Conceptual Focus: A practical guide to understanding levels of analysis in science

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An Intuition and a Paradox

- A hierarchy of psychiatric entities

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  - Problems in living
    - Marital status, bankruptcy
  - Complex psychiatric
    - Neurosis, dysphoria

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  - Complex neurological
    - Dementia, Parkinson's
  - Major Genetic Disorders
    - Huntington's, Down's
  - Frank brain disease
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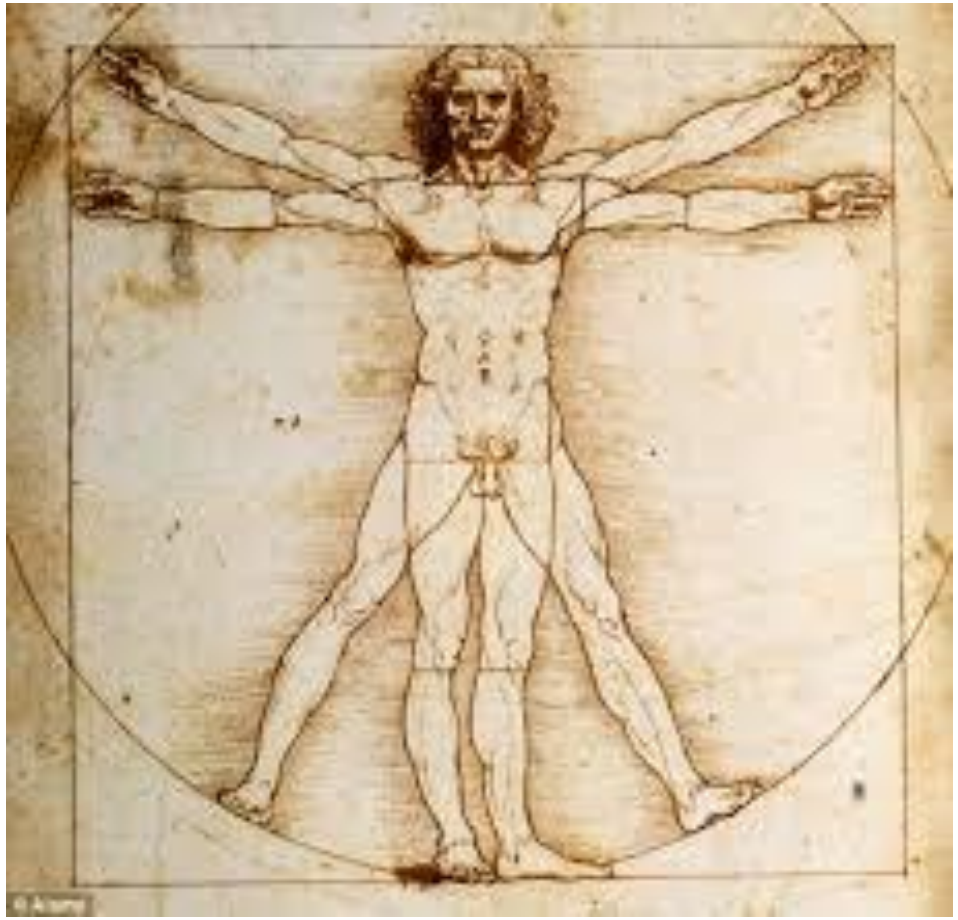
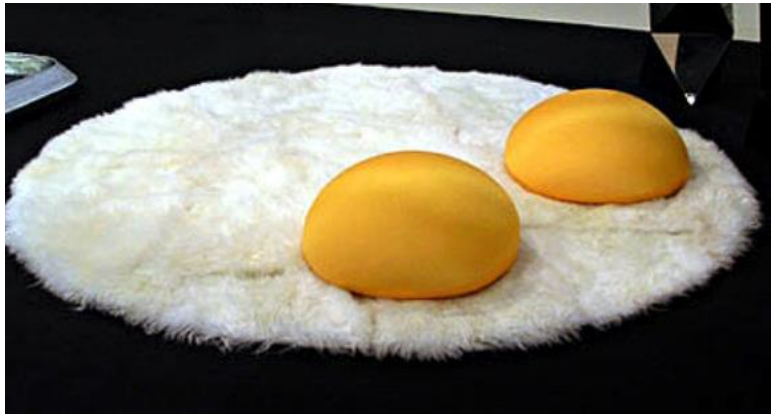
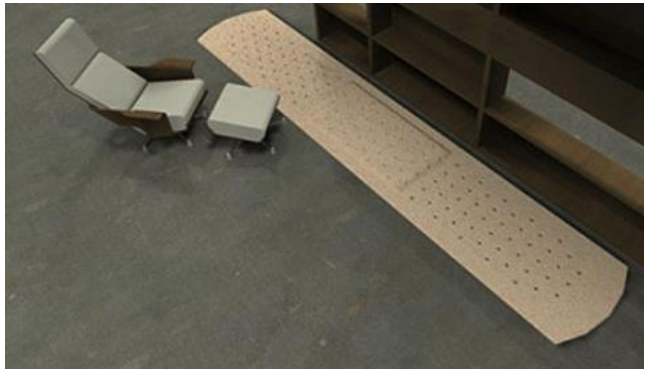
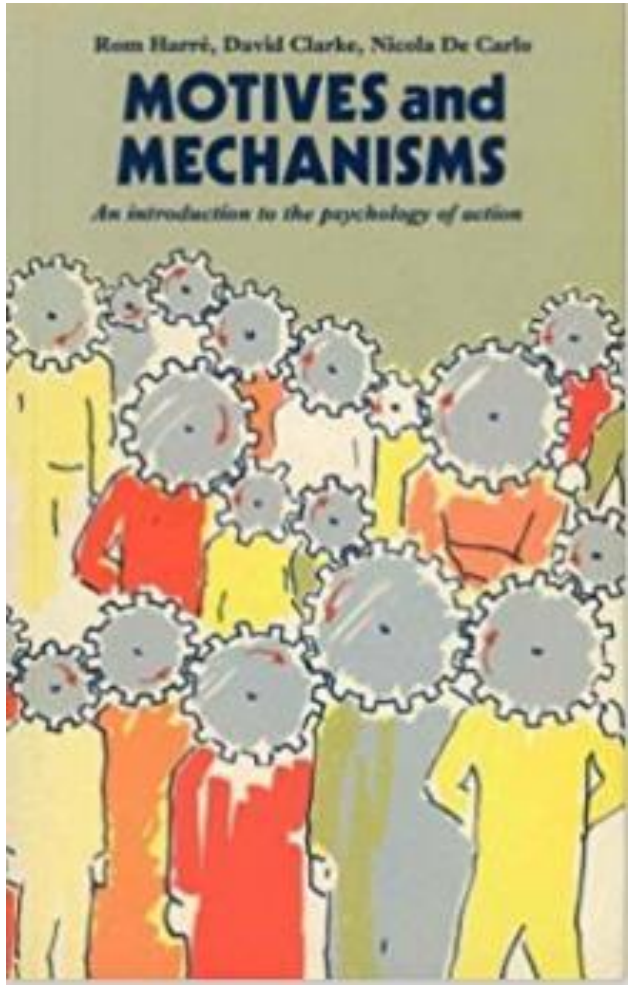


