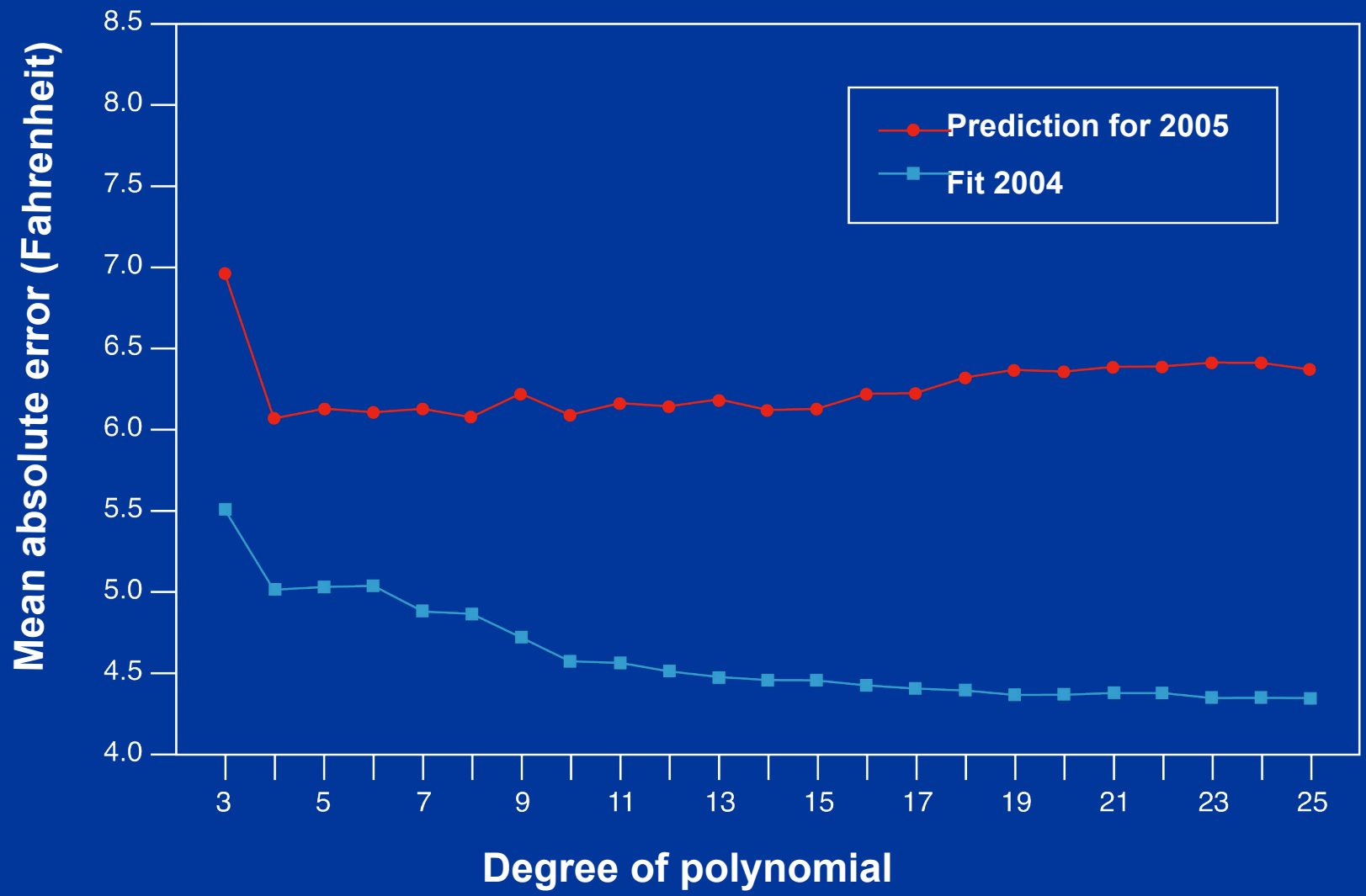
Brighton 2007

Which Strategy Predicts Best?

Temperature in New York



Best Fit ≠ Best Prediction



III.

How to Design Intuitive Decision Systems?

