Real but Only When Measured: On the Principle Entanglement of Psychological Constructs and Measurement

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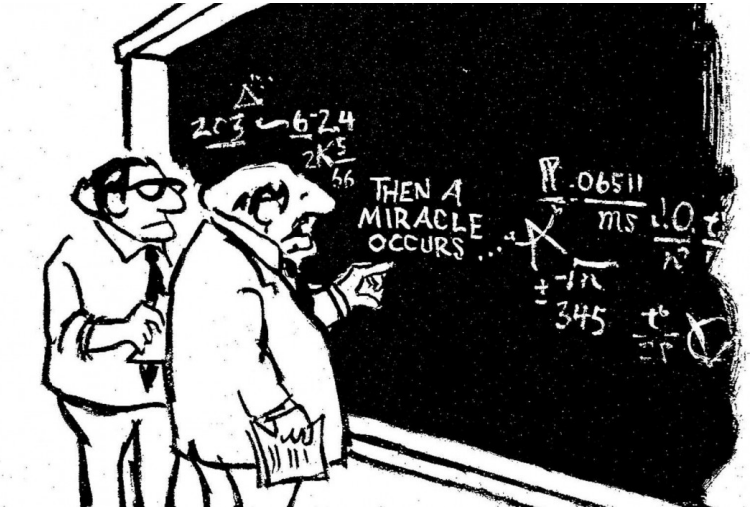
Measurement in Psychology



Goal

A General Theory of Measurement Effects in Psychology

Outline

- The Attitudinal Entropy (AE) framework
  - Principles
- Implications for meaurement
  - Measurement error
  - Measurement bias
  - Measurement all the way down
- Philosophical implications

The Attitudinal Entropy (AE) Framework

Principles

- Attention & thought reduce mental entropy[1]
- Formal implementation based on the Ising model[2]

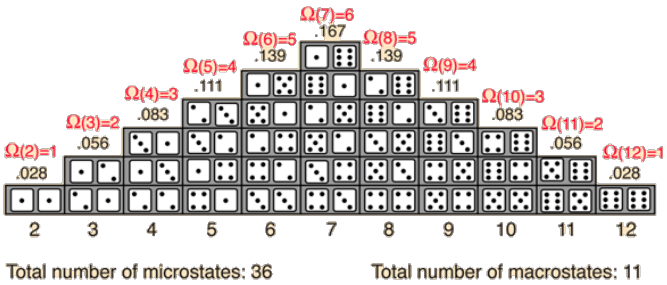
[1] Dalege, J., Borsboom, D., van Harreveld, F., &, van der Maas, H. L. J. (in press). The Attitudinal Entropy (AE) framework as a general theory of individual attitudes. *Psychological Inquiry*

[2] Ising, E. (1925). Beitrag zur Theorie des Ferromagnetismus [Contribution to the theory of ferromagnetism.] *Zeitschrift für Physik, 31*, 253-258.

The AE framework

Principles

- Micro- and Macrostates of Attitudes:
  - Microstate: Exact configuration of attitude elements
  - Macrostate: Number of positive vs. negative attitude elements

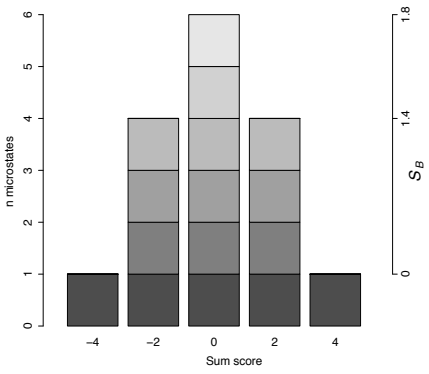


The AE framework

Principles

(a) **Boltzmann Entropy**

$$S_B = \ln W \quad (1)$$



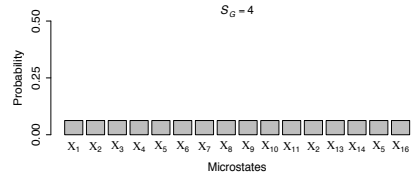
The AE framework

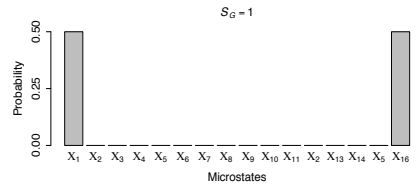
Principles

(b)