Physics of Carpets





Rom Harré


Rom Harré, David Clarke, Nicola De Carlo
MOTIVES and MECHANISMS
An introduction to the psychology of action


represented in iconic models.
Perceptible
Manipulable
Manipulably
affordances
conservative
ontologically
indeterminate

Harré, Rom & DeCarlo

But it is just this apparently sensible point of departure that leads to the problems. First, familiar categories of phenomena do not always correspond one-to-one with sensible divisions of the underlying process. In other words, although every product is produced by a process, the same kind of product is produced sometimes by one kind of process, sometimes by another. This is why there is no 'physics of carpets'. Of course, every feature of every particular carpet is produced by some particular physical and chemical processes, which could serve as an explanation for colour (why *this* carpet is just *this* colour), but there are all sorts of ways of making carpets of a given colour and texture. Furthermore, carpets are human artefacts, and what makes something a carpet is a human convention. So no coherent branch of physics could, in its own right, represent the study of carpets and all the processes that go to make them what they are, taken as a set. To put it another way, carpets are not a *natural kind*. For the same reasons, the psychological explanation for social

Original Articles

The Physics of Carpets

G. A. Carnaby & E. J. Wood

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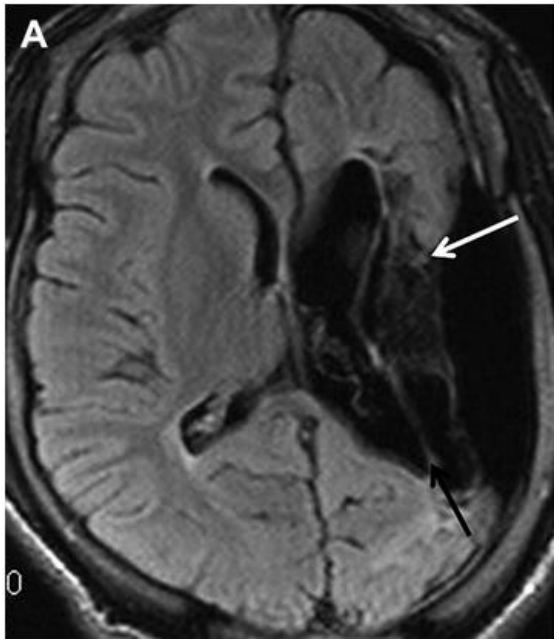
Abstract

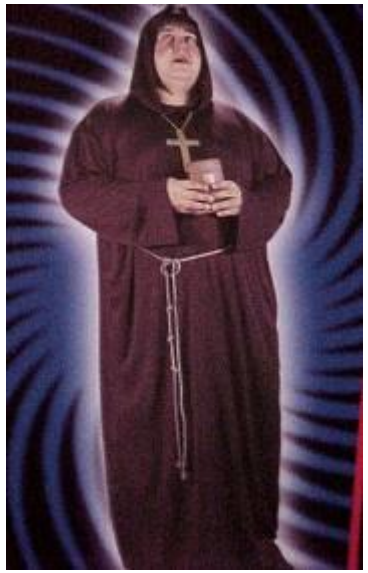
The physical properties of a carpet, especially the mechanical and optical properties, largely determine its performance as a floorcovering. The mechanical properties influence the walking comfort and are closely linked to the changes in appearance during wear. New instrumental techniques, notably those using digital image analysis, are being developed in order to quantify the texture characteristics of the pile. These are now being used in product optimization.

Physics of Carpets

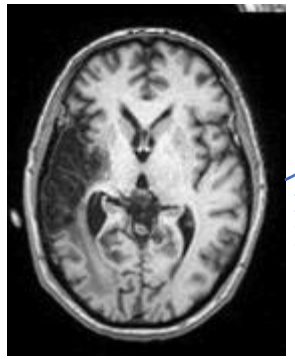
- Evidently it isn't crazy to talk about the physics of carpets
- Of course carpets "have" or "embody" physics
- On the other hand it wouldn't occur to us to ask what physical properties "cause" something to be a carpet
- Or physical "markers" of carpet status
  - Although there is nothing preventing it
- Notice that the mechanical and optical properties the article talks about are independent of carpets *per se*
- Some physical properties make things in general (not just carpets) more durable or brighter

