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Knowledge Transfer from System Experts to their Heirs Apparent Using a NAVIS-based Strategy

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Overview

1. Introduction of Problem & Partial Solution
2. Need for Continuity & Growth of Expertise
3. Expertise & Knowledge Transfer
4. The NAVIS-based Taxonomy of Biases
5. Application of NAVIS to Knowledge Transfer
6. Conclusion

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Introduction of Problem

- **Problem:** Knowledge transfer among personnel within organizations is often suboptimal for maintaining desired performance (safety, stability, improvement, innovation) over time.
- **Objective:** Efficient & effective transfer of knowledge and skills from system experts to the next generation of designers, builders, operators, and maintainers. This activity is of critical importance in high-consequence domains (e.g., nuclear power, nuclear weapons, hazardous chemicals, oil & gas production, bridge building, air transport, …)

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Introduction of Problem

Potential Experts ENTER

System Experts:

- Skills
- Heuristics
- Knowledge

Proven Experts LEAVE

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Partial Solution

Apply *portions* of a unique, recently developed decision making process to improve knowledge transfer by:

- **Preparing a willing expert to be an effective teacher**
- **Identifying potential heirs apparent & preparing them to be proficient learners**
- **Helping identify promising matches of heirs apparent & experts**
- **Improving the knowledge transfer process—particularly if experts and 'heirs apparent' are in multiple relationships**

How?

- Enable greater understanding of backgrounds, biases, & bias mitigation
- Achieve disposition of inquiry, observation, & inference that supports knowledge transfer

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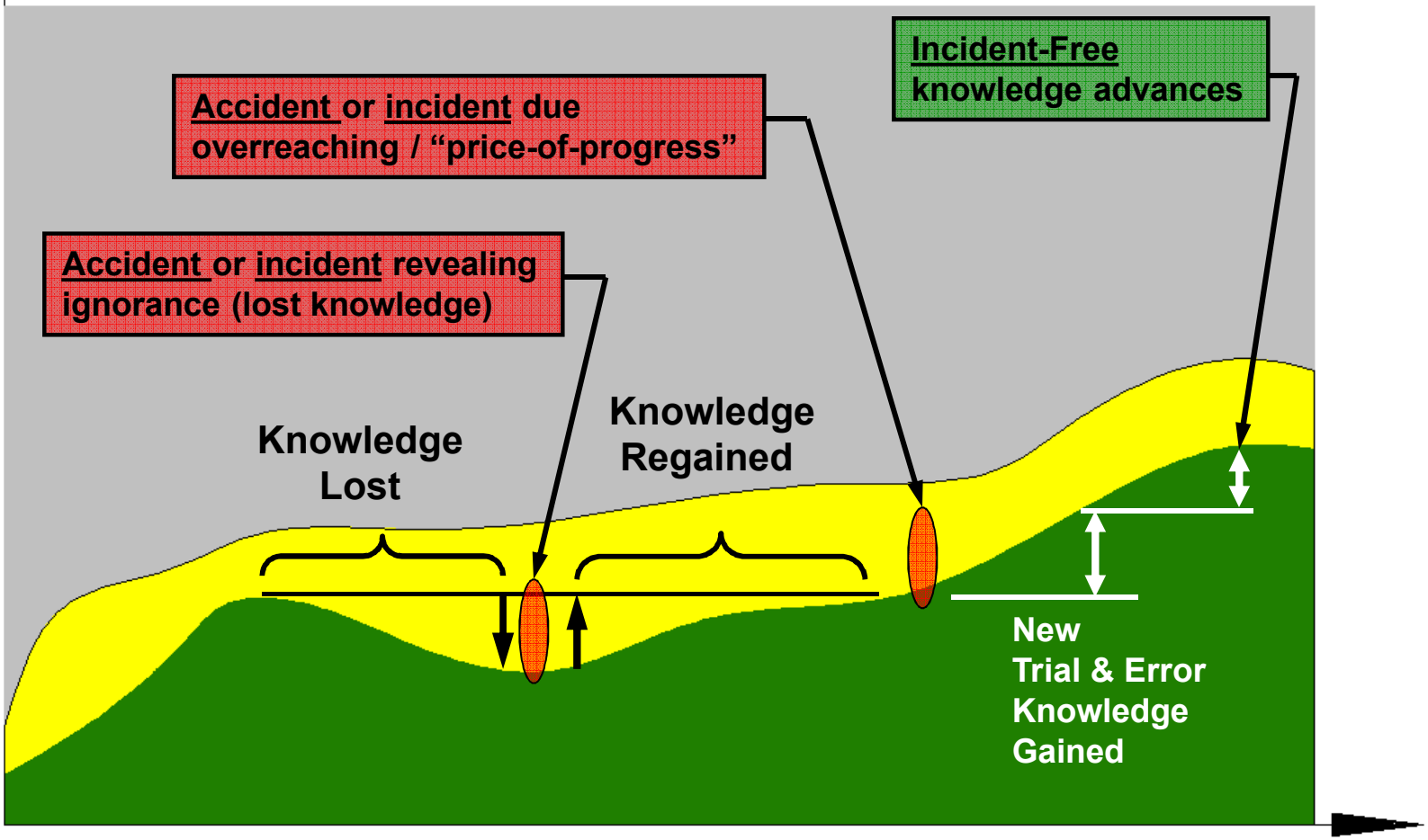
Cyclical Nature of System Knowledge