Gibbs Entropy

$$S_G = -\sum_X \Pr(X)\log_2\Pr(X) \quad (2)$$





The AE framework

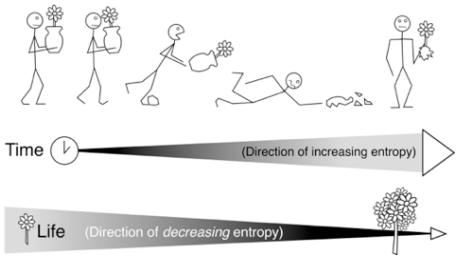
Principles

- 2nd law of thermodynamics: Entropy (of a closed system) *always* increases

The AE framework

Principles

- Living organisms *must* reduce their entropy[3]
- Reduction of entropy: most important evolutionary fitness criterion[4]



[3] Schrödinger, E. (1944). *What is life?* Cambridge: Cambridge University Press.

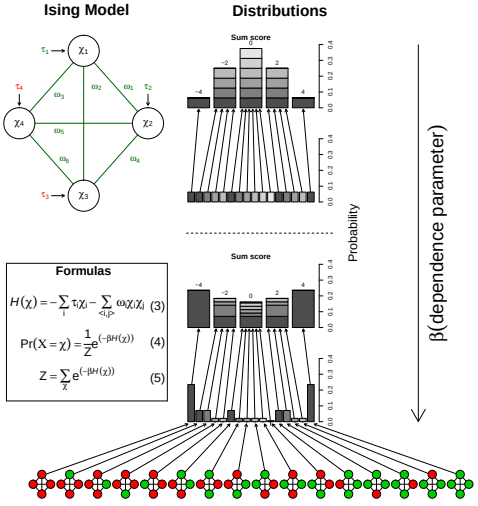
[4] Kauffman, S. A. (1993). *The origins of order: Self-organization and selection in evolution.* New York: Oxford University Press.

The AE framework
Implications for Measurement

- Psychological measurement principally requires the attention of the subject
  - $->$ measurement influences the consistency of the construct
  - $->$ more attention required by the measurement $=$ higher consistency of the construct
  - no measurement $=$ maximum entropy $=$ construct is nonexistent

The AE framework

Implications for Measurement



The AE framework

Implications for Measurement: Explaining Implicit Measures

- 'Puzzles' of implicit measures:[5]
  - Individual level: low stability, weak behavior prediction
  - Group level: high stability, strong behavior prediction

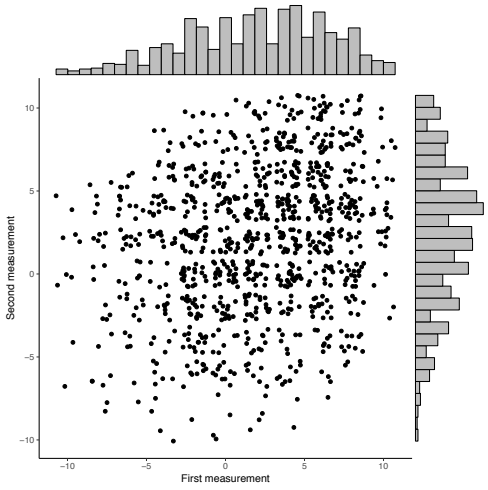
[5] Payne, B. K., Vuletich, H. A., & Lundberg, K. B. (2017). The bias of crowds: How implicit bias bridges personal and systemic prejudice. *Psychological Inquiry, 28*, 233-248.