Silence: The Aphasic And the Monk





Behavioral Consequences of Stroke



Mood changes

Cognitive Function

Aphasia

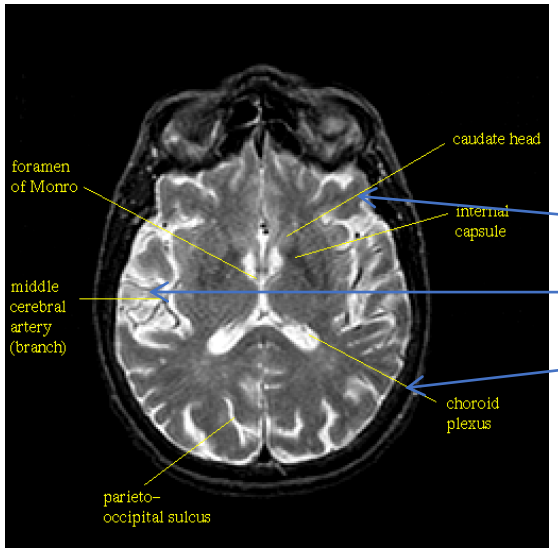
Right Side Weakness

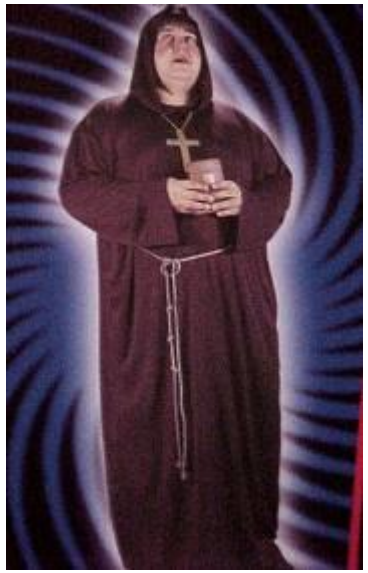
Personality Change

Circumscribed neurological event

Diffuse phenotypic changes

Neurological / Genetic Correlates of Ascetic Silence





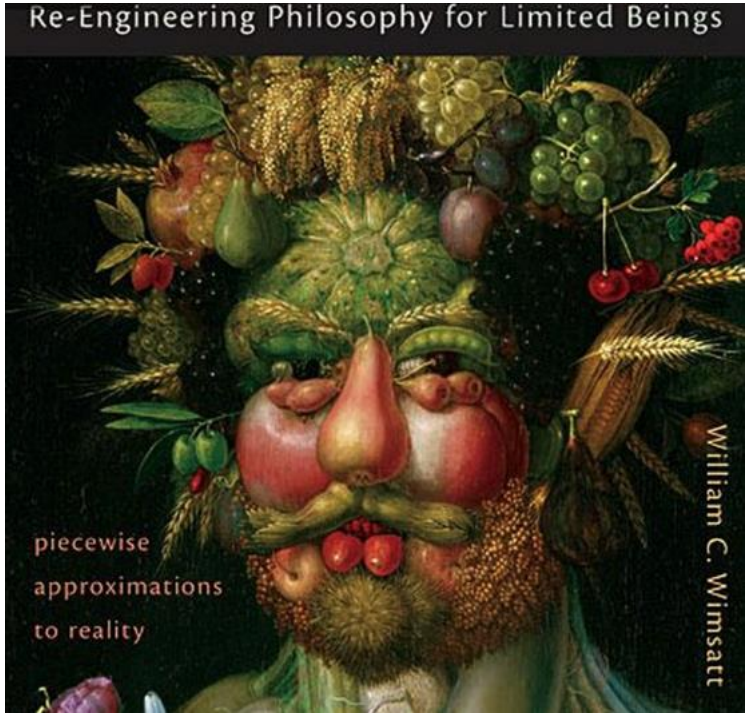
Diffuse neurological (or genetic) background

Circumscribed behavioral phenotype

Monks are like carpets

- Monks have brains and genes
- There are certainly probabilistic relations of certain neurologic or genetic qualities with religious devotion
  - Religiosity is heritable
  - Very occasionally, religious devotion turns out to be the result of a specific neurological event (temporal lobe epilepsy)
- Nevertheless, the genetics/neurology of monkdom is going nowhere
- Why?

Wimsatt on levels and entities



Wimsatt

- Wimsatt views levels in a fairly literal way, as the hierarchical scale of the physical world
  - *By level of organization, I mean here compositional levels- hierarchical divisions of stuff (paradigmatically but not necessarily material stuff) organized by part-whole relations, in which wholes at one level function as parts at the next (and at all higher) levels. (201)*
- Wimsatt is committed to the theoretical necessity of higher levels
  - *Nor should it be taken as implying, either in evolutionary history, or in current state-of-the-art genetic engineering, that usually or always, the preferred, most effective, or (stepping back to punt) even a practically possible way of making a given upper-level object is by assembling a bunch of lower-level parts.*