System Knowledge is Lost then Recaptured; and
New Knowledge is Gained (experience, risk taking / "progress")



- Petrochemical
- Space Exploration
- Weapons

Unknown unknowns

Known Unknowns

Known Knowns

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Expertise & Knowledge Transfer

Characteristics of Expertise (not complete, not exhaustive):

- Ability to leverage many years of knowledge & skill gained in wide variety of contexts to recognize patterns
- Selective retrieval of relevant information with extrapolation to fluidly produce an appropriate response
- Know when rules apply & when an unusual pattern requires an exception
- Broad and deep tacit knowledge
- Technical skills, understanding of management systems, norms & values, and understand the "power perspective"
- Provide best estimates for types of risk taking that is deemed judicious (even if the outcome is bad) versus risk taking that is deemed foolish, imprudent, or dangerous
- Expertise, contrasted with competence, often takes 10 or more years to develop

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Expert's Potential Concerns

If knowledge = power

And

I have lot's of knowledge (i.e., power) that is *recognized* and *rewarded* by the organization

Why should I risk losing or diffusing my power by training my future competition?

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Expert's Potential Concerns

Manager says:

So you are the only expert we have who knows everything about Topic Z and can consistently push Topic Z beyond the state-of-the-art; we must do some knowledge transfer – what happens if you get hit by a bus tomorrow?

Employee responds:

Well, I see what you mean, but instead of knowledge transfer to my future competitor(s) I'd rather get a pay raise so I can buy a new sports car…and a professional driver

Key Assumption in this presentation:

Experts are ready and willing to share their expertise…

…now let's discuss why they would/ should be willing to share…

Expertise & Knowledge Transfer

Types of Knowledge Transfer:

- **Person-to-person**
- **Self-study techniques**
- **Expert systems**
- **Person-to-group** *(lecture, lab, field study)*
- **...**

Ancient History for Person-to-Person Processes: Guild, Artisanship, Apprenticeship

- **Novice (beginner)**
- **Apprentice (intermediate)**
- **Journeyman (advanced)**
- **Master (expert / virtuoso)**

Focus Here: transition from *heir apparent* to *expert*; analogous to transition from *journeyman* to *master*

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Expertise & Knowledge Transfer

Benefits of Mentoring:

- **Increased job satisfaction**
- **Higher employee retention**
- **Better performance**
- **More rapid promotions**
- **System performance stability**
- **System performance improvement**

Emphasizes the Criticality of:

- Preparing experts
- Identifying & preparing heirs apparent
- Gently facilitating the matching process
- Nurture a strong, long-lasting relationship

Challenges for Mentoring:

- **Substantial immediate costs in time, training, & relationship facilitation for expert & heir apparent**
- **Shadowing activities often not billable**
- **Experts concerned about being rewarded by management for effort**
- **Loss of promising heir apparent "investments" to other organizations or fields can dampen support**
- **Swap et al. (2001), "mentoring requires a light—and sophisticated—managerial hand"**

