On Facing Up to the Semantic Challenge

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- **a**-semantics
- **e**-semantics
- **c**-semantics ?

Grush, R. (2001). **The Semantic Challenge to Computational Neuroscience**. In Machamer, P.K., Grush, R. & McLaughlin, P. (eds.) *Theory and Method in the Neurosciences* (pp. 155-172). Pittsburgh, University of Pittsburgh Press.

”The Semantic Challenge to Computational Neuroscience”

- How to distinguish between computation - understood as computational processing of ”genuinely semantic” information - and any other complex causal process, merely governed by a computationally tractable rule?

”The Semantic Challenge to Computational Neuroscience”

- State transitions which can be modeled or **simulated** computationally occur in countless physical systems that are not computers.
- How does one distinguish **computationality** (the system *performs* computations) from **computability** (the system can be *simulated* by computations)?

- “Mechanical and causal explanations of chemical and electrical signals in the brain are different from computational explanations. The chief difference is that a computational explanation refers to the **information content** of the physical signals and how they are used to accomplish a task.”

Sejnowski, T., Koch, C. & Churchland, P.S. (1988)

‘Computational Neuroscience’ *Science, 241*.

Grush's solution

- "The brain (or parts thereof) computes in the sense that it processes information - it deals with what genuinely are information-carrying states – e.g. states that carry information about objects or states of affairs in the environment".

Grush, R. (2001). **The Semantic Challenge to Computational Neuroscience**. In Machamer, P.K., Grush, R. & McLaughlin, P. (eds.) *Theory and Method in the Neurosciences* (pp. 155-172). Pittsburgh, University of Pittsburgh Press.

Grush's solution

- "[I]f there were some principled means to determine which states are representing aspects of the environment, we could exploit this to determine which of the [computable] cases are in fact [computational] cases".

Grush's solution

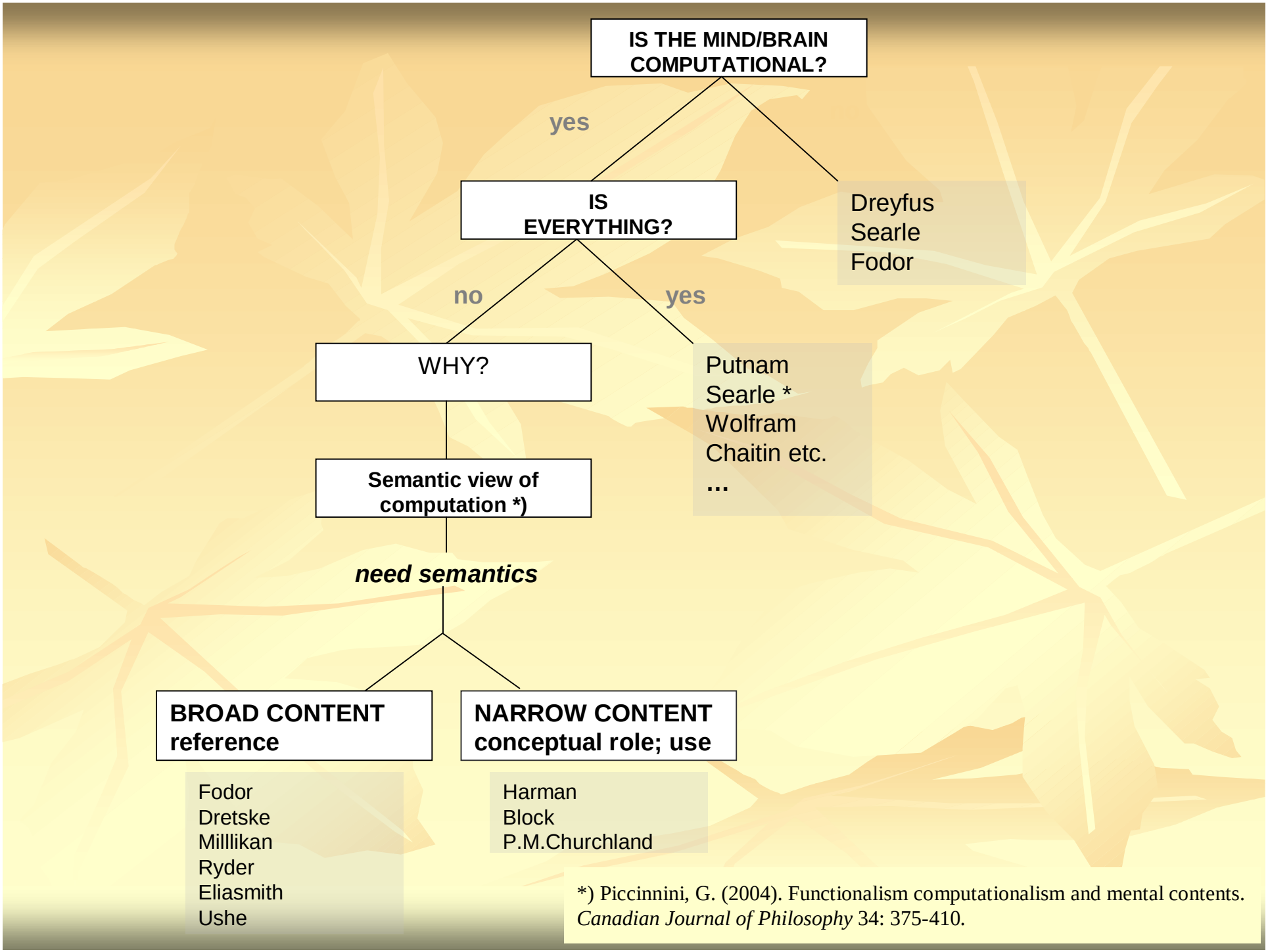
- "We would have the means to distinguish those systems that are genuinely computational in the required sense, and there would be no danger of computational neuroscience being assimilated without residue into the general category of computer simulation studies."