The heart disease predictive instrument (HDPI)

Chest Pain = Chief Complaint

EKG (ST, T wave Δ's)

History	ST&T Ø	ST⇔	T⇑⇓	ST⇔	ST⇔&T⇑⇓	ST⇑⇓&T⇑⇓
No MI& No NTG	19%	35%	42%	54%	62%	78%
MI or NTG	27%	46%	53%	64%	73%	85%
MI and NTG	37%	58%	65%	75%	80%	90%

Chest Pain, NOT Chief Complaint

EKG (ST, T wave Δ's)

History	ST&T Ø	ST⇔	T⇑⇓	ST⇔	ST⇔&T⇑⇓	ST⇑⇓&T⇑⇓
No MI& No NTG	10%	21%	26%	36%	45%	64%
MI or NTG	16%	29%	36%	48%	56%	74%
MI and NTG	22%	40%	47%	59%	67%	82%

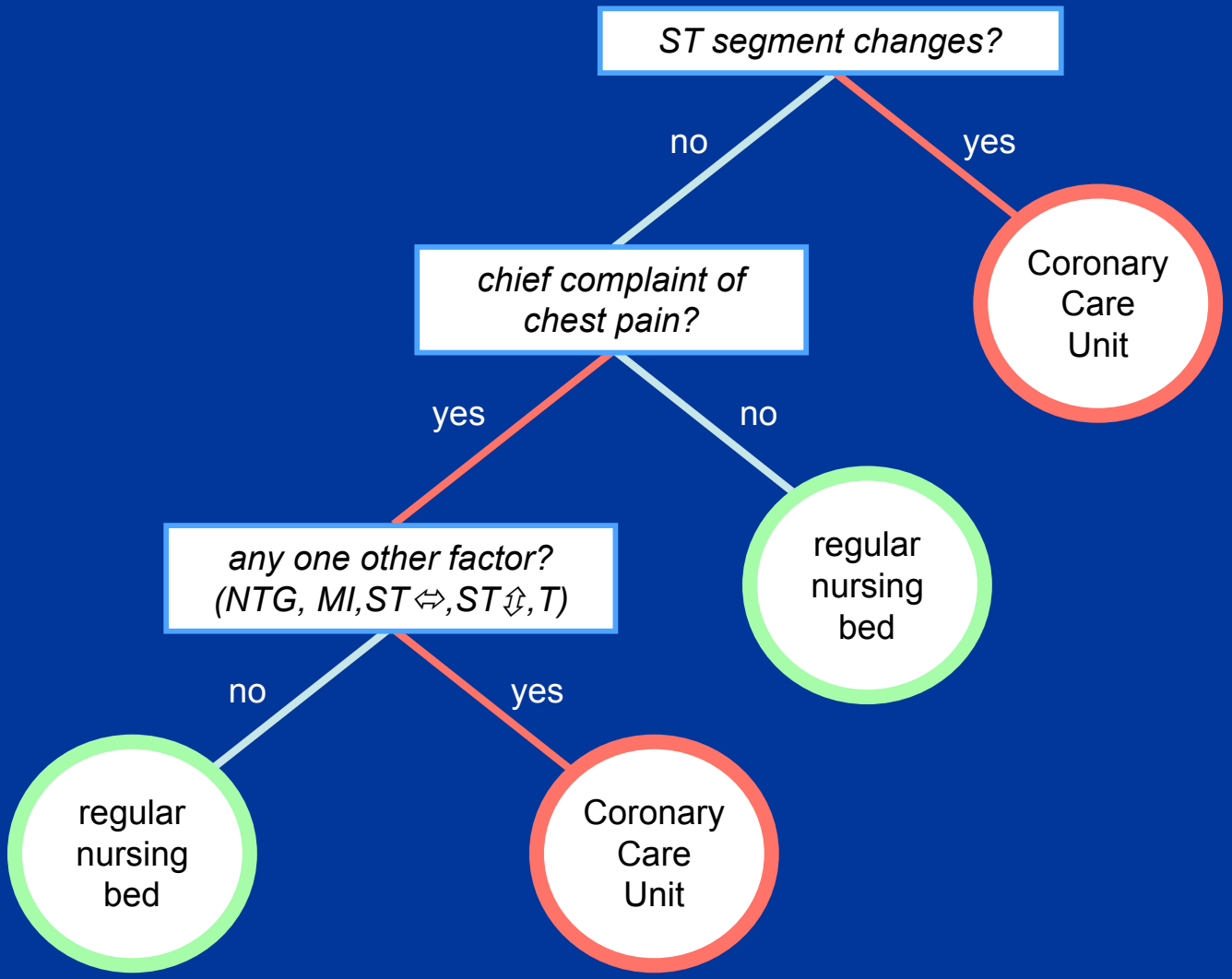
No Chest Pain

EKG (ST, T wave Δ's)

History	ST&T Ø	ST⇔	T⇑⇓	ST⇔	ST⇔&T⇑⇓	ST⇑⇓&T⇑⇓
No MI& No NTG	4%	9%	12%	17%	23%	39%
MI or NTG	6%	14%	17%	25%	32%	51%
MI and NTG	10%	20%	25%	35%	43%	62%