The NAVIS-based Taxonomy of Biases

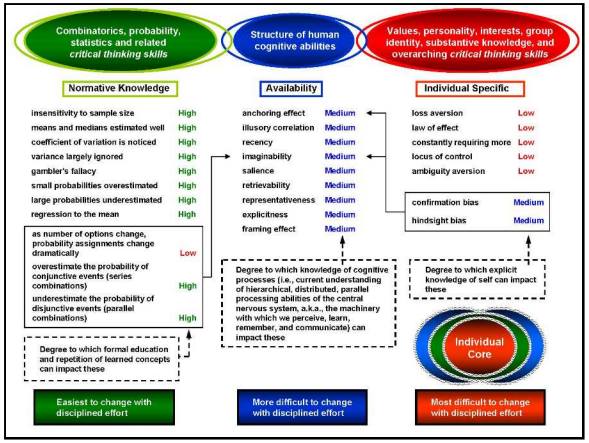
Overview of Bias Processes

3 categories

- **N**ormative Knowledge
- **AV**ailability
- **I**ndividual **S**pecific

29 bias processes in the NAVIS taxonomy

NAVIS



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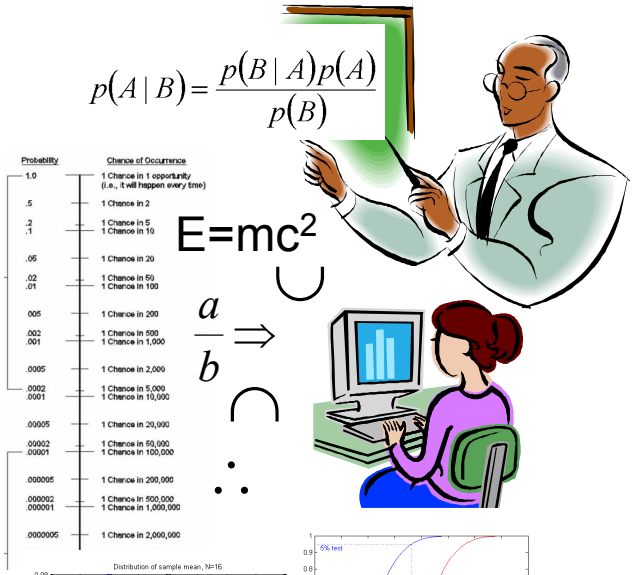
Combinatorics, probability, statistics and related *critical thinking skills*

Structure of human cognitive abilities

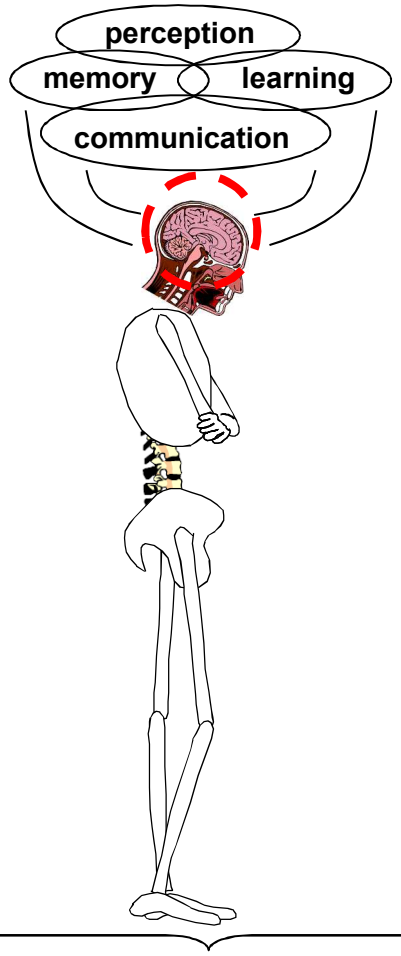
Values, personality, interests, group identity, substantive knowledge, and overarching *critical thinking skills*