Wimsatt

- Entities are real objects, “robust” regularities in the world that can be detected by multiple methods
  - *At a certain stage, we will accept the existence of the entity or property as established-however corrigibly-and begin to use the differences observed through the diverse means of access to it as telling us still more about the object. (It is after all that kind of thing or property that is detectable via these diverse means, and shows itself differently through them.)*
- The level at which entities exist is an empirical matter of utility
  - *Theories come in levels (to analogize an observation of John Dillinger) because that's where the entities are. Simpler theories can be built with those entities (and their major interactions) than with slightly larger or smaller or otherwise different ones. On this account of the theorist as bank robber (or forager, or economist), theories of entities at levels provide the biggest bang for a buck.*

Wimsatt

- People live mostly at a particular mid-scale level
  - *We live in or at one, and most of our important everyday interactions are with other entities at our level of organization-i.e., with people, tables, chairs, cars, dishes, or computers. We don't normally interact with a person's cells, or with a computer's memory chips. Persons and computers are designed to be opaque with respect to the operation of their lower-level hardware-we don't usually "see" such hardware details unless they cause a macroscopically observable malfunction, or unless we take the deliberate and special additional steps to allow us to observe things at different levels. Most of the explanations of the behavior of an entity, and most of the means for manipulating, causing, or modulating its behavior, will be found and most naturally expressed in terms of entities, properties, activities, and regularities at the same level. Our level is our common world of folk psychology, or more broadly, of the objects that populate Sellars' "manifest image" or its scientific same-level descendants.*

Interlude 1: Entity Focus

- We can take an analogy from optics, in which our distance from objects determines whether they are in focus
- Blurry objects don’t disappear, it just becomes impossible to see their edges
- Step 1 in analyzing a visual scene is focusing on the objects that interest you

Interlude II: obvious point

- People exist at many levels: molecules, genes, neurons, organs, individuals societies etc.
  - Yes as commonly noted it is possible to study people at multiple levels
- Entities, per Wimsatt, do not exist at all levels
  - That is why there is no physics of carpets
  - Not because carpets aren't physical, but because the entity "carpets" is out of focus at a physical level
  - Monks are out of focus in the genome; stroke lesions are out of focus behaviorally
- In the same way, the entity "dopaminergic neurotransmitter" is out of focus at a person level
- But it isn't as though entities disappear when you are at a sub-optimal level. You just can't see their edges. They are blurry.

Interlude III: Causation and Composition

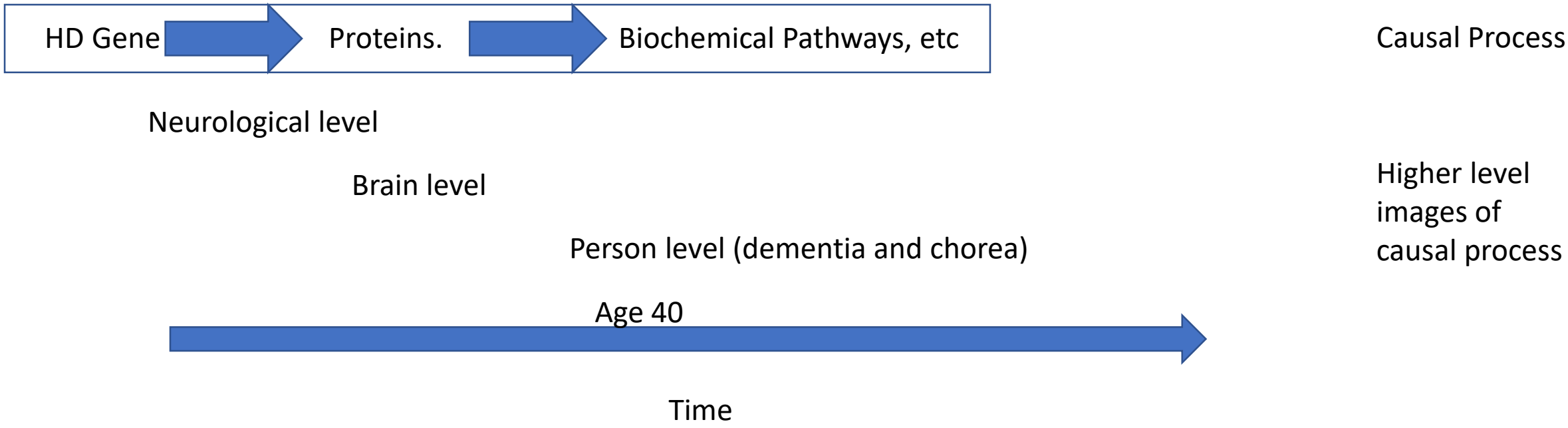
- Wimsatt: *I suspect that [reductionistically inclined writers] are bothered here by the feeling that some entity under one description is the cause of its own behavior under a different description.*
  - Entities are interlevel in the sense that monks have genes and neurons, and stroke patients have experience
  - But the causes of religious devotion are psychological, and the causes of stroke are physiological
- *Compositional* assertions (carpets are more likely to be made of wool than fiberglass)
  - Aren't causal assertions
- It's wrong to say that religious devotion causes something on an fMRI, or the other way around, because they are simultaneous. Two representations of the same event.
  - You can't change someone's (focused) religious attitudes via brain stimulation
  - But that is a problem in level-focus, not causation