Grush's solution

- **a-semantics:** isomorphism between the causal neural processes and *some* abstract algorithm (at least implicitly assumed by most neuroscientists; not genuine computation)
- **e-semantics:** isomorphism between the causal neural process and the physical causal processes of the environment -representation (computation defined as operations over representations; genuine computation; should be adopted)

Where we're at:
Some Diagnostic Questions:

- **Question #1:** Is the mind/brain a computational system?
  - *Answer: Yes.*
- **Question #2:** Is everything a computational system?
  - *Answer: No.*
- **Question #3:** Why not?
  - *Answer: Semantic view of computation. (Need semantics).*
- **Question #4:** Is semantic content, to a first approximation, functional role (internalistic, narrow content, based on *use*) or reference (externalistic, broad content)?
  - *Answer: Broad content; causal theory of reference.*



*) Piccinnini, G. (2004). Functionalism computationalism and mental contents. *Canadian Journal of Philosophy* 34: 375-410.

Some terminology

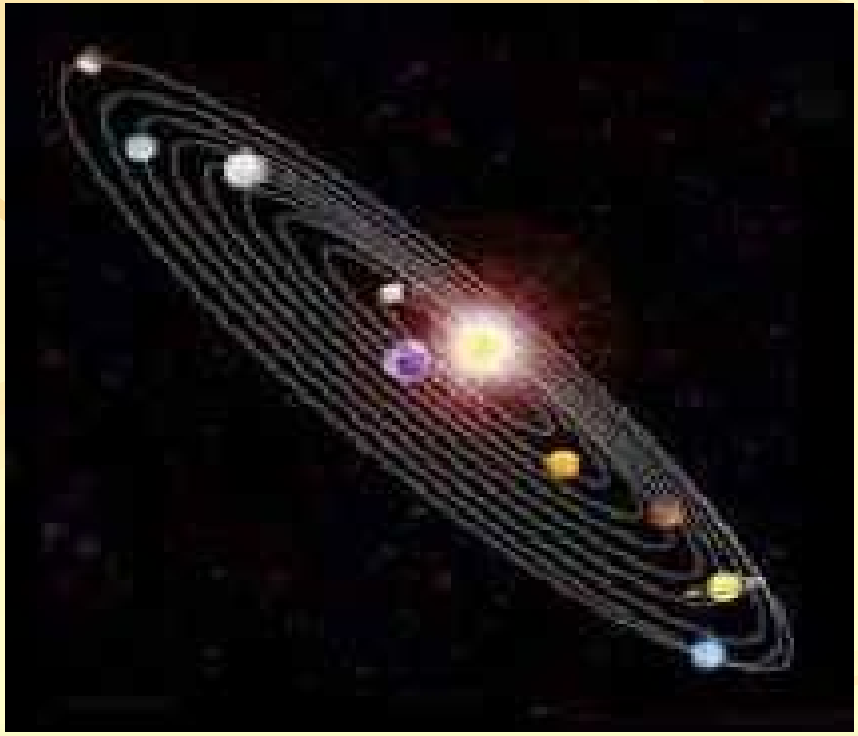
- CONTENT
- VEHICLE
- SYNTAX
- ENVIRONMENT
- REFERENT
- DENOTATION
- REFERENCE

a-semantics

"In a most general sense we can consider a physical system as a computational system just in case there is an appropriate (revealing) mapping between some algorithm and associated physical variables. More exactly, a physical system computes a function $f(x)$ when there is (1) a mapping between the system's physical inputs and x, (2) a mapping between the system's physical output and y, such that (3) $f(x) = y$"

Churchland, P.S., Koch, C. & Sejnowski, T. (1990). 'What is Computational Neuroscience?' In: Schwarz, E. (ed.): Computational Neuroscience. Cambrdge, MA: MIT Press.

