Understanding, Predicting and Preventing bias

(through cognitive and individual differences psychology)

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Current Role(s)

- Senior Research Fellow
  - Australian School of Petroleum and Energy Resources
  - Industry Decision Making

- Tutor, Lecturer and Course Coordinator
  - ASPER and School of Psychology
  - Decision Making, Individual Differences & Human Factors

My Background

- B.A. (Hons) in Philosophy
- B.Sc. (Hons) in Psychology
- Ph.D. in Psychology
  - Structure and genetic basis of intelligence
- Graduate Certificate in Education (Higher)
- Currently getting my M.Psych. (Organisational & Human Factors)

Research Work pre-ASPER

- Networked Fire Chief
  - Ted Nettelbeck and Vanessa Mills (DST)
  - Communication architectures
  - Naturalistic decision making

- Decision Making
  - Michael Lee and Brandon Pincombe (DST)
  - Modelling decision making
  - Document similarity judgements
  - Optimal stopping rules for searches

Research Work ASPER

- Psychological Aspects of Decision Making
  - Steve Begg and Reidar Bratvold
  - Decision Analytic approach
- Heuristics and Biases
  - Understanding
- Elicitation Methods
  - Preventing
- Individual Differences
  - Predicting

What are Biases?

- Systematic deviations from normative decision making

- Motivational
  - Resulting from deliberate choices
  - Misaligned incentives

- Cognitive
  - Resulting from normal human cognition
  - Cognitive shortcuts and limitations

Cognitive Biases

- Tversky & Kahneman (1974) Heuristics and Biases
  - Named 3 heuristics and accompanying biases
  - since then….

Knowing vs Understanding

- We have named many more biases
  - Described how they affect people (in general)
  - Under what conditions

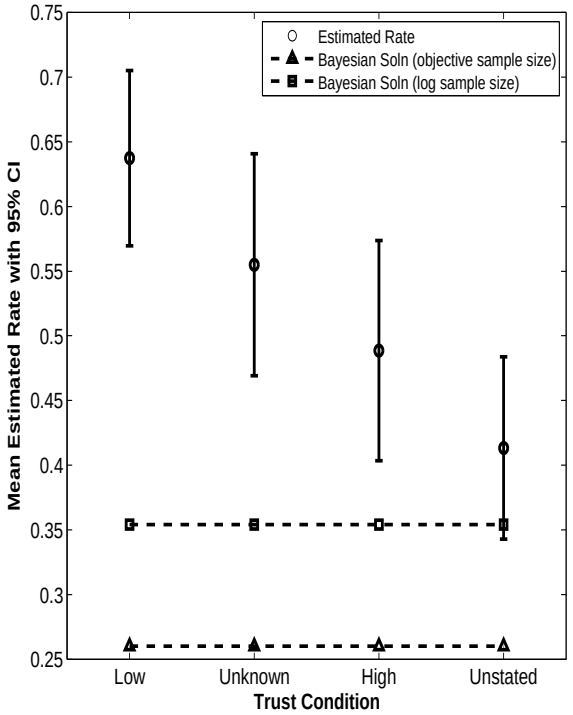
- Do we understand them?
  - Why do they occur?
  - Can we avoid them?
  - Who is most susceptible?

- If so, we could
  - Select good decision makers
  - Predict biases
  - Avoid them