Causation and Composition IIIb: Genes

- That story is easy to tell for carpets and wool or fMRI and religious devotion, since the two are literally simultaneous
- But what about genetics?
  - Plomin and von Stumm: *GPSs are unique predictors in the behavioural sciences. They are an exception to the rule that correlations do not imply causation in the sense that there can be no backward causation when GPSs are correlated with traits. That is, nothing in our brains, behaviour or environment changes inherited differences in our DNA sequence.*
- Isn't HD gene at conception the cause of adult HD symptoms?

Causation and Composition III: Out on a limb

- No, the HD gene doesn't cause HD, it *is* HD
  - Genes cause gene-level things
  - The person-level manifestations of HD gene don't come into focus until adulthood
  - Clinical HD is a blurry image of a focused genetic entity
  - Things don't usually work out this way



Activities for level-based scientists

- At what level is my entity focused?
  - There is a suite of formal and informal activities that we use to diagnose whether we are operating at too high or low a level. If we are *in focus*.
  - Is my entity actually a blurry image of an entity that is actually focused at a higher or lower level?
- What are the causes of my entity?
  - Contingent on first activity
  - Intra-level exogenous relations with other entities
- Can I learn anything about my entity by studying it at a different level of analysis?
  - Physics of carpets
  - Genetics of religiosity
  - Phenomenology of HD

Is my apparently high-level entity actually a blurry image of an entity at a lower level of analysis?

- It is always cool when something we thought was focused at the person level turns out to be a blurry image of something that is *really* focused at a lower level
- Single gene disorders, like Huntington's
  - HD was known as a syndrome before genetic mechanism was understood
- In 1913, it was discovered that syphilitic spirochetes were the cause of general paresis
  - Psychiatry has been waiting 100 years for it to happen again

Methods to detect entities at LOWER level of analysis (Am I at TOO HIGH a level?)

- Meehlian taxometrics (entities = taxa = latent classes)
- Many casual indicators
  - Historical and cultural invariance
  - Resistance to psychological intervention
  - Unfocused causal relations with high-level constructs
  - Qualitative discontinuity with normal experience
  - Phenomenology of trait acquisition
  - Phenotypic null hypothesis of heritability (violation)
  - Kendler coherence
  - Crisp low-level medication response
- The answer is almost always NO, most apparently high-level entities ARE high-level
  - It isn't that it can't happen, but all the spirochetes and aphasias have already been found.

Methods to detect entities at HIGHER level of analysis (Am I at TOO LOW a level?)

- Meehlian taxometrics
- Boorsbom networks vs latent variable models
- Many casual indicators
  - Historical and cultural variability (eg HD vs religiosity)
  - Amenability to psychological intervention
  - FOCUSED causal relations with high-level constructs
  - Qualitative continuity with normal experience (schizophrenia v. anxiety)
  - Phenomenology of trait acquisition
  - Phenotypic null hypothesis of heritability (null)
  - Kendler coherence
  - “Probabilistic” gene effects
  - Pleiotropy
  - Side effects of low-level medications

Even if my entity is high-level, what does the low-level blurry image look like?