Normative Knowledge



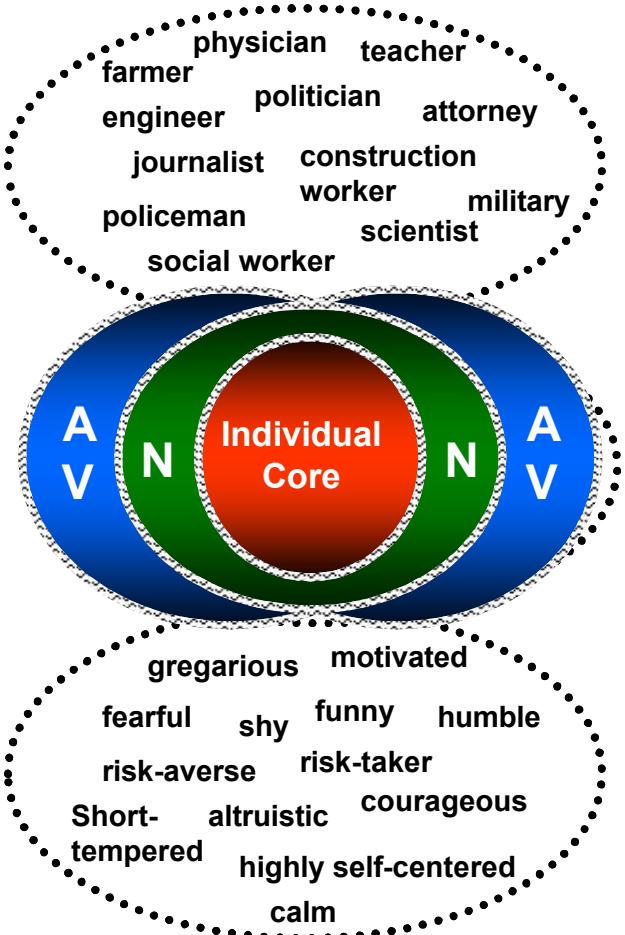
Number sense & analytical skill

Availability

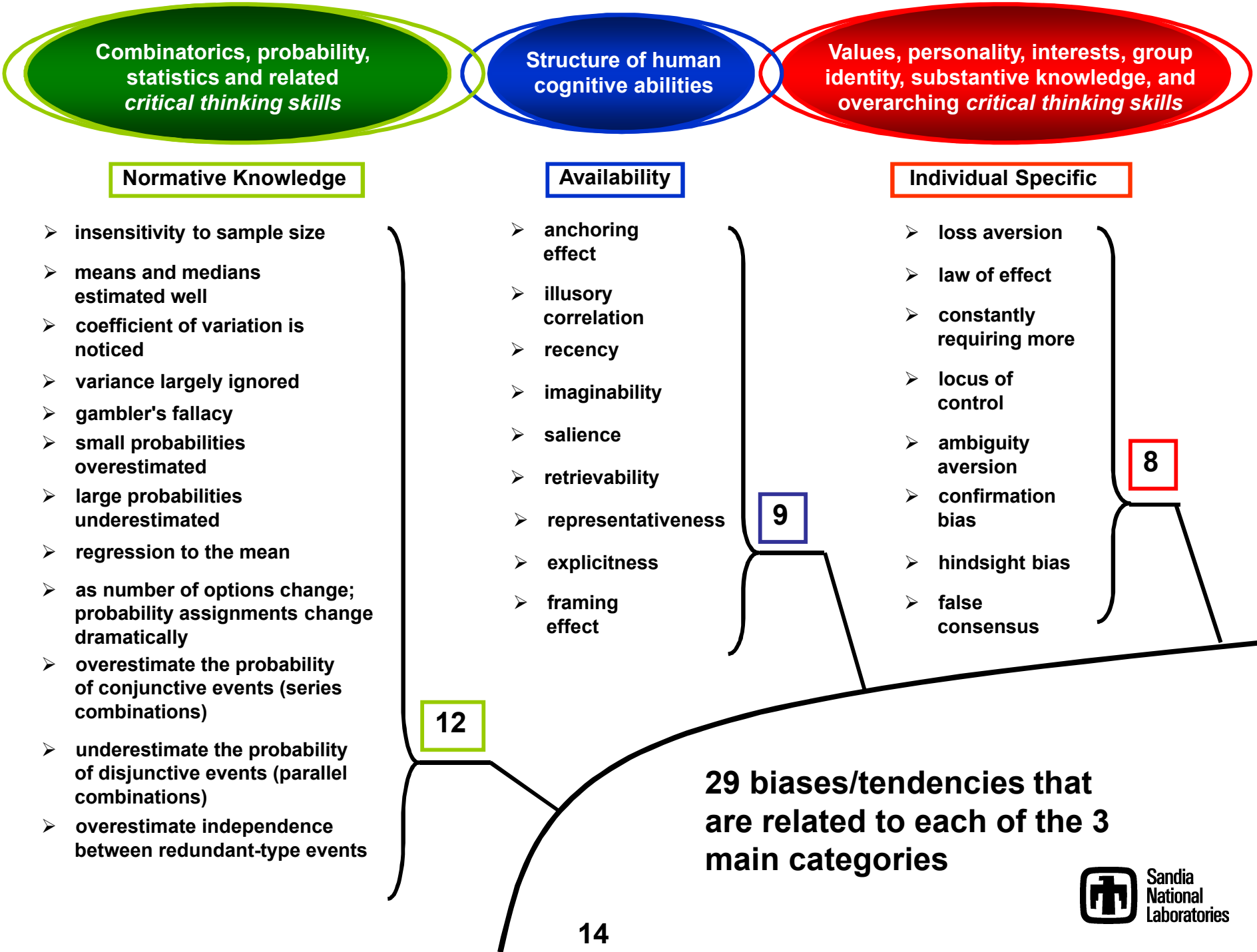


The human 'machinery'