Individual Differences in Biases

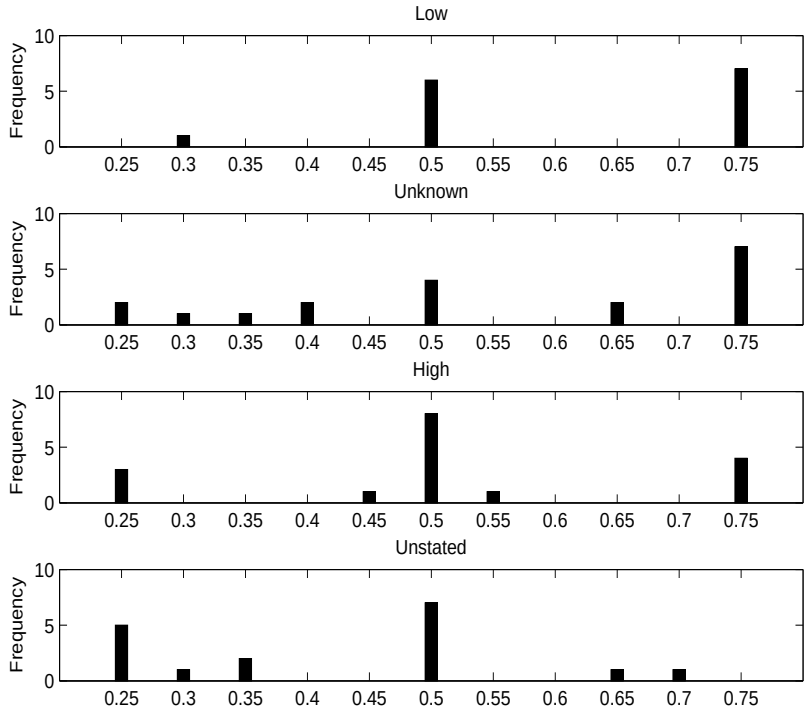
- Seeing is Believing (Welsh & Navarro, 2012)
  - Base Rate Neglect Experiments
    - Tendency for people to ignore base rates when given new information
  - Seeing if people are sensitive to the quality of base rates
    - Gave them base rate of 25%, new data suggesting a 75% rate and varied the reasons to distrust the base rate
  - Concluded they were sensitive to data quality
    - Greater trust in base rate

    => closer to 'optimal' solution
  - But….



Individual Difference in Base Rate Neglect

- Looking at the data closely people weren't combining the probabilities in expected ways
- Most were changing which number they were relying on or taking a simple average
- Looking at individual results suggested different strategies not captured by a simple definition



Solution Types

- Base Rate Neglect
  - Ignore base rate in favour of new data (choose 75)
- Base Rate Overreliance
  - Ignore new data in favour of base rate (choose 25)
- Mathematical Combination
  - Combine old and new rate – average, subtract or multiply (50, 50 or 18.75)
  - WORSE results than just ignoring the new data
- Bayesian Solution
  - Use Bayes Theorem to update probability

Implications

- Follow-up work
  - Mathematically inclined people more likely to combine rates
  - Did not always give better outcomes
- Better strategy => worse outcome
  - Depending on initial problem set-up
- Individual differences predicted what people would do
  - Not always how well they performed

=> Thinking about how to integrate bias and individual difference work

Experimental vs Psychometric Psychology

- Cronbach (1957) noted two disciplines of scientific psychology

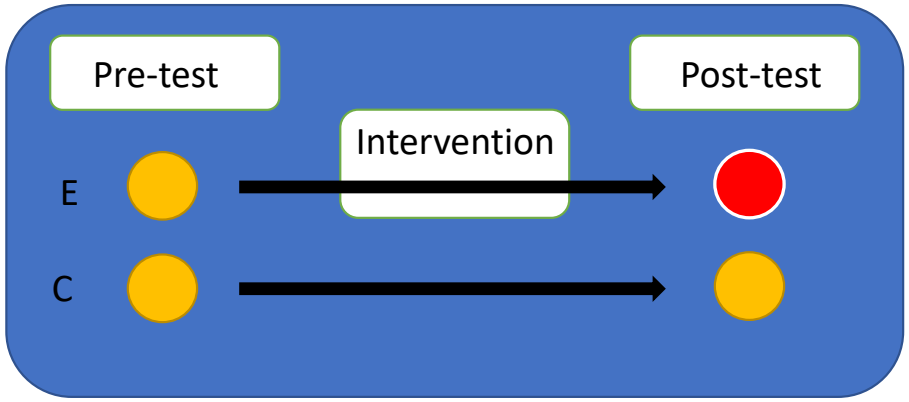
- Experimental: experimenter limits external factors by matching groups and manipulating single factors
  - Looking for commonalities in behaviour