- Carpets are more likely to be made of animal fibers than they are of metal fibers
  - Why?
    - Material properties, economics, aesthetics
- Depressed people are more likely to be composed of some genes / neurons / whatever than others
  - This may or may not be a useful thing to know

Even if my entity is low-level, what does the high-level blurry image look like?

- Phenomenology
- Neuropsychology of aphasia
- Descriptive behavioral pathology of HD
- Medical anthropology
- Supportive psychotherapy
- Useful medications, side-effects notwithstanding

Level-Focus Errors are Asymmetrical

- Conducting unfocused research about high level entities at a lower level
  - Serotonergic theory of depression
    - Confuses composition with cause
    - And was wrong anyway
    - But it’s cool technologically
    - And produces sensible genomics or neurology or biochemistry, even though it doesn’t explain depression
- Mistakenly conducting research about low level entities at a higher level
  - Psychoanalysis of OC content
  - There is no new social scientific methodology
  - Most decisive scientific experiments are denied to us anyway

Entities, Levels, and Explanation

- The most important consequence of Wimsatt entities at levels is that they give us a way out of unending level reduction
- Creating an entity [depressed person] walls off the higher level properties from causal explanation from below because they are now part of a single system
- The most important task for psychopathology is often not, “What causes X?,” but “What sort of thing is X?”
- Keeping compositional relations separate from causal relations helps us recognize that the causes of most entities are intra-level

An Example: Depression

Genome-wide association analyses identify 44 risk variants and refine the genetic architecture of major depressive disorder

Major depressive disorder (MDD) is a notably complex illness with a lifetime prevalence of 14%. [1] ***It is often chronic or recurrent and is thus accompanied by considerable morbidity, excess mortality, substantial costs, and heightened risk of suicide.*** [2-7] ***MDD is a major cause of disability worldwide.*** [8] ***We conducted a genome-wide association (GWA) meta-analysis in 130,664 MDD cases and 330,470 controls, and identified 44 independent loci that met criteria for statistical significance. We present extensive analyses of these results which provide new insights into the nature of MDD. The genetic findings were associated with clinical features of MDD, and implicated prefrontal and anterior cingulate cortex in the pathophysiology of MDD (regions exhibiting anatomical differences between MDD cases and controls). Genes that are targets of antidepressant medications were strongly enriched for MDD association signals ($P=8.5x10^{-10}$), suggesting the relevance of these findings for improved pharmacotherapy of MDD. Sets of genes involved in gene splicing and in creating isoforms were also enriched for smaller MDD GWA P-values, and these gene sets have also been implicated in schizophrenia and autism. Genetic risk for MDD was correlated with that for many adult and childhood onset psychiatric disorders. Our analyses suggested important relations of genetic risk for MDD with educational attainment, body mass, and schizophrenia: the genetic basis of lower educational attainment and higher body mass were putatively causal for MDD whereas MDD and schizophrenia reflected a partly shared biological etiology. All humans carry lesser or greater numbers of genetic risk factors for MDD, and a continuous measure of risk underlies the observed clinical phenotype. MDD is not a distinct entity that neatly demarcates normalcy from pathology but rather a useful clinical construct associated with a range of adverse outcomes and the end result of a complex process of intertwined genetic and environmental effects. These findings help refine and define the fundamental basis of MDD.***

Cognitive Behavioral Therapy as Level-Focused Theory of Depression

- Despite all the focus on genetics and neuroscience, the science of depression has actually been revolutionized by CBT
- Beck, trained as an analyst, realized he had to come down a level
- CBT is a level-strategy, based on the level-theory that depression *is focused at* a cognitive entity
- Concordance between etiological and treatment models
- No side-effects

An intuition and a paradox

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    - Marital status, bankruptcy
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- The hierarchy of psychiatric entities refers to the level at which entities are defined
- Not just a matter of language, language follows focus
- Low level properties do not cause high level properties
- Primary task of psychiatry is understanding level at which entities are focused
- Only then can we examine causal processes at the appropriate level
- Asymmetries in realization and available scientific methodology tend to push us downward
- The empirical justification for doing so is not especially strong

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