Week 5: Analogue Magnitude Representations

Mental Iconicity • Gabriel Greenberg

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Grades of map-likeness

Grade I: physical map (iconic)

Grades II-III: same content + similar semantic structure to actual map (iconic)

Grade VI: same content + dissimilar semantic structure (symbolic)

Grade VII (not map-like): same content + dissimilar semantic structure (symbolic)

Do we think in maps?

Camp 2007 argued successfully that map-like representations can in principle be counterexamples to Fodor's argument.

But not all grades of map-like representation are counterexamples.

So are there actually mental maps which are also counterexamples?

In other words: are there representations in the mind which are both **map-like and iconic**?

Three sources of doubt.

First: functional space. Camp concedes that in neural implementation, map space is "functional", but this is ambiguous about the kind of functionality involved (i.e. Does a Grade VI map count?)

Second: empirical examples. The hippocampus is one of the central areas implicating in geographic representation, but to our knowledge, contains no reliably topographic functional structure.

Third: computation. If you start to give an account of the complex computations involved in using and maintaining a (functional) map, it is very natural to make use of underlying language-like structure as the medium of computation. At the very least, *we know how to do this.* This is part of Fodor's point in calling it the "best game in town."

These kinds of doubts suggest **a general challenge** for any argument for mental iconicity.

The (functional) structure must be specified— not merely the constraints in obeys.

There must be areas whose neural realization implies this functional structure.

There must be computational mechanisms which make use of the iconic structure of the representation.

Is neuroscience relevant to philosophy?

Comparison with philosophy of language: general principles vs. specific insights.

Without neuroscience, we are always just trying to guess the underlying representations. So there is little space to do independent investigation of the semantics.

Evidence for genuinely iconic representations and computations — beyond in-principle proofs.

AMRs: a case study in mental iconicity

What are AMRs? Representations of approximate magnitude.

Distribution in the population: infants, mammals, birds, (some) fish.

Used across many contexts.

Beck's analysis of structured AMR content:

Size: *a magnitude*

Mode: *numerosity, duration, size, etc.*

Object: *food*, *heat*, *dangers, cookies, etc.*

The argument for iconicity

Weber's Law: whether two stimuli can be distinguished is a function of their ratio, and not of their absolute value or absolute difference.

Inference to the best explanation: Carey (2009) argues that analogue representation is the best explanation of Weber's law.

"We do not know how these analog representations are actually instantiated in the brain—larger quantities could be represented by more neurons firing or by faster firing of a fixed population of neurons, for example [. . . But however] analog magnitude representations are instantiated in the brain, their psychophysical signatures strongly suggest this type of representational scheme." (Carrey 2009)

Qualification 1: defining analogicity (Beck):

From Parts Principle to Mirroring conceptions.

Parts principle a la Carey:

R is an analogue representation of X if and only if the parts of R represent the parts of X.

Mirroring principle a la Beck:

R is analogue if some property P of R monotonically increases/decreases with the magnitude M it represents.

Qualification 2 : analogicity with continuous vs. discreet elements (Beck).

As I would put it:

The Weber's law argument demonstrates iconicity, not continuity.

The Weber's law argument is ambiguous between 1st and 2nd order iconicity

Logarithmic encoding: even more IBE

Logarithmic encoding, the very idea. Logarithmic encoding is very common in the brain. The idea is that differences between low values are extremely easy to detect, but differences between high-values are hard to detect.

What explains Weber's Law? This is the question that powers Careys exposition of the argument of analogicity

Not symbolic encoding: consider the possibility.

Not linear encoding + constant noise: consider the possibility.

Two possibilities:

Linear encoding + scalar noise (accumulator model, Meck and Church)

Logarithmic encoding + constant noise (Fechner's model)

A note on the methodology:

Psychophysics.

Outside-in abduction.

Beyond Outside-In Abduction

Finding 1: Neurons for numerosity

Finding 2: Numerosity maps

Harvey, Klein, Petridou, and Dumoulin 2013

Second-order logarithmic encoding

Explaining Weber's law?

Comparing map positions

Variable distance between peaks

Variable precision of estimation