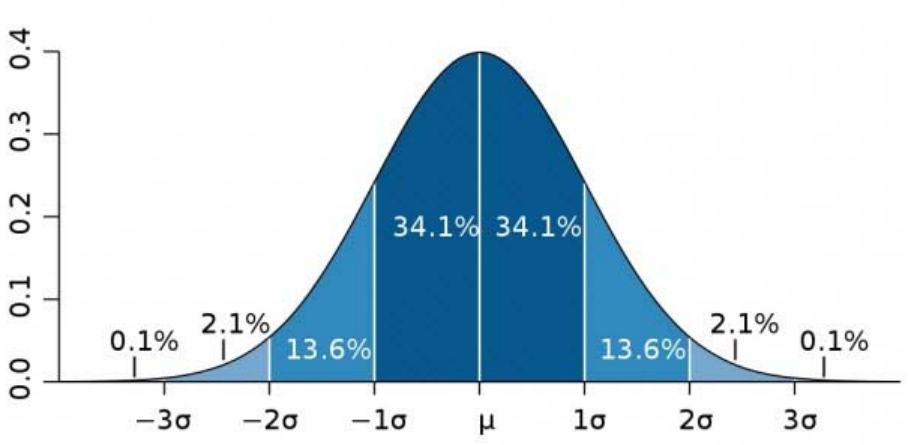
- Correlational: researcher examines pre-existing differences on traits and looks for the relationships amongst them
  - Looking for differences in behaviour

- But they don’t communicate….

Calls to close the gap…

- McNemar (1964)
- Eysenck (1967)
- Owens (1968)
- Carroll, Glaser & Pellegrino (1978)
- Sternberg (1978)
- Eysenck (1995)
- Kyllonen (1996)
- Caroll (1998)
- Gustaffson (1999)
- Deary (2001)





Previous Individual Differences & Bias work

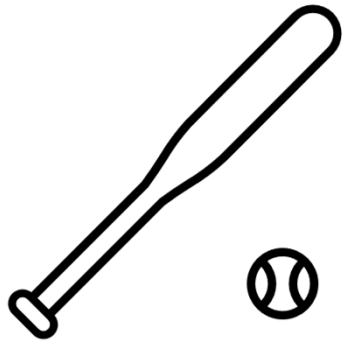
- Heuristics & Biases approach is cognitive/experimental
  - Looking for what ‘people’ do
- Not useful for selection of personnel
- Individual differences work has been patchy

Intelligence and Decision Making

- Stanovich & West (1998, 2008)
  - Argue intelligence and 'thinking biases' are largely independent
  - That intelligence tests don't assess 'rationality'

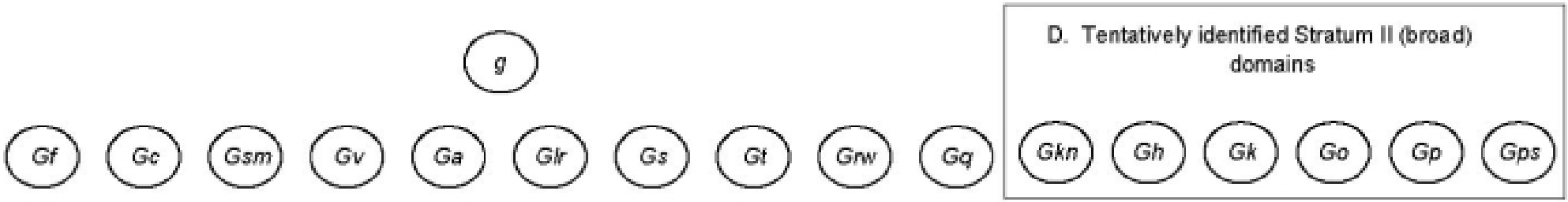
- Frederick (2005)
  - Cognitive Reflection Test
    - A bat and a ball together cost $1.10…
  - Predicts decision ability better than intelligence

- Measures of intelligence
  - Self-reported SAT and ACT scores
  - Wonderlic Personnel Test



X+Y = $1.10
X-Y = $1.00
Y = ?