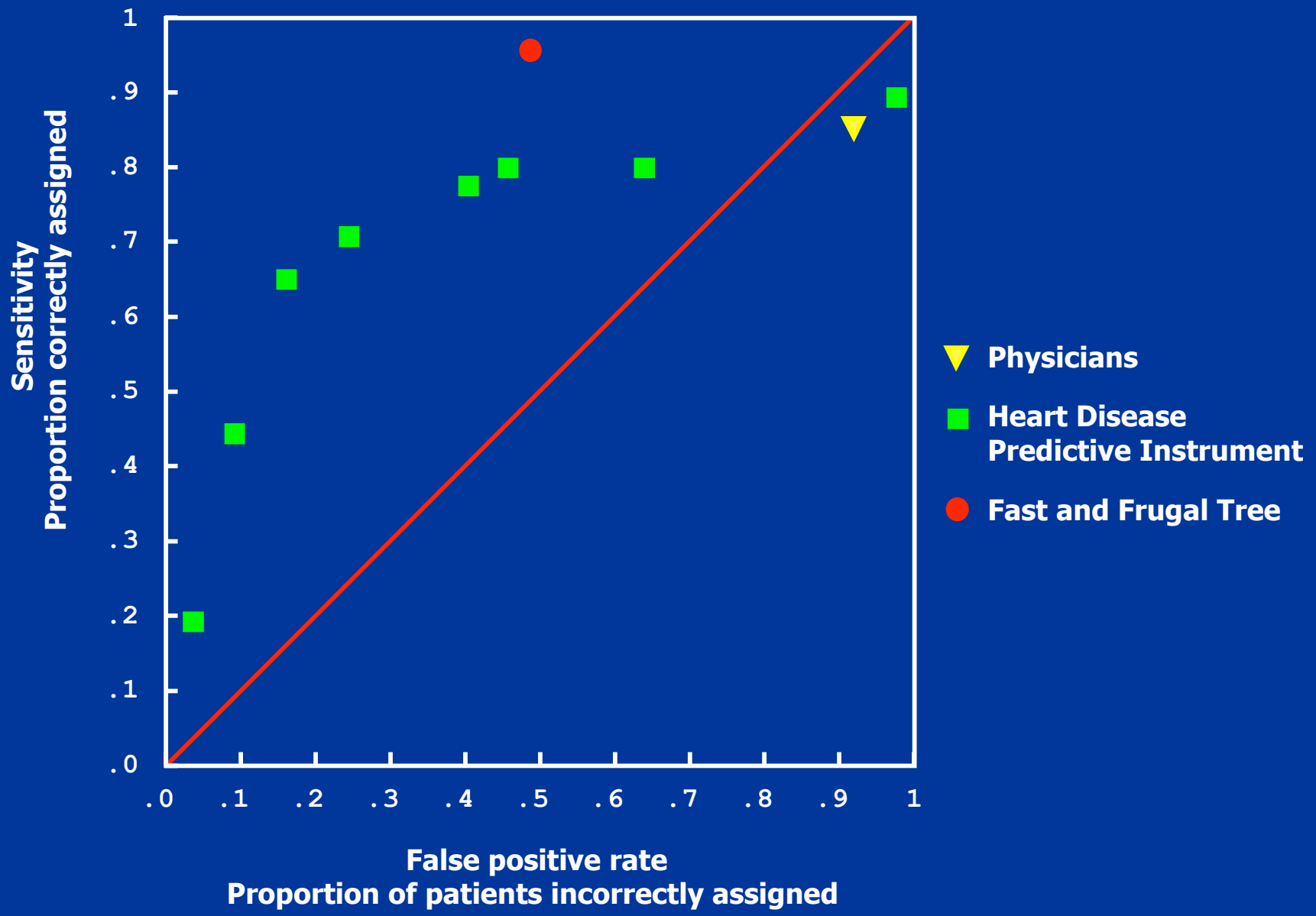
See reverse for definitions and instructions

Fast and frugal tree: treatment allocation



Green & Mehr (1997)

Emergency Room Decisions: Admit to the Coronary Care Unit?



INTUITION

1. Gefühltes Wissen: rasch im Bewusstsein, Gründe unbewusst, lenkt Entscheidung.

2. Schnelle heuristische Prozesse

3. Oft bessere Entscheidungen als komplexe statistische Verfahren.

4. Mehr Zeit, Informationen und Berechnungen sind nicht immer besser.

Gigerenzer, 2007. *Gut Feelings: The Intelligence of the Unconscious*. NY: Viking Press
Deutsch: *Bauchentscheidungen*. Bertelsmann