Individual Specific



A specific person


Combinatorics, probability, statistics and related *critical thinking skills*
Structure of human cognitive abilities
Values, personality, interests, group identity, substantive knowledge, and overarching *critical thinking skills*
Normative Knowledge
insensitivity to sample size
means and medians estimated well
coefficient of variation is noticed
variance largely ignored
gambler's fallacy
small probabilities overestimated
large probabilities underestimated
regression to the mean
as number of options change; probability assignments change dramatically
overestimate the probability of conjunctive events (series combinations)
underestimate the probability of disjunctive events (parallel combinations)
overestimate independence between redundant-type events
12
Availability
anchoring effect
illusory correlation
recency
imaginability
salience
retrievability
representativeness
explicitness
framing effect
9
Individual Specific
loss aversion
law of effect
constantly requiring more
locus of control
ambiguity aversion
confirmation bias
hindsight bias
false consensus
8
29 biases/tendencies that are related to each of the 3 main categories
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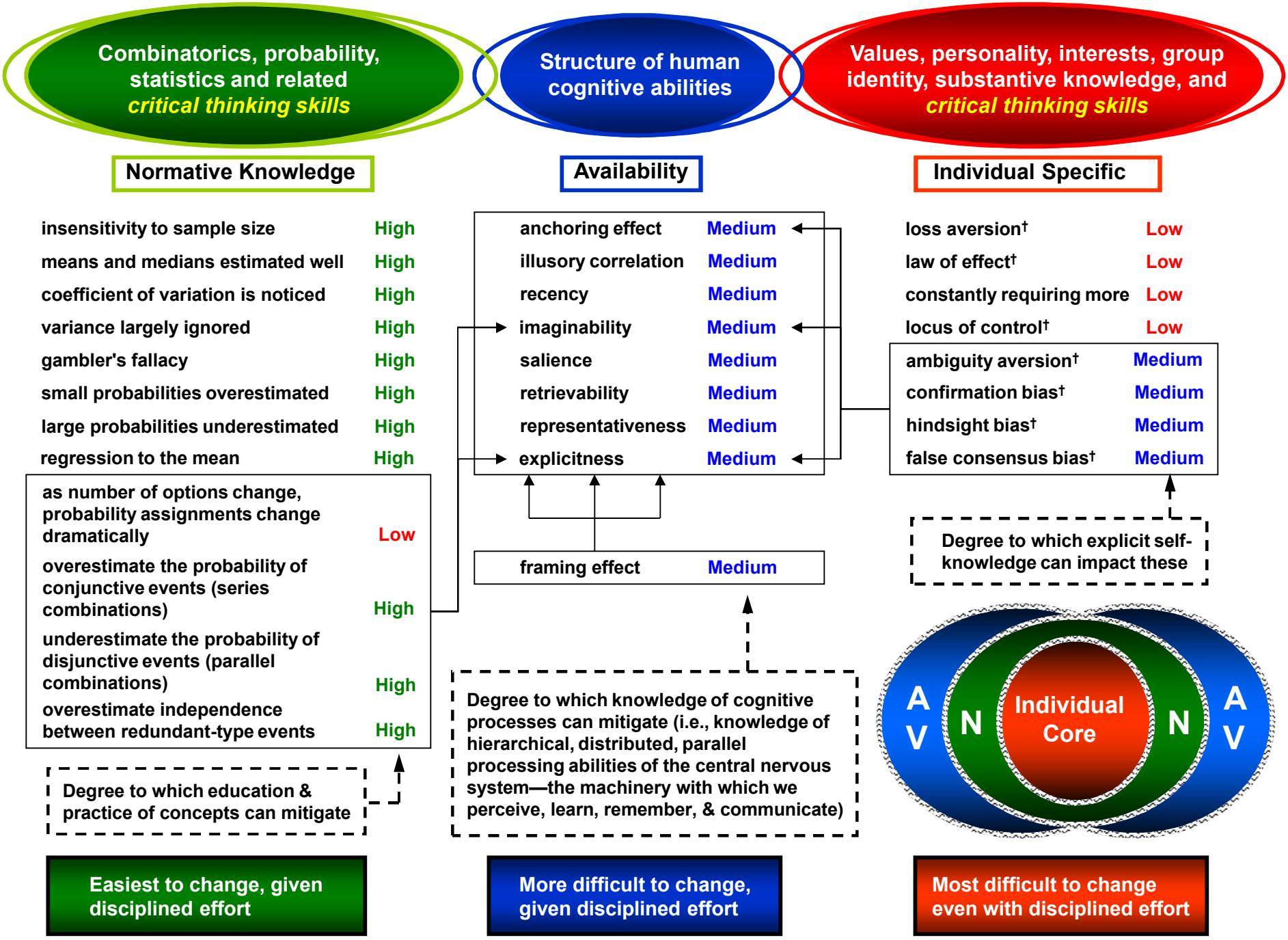
14