Cattell-Horn-Carroll Model of Intelligence



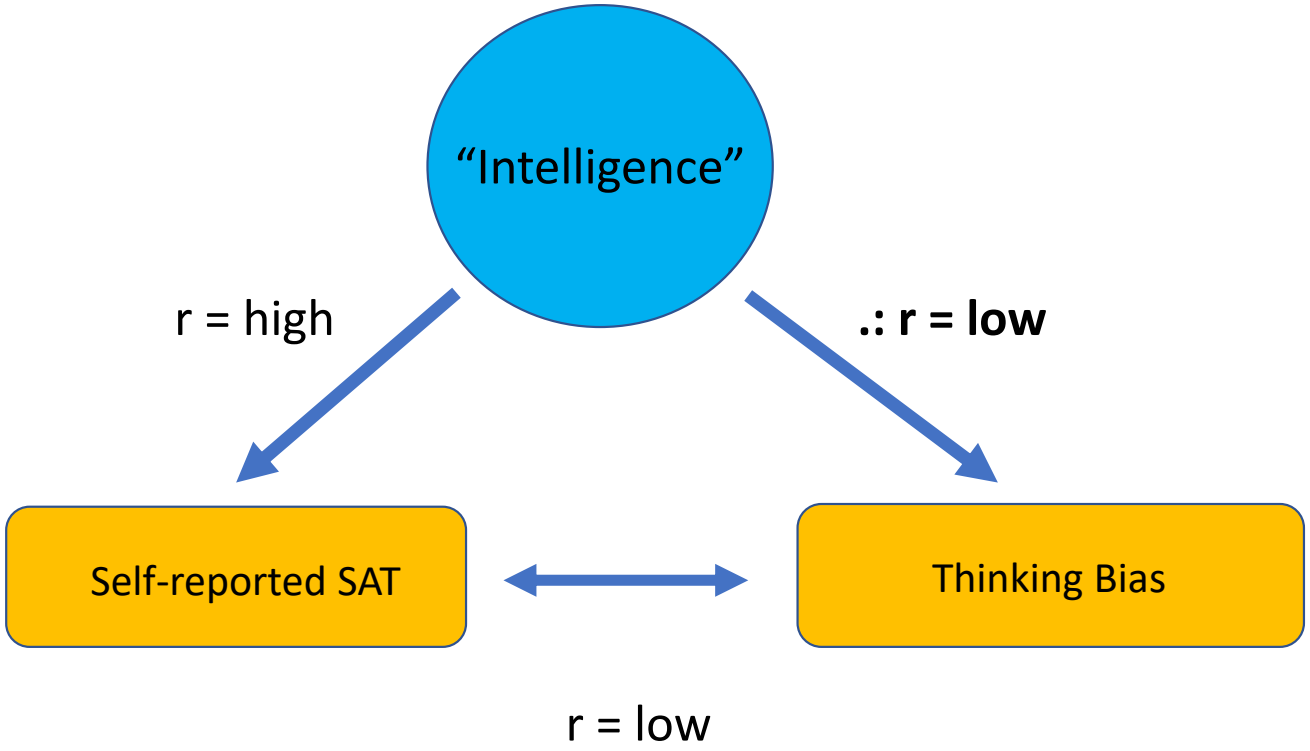
(Missing *g*-to-broad ability arrows acknowledges that Carroll and Cattell-Horn disagreed on the validity of the general factor)