The solar system



”Horizontal” information &coding

- **Physical signals carry information from/about the environment into the organism**.The environment thus ends up ”represented by” or reflected within the internal structure of the organism

”Vertical” information & coding

- Properties within the organism represent some variables (abstract entities; descriptions).
  - The fact that the vehicle was in such-and-such state “stands for” the fact that the value of the variable is such-and-such.

”Vertical” information & coding

- **In genuinely semantic contexts, the variables would be elements of a mental representation of some domain** “content” encoded into the organism (rather than physical things in the environment driving the organism’s internal dynamics).

Horizontal: physical to physical

Vertical: mental/abstract to physical

How does this relate to Grush's a-semantics and e-semantics?

- Grush's *e-semantics* is *horizontal*, while *a-semantics* is *vertical*
  - yet what Grush chastises computational neuroscience for is adherence to a vertical semantics (a-semantics), and champions a horizontal approach (e-semantics).
- However: Grush's solution does not exhaust the options.

C-semantics

- In **a-semantics** the internal physical configurations of neural tissue and their state transitions can be seen as instantiations of *some* variables and *some* algorithm.
  - They are **interpreted**, as it were, **“bottom up”,** starting from the brain states (*vehicles*).
  - This “interpretation” does not require the variables and algorithms thus instantiated to be part of a *mental* representation of some domain. (Add this requirement, and you get a **“top down”** vertical semantics, what you might call a **“c-semantics”).**

C-semantics

- In a-semantics the algorithmic computations are a representation of the organism (*bottom-up*), whereas in c-semantics the organism (or its parts) is a representation of the computations (*top-down*)

C-semantics

- If your theory of **content** is one of broad content, the difference between a-semantics and c-semantics is quite clear
  - only the latter makes essential theoretical use of the environment of the organism (truth conditions or mind-independent conditions of satisfaction) and is therefore genuinely *semantic* (rather than a higher level physical theory of the brain).

Some Diagnostic Questions (reprise)

- **Question #5:** How do you feel about the poverty of the stimulus?

Poverty of the stimulus

- The extensions of many/most/some interesting concepts do not constitute physical natural kinds - only the concept constitutes a (psychological) natural kind

Grush's position (& D.Ryder's, & C.Eliasmith's & M.Usher's & R.Millikan's & P.S.Churhcland's…):

- *Let us hope it's generally not true.*

e-semantics and veridicality

- The difference between **e-semantics** and **c-semantics** is that in e-semantics the organism's internal states (vehicles), have the function of "standing in" for something *physical*
  - Their *function* is to be isomorphic with something that is really "out there" in the environment (rather than standing in for *content*).
  - The brain's task is to build a good model of the (physical) structure of the denotation. It "discovers" the structure in the denotation.

  = ***veridicality assumption***

Poverty of stimulus

- According to poverty of stimulus **there is no theory of denotation** (as such); nothing to be discovered (as would be required by the veridicality assumption).
  - For example, denotiations of color concepts such as BROWN do not constitute physical natural kinds, only the color concept BROWN constitutes a (cognitive) kind.

Poverty of stimulus

- The information you need in order to get from physical description of the referent to physical description of the denotation (which is the classification behavior of vehicular responses) is just a random list of facts.
  - No *theory of denotation* as such. The denotation appears *accidental*.
  - *Unless you take into account a theory of the organism?*

If you subscribe both to poverty of the stimulus and broad content:

- The mental variable (vertical information content) is not reducible to the physical state of the environment (by *poverty of the stimulus*), but nor does it supervene on the narrow causal-functional state of the individual's brain, either (by *broad content*).
  - the *content* of the mental state is instead a function of *both* the environment *and* the organism.

The semantic challenge:

Can broad content and poverty of the stimulus be reconciled to a coherent philosophical theory of computational/informational/ representational content that is useful for computational neuroscience?

Objections and open questions:

- Is poverty of the stimulus (as defined) true? Is there any empirical reason to believe it?

  Answer: yes.

- Doesn't this antirealism lead down a slippery slope to nominalism, relativism, idealism…?

  Answer: no (probably not).

- How do we account for shared content if not by means of reference to real kinds?

  Answer: This is what a theory of content/truth should tell us.

- If theory of truth isn't based on veridicality, what then (show us the theory)?