†Key for "overconfidence" phenomena

Critical thinking processes

1. Raising the **questions**: "What do we know…? How do we know…? Why do we accept or believe…? What is the evidence for…?
2. Clear and explicit awareness of **information gaps** (i.e., recognizing when one is taking something on faith).
3. Discriminating between **observation and inference**, between established fact and subsequent conjecture.
4. Recognizing that **words are symbols for ideas** and not the ideas themselves. Recognizing the necessity of using only words of prior definition, rooted in shared experience, in forming a new definition and in avoiding being misled by technical jargon.
5. **Probing for assumptions** behind a line of reasoning.
6. **Drawing inferences** from data, observations, or other evidence and recognizing when firm inferences cannot be drawn (i.e., **inference adequacy check**).
7. **Hypothetico-deductive reasoning**; apply relevant knowledge of principles and constraints, and abstract visualization of plausible outcomes from imagined changes imposed on the system.
8. Discriminating between **inductive and deductive reasoning**; that is being aware of when an argument is made from the particular to the general or from the general to the particular.
9. Test one's own line of reasoning and conclusions for **internal consistency**.
10. Develop **self-consciousness** concerning one's own thinking and reasoning processes.

Application of NAVIS to Knowledge Transfer

- **Provide structured basis for generating *explicit* self-inventories of biases, values, interests, & substantive knowledge**
  - **Exercises / word problems testing abilities relative to each of the normative knowledge biases and related critical thinking skills**
  - **Read multiple narratives and/or view carefully designed video programs and complete questionnaires to test abilities and awareness relative to availability biases**
  - **Complete interview/questionnaire process to capture individual specific characteristics and related critical thinking skills**

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Application of NAVIS to Knowledge Transfer

- Inventories could be used to identify training needs: bias awareness and mitigation, critical thinking processes, and teaching skills
- Periodic inventories (complete or partial) could help identify when an heir apparent may be ready to seek expert-level capability
- Comparison of NAVIS inventories could aid in identifying potential matches of experts and heirs apparent—these potential matches could then be 'gently encouraged' by providing opportunities for interaction
- Review of *all* or *part* of NAVIS inventories by parties in a knowledge transfer relationship could enable improved communication and strengthen the relationship over time

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Application of NAVIS to Knowledge Transfer

- **Periodic inventories could help identify when expertise is achieved (i.e., include expert, peer, and management input)**

  Note: Research is still required to fully articulate an efficient inventory/assessment and training process based upon the NAVIS approach

  However: SAND2005-5730 contains many specific bias mitigation techniques and a thorough exposition of the critical thinking processes and associated examples that could be readily applied to knowledge transfer.

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Conclusions

Effective & efficient knowledge transfer is essential for maintaining safety, stability, continuous improvement, & innovation within complex, high-consequence systems.

NAVIS-based knowledge transfer is proposed to provide a systematic basis for:

- **Preparing willing experts to be effective teachers**
- **Preparing willing heirs apparent to be effective pupils**
- **Helping identify matches of heirs apparent & experts**
- **Improving the knowledge transfer process—particularly if experts and 'heirs apparent' are in multiple relationships**
  - **Enabling greater understanding of backgrounds, biases, & bias mitigation**
  - **Achieving disposition of inquiry, observation, & inference that supports knowledge transfer**

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