CHC Broad (Stratum II) Ability Domains

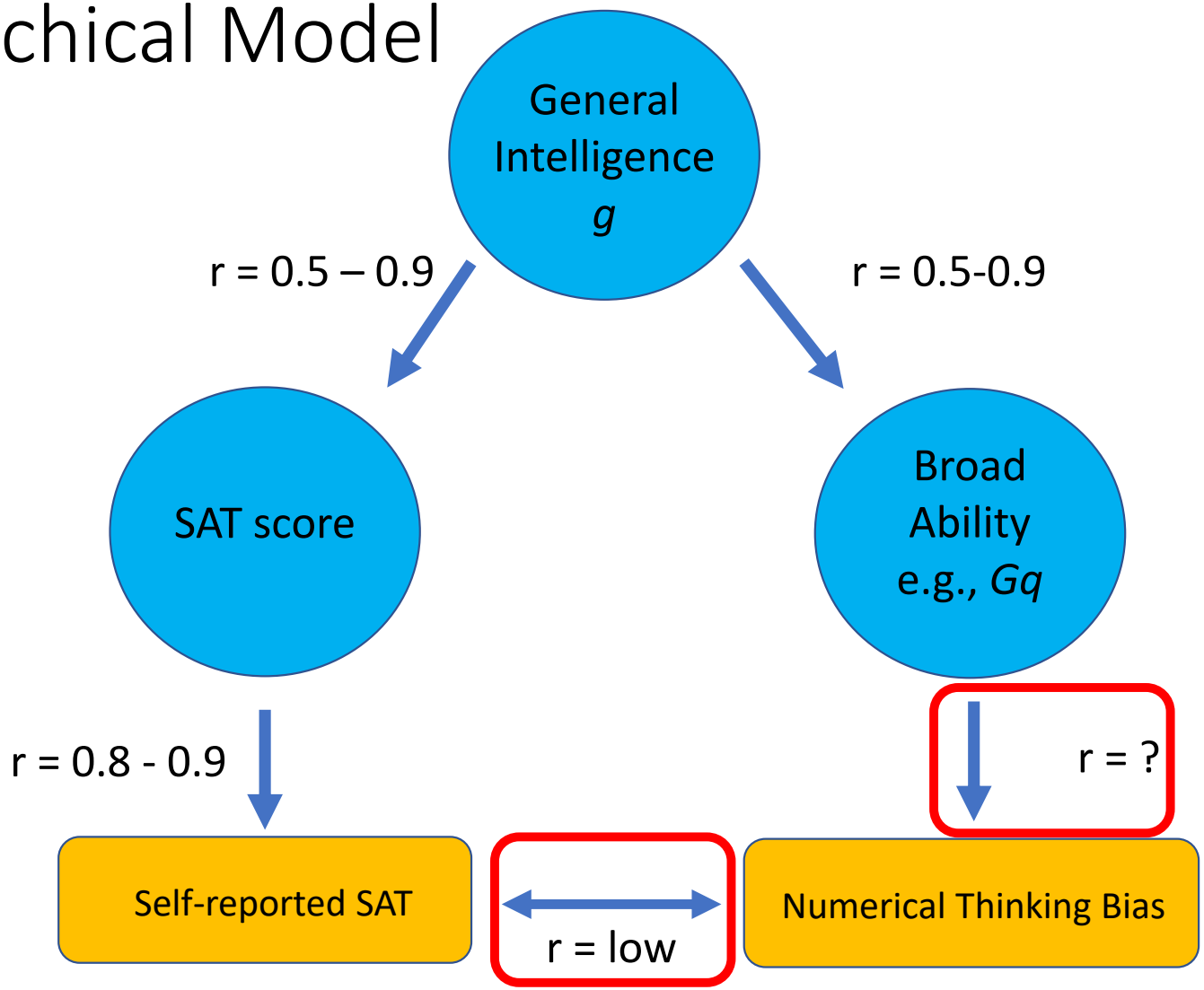
Gf	Fluid reasoning	*Gkn*	General (domain-specific) knowledge
Gc	Comprehension-knowledge	*Gh*	Tactile abilities
Gsm	Short-term memory	*Gk*	Kinesthetic abilities
Gv	Visual processing	*Go*	Olfactory abilities
Ga	Auditory processing	*Gp*	Psychomotor abilities
Glr	Long-term storage and retrieval	*Gps*	Psychomotor speed
Gs	Cognitive processing speed		
Gt	Decision and reaction speed	(see Table 1 for definitions)	
Gnw	Reading and writing		
Gq	Quantitative knowledge		

From McGrew (2009)