The AE framework
Explaining Implicit Measures

- Network with ten nodes
- 1000 simulated individuals
- Dispositions of beliefs vary uniformly between mildly negative to strongly positive
- 1000 runs per individual
- First measurement after 500 runs, second measure after 1000 runs
- Low β

The AE framework

Explaining Implicit Measures

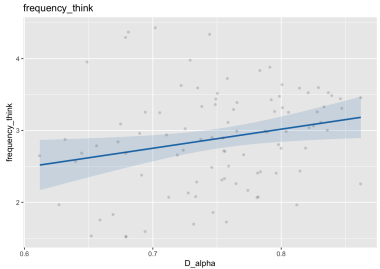


- Low correlation
  - $r = .24$, $p < .001$
- Means virtually the same:
  - First measurement: 1.91
  - Second measurement: 2.04
  - $t\ (999) = 0.71$, $p = .479$
- Substantial variation
  - First measurement: $\sigma = 4.55$
  - Second measurement: $\sigma = 4.45$

The AE framework

Recent Direct Test of Prediction of the AE Framework[6]

- Test of relation between thought and consistency
  - $>$ 150,000 participants
  - Each participant was administered one of 190 different IATs
  - Ratings of how often participants think about the topic of the IAT



$\beta = .24, p = .021$

[6]Van Dessel, P., De Houwer, J., Hughhes, S, & Hussey, I. (in press). An Analysis of the Scientific Status and Limitations of The Attitudinal Entropy Framework and an Initial Test of Some of Its Empirical Predictions. *Psychological Inquiry*.

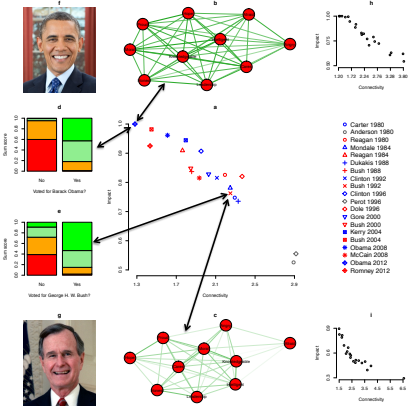
Implications for Measurement

Measurement Error

- Defintion: *Random* variation around construct score
- Requires assumptions:
  - 1. Construct score exists independent of measurement
  - 2. Random variation is *only* caused by imperfect measurement
    - $->$ should not relate to anyhing

Implications for Measurement

Consistency of Political Beliefs Predicts Impact on Voting Decision[7]



[7] Dalege, J., Borsboom, D., van Harreveld, F., Waldorp, L. J., & van der Maas, H. L. J. (2017). Network structure explains the impact of attitudes on voting decisions. *Scientific Reports, 7*, 4909

Implications for Measurement

A Theory-Driven Approach to Measurement Error

- Measurement error is only random variation that is *not* caused by:
  - the measured construct
  - the measurement instrument
  - the measurement context
- Might be so small that it is negligible

Implications for Measurement

Measurement Bias

- Defintion: *Systematic* variation around construct score
- Again requires assumption of measurement-independent construct score
- Alternative: Measurement as simulation of real-world analogue

Implications for Measurement

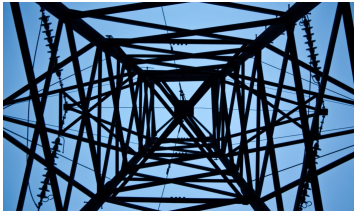
Measurment all the Way Down

- Everyday-processes as analogues of measurement
  - Conversations
  - Thinking
- Implications
  - Thinking leads to a narrower probability distribution
  - Measurement can affect the nature of psychological constructs

Philosophical Implications

Structural Realism

- Structure is all that matters - entities might not be real[8]
- Focus on what psychological constructs *do* and not what they *are*
- Consistent with Dennett's theory of the intentional stance[9]
- Psychological constructs are not reducible to states of the brain



[9]Ladyman, J. (1998). What is structural realism? *Studies in History and Philosophy of Science, 29*, 409-429

[9]Dennett, D. C. (1989). *The intentional stance*. MIT press.

Philosophical Implications
Mental Causation

- Specific instance of downward causation
- Downward causation by coarse-graining[10]
- Coarse-graining shares similarities with entropy reduction

[10] Flack, J. C. (2017). Coarse-graining as a downward causation mechanism. *Philosophical Transactions A, 375*, 20160338

Thank you!

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