Unitary Model



Hierarchical Model



Benefits of using Hierarchical Model

- Clarify relationships by direct measurement of mediating variables
- Broad abilities map onto cognitive processes
  - *Gsm* ≈ short term memory
  - *Glr* ≈ retrieval from long term memory
  - *Gc* ≈ long term memory
- Predictions of which biases will relate to which abilities
- Pattern of correlations can point to biases' modes of action

Example: Overconfidence

- Overconfidence (overprecision)
  - Producing ranges that capture true/future values less often than expected
  - Asked for ranges people are 80% confident in yields ~40% accuracy
- Capen (1976) tested oil industry people's overconfidence
  - Ranges expected to contain 80% of true values captured: 32.9%
- Norwegian oil production data (2018)
  - Ranges expected to contain 80% of true values captured: 45.8%
- Why so little improvement?
  - People *resist* efforts to reduce their overconfidence
  - Maybe we don't understand WHY they are overconfident

Causes of Overconfidence

- Informativeness
  - Preference for best guesses over ranges
    - A) Mt Everest is between 7 and 8 km high
    - B) Mt Everest is between 5 and 15 km high
  - Prefer A over B - even knowing it's wrong
  - Because it is more *informative* of where that person's best guess is.

- Memory effects

Memory and Overconfidence

- Naïve Statistician
  - Overconfidence caused by limited sampling within short term memory
  - .: expect stronger link with Gsm

- Misremembering
  - Memories encoded incorrectly
  - Failure to recall information accurately

Memory, Hindsight Bias and Overconfidence

- Hindsight Bias
  - People update their memories when new information arrives
  - I.e., they “remember” predicting things they didn’t predict
  - Increasing their confidence…
  - .: expected stronger link with Gc or Glr

- This is a feature, not a bug
  - Updating your understanding of the world is necessary
  - Keeping old, incorrect expectations is cognitively expensive

Individual Differences in Memory

- Bias research is based in cognitive psychology
  - Concerned with typical or universal behaviours
  - Not differences between people
  - Has used ‘blunt’ measures of ability

- Do individual differences in memory correlate with overconfidence?
  - Relationships could help isolate the cognitive causes of bias
  - Memory Processes ≈ Broad Cognitive Abilities (CHC Model)

Overconfidence & Intelligence

- N=300
- Broad ability factors derived from sets of cognitive ability tests
  - *Gc.* Crystallized
  - *Glr.* Long Term Retrieval
  - *Gsm.* Short Term Memory

Gc	Glr	Gsm
.23***	.20***	.13*

Conclusion

- Overconfidence is linked to Hindsight Bias
  - Correlation between these is 0.37
  - Both biases predicted by Long Term Memory
    - Gc – crystallized intelligence
    - Glr – retrieval fluency
- Naïve Statistician model is not supported
  - Gsm - Short term memory doesn't have much effect
  - Correlation goes away if fluid ability, Gf, is controlled for
- Incorporating individual differences clarifies underlying structure

Other Biases

	Gf	Gc	Glr	Gq	Gsm
Illusory Correlations	.47***	.34***	.18**	.39***	.16**
Sample Size Invariance	.28**	.17**	.10	.28**	.08
Confirmation Bias	.23**	.17**	.15**	.17**	.13*
Outcome Bias	-.01	.14*	-.03	-.02	-.03
Base Rate Neglect	.23**	.04	.01	.35***	.28**
Anchoring	.12*	.10	.00	.16**	.09
Availability (Rare events)	.26***	.37***	.35***	.16**	.03

* p <.05, ** p <.01, *** p <.001

Conclusions

- Overly simple models of intelligence can obfuscate relationships
- Different broad abilities predict different biases
- Incorporating individual differences allows us to:
  - More accurately predict susceptibility to particular biases
  - Test alternative hypotheses about causes of bias
  - Gain insight into underlying cognitive processes
  - Gain insight into the taxonomy of biases

What's next?

- Incorporating individual difference with biases
  - Improves our understanding of the nature of bias
  - And our ability to predict performance

- Improving Debiasing and Elicitation
  - Interventions requiring people to override core cognitive processes are unlikely to work
  - As are those targeting the wrong processes (e.g., STM for overconfidence)
  - Interventions that understand and take account of the processes involved should be more effective

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