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FUNCTIONAL ACCOUNT OF COMPUTATIONAL EXPLANATION

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Presentation Plan

- CL account of explanation and Cummins' critique
- Cummins's positive view of computational explanation
- Weak and strong equivalence

CL in a Nutshell

- Covering-law account is the most general theory of explanation in philosophy of science.
- It is admittedly too broad but very simple.
- We can understand how algorithms explain, if we take them to be laws; or if we take them to be descriptions of configurations of machines, and the laws as generalization about machines (e.g., UTMs).

CL in a Nutshell

- CL links explanation with prediction but this is not a disadvantage. It is a good feature, good for testing models.
- But you cannot really choose among two ways of understanding computational explanations:
  - Is it about abstract machines?
  - Is it about algorithms?
- No details of implementation are required. Strange, and bad for testing explanations.

Implementation detail and CL account

- If you think that it is the algorithm or the abstract machine that is the core of the computational models, some features of these models remain out of the scope of explanation.
  - Performance (speed) of computers relies on their physical makeup. You cannot really use the reaction time in full…
  - And there is no way to decide between functional structures and other things such as laptop stickers… Weird.

Robert Cummins on functional explanation

- Cummins criticizes the CL account: explanation is not subsumption under a law
- Psychology is not interested in laws, but in effects
- Yet a description of an effect, such as the McGurk effect is not its explanation!

McGurk effect

- "No one not in the grip of the DN model would suppose that one could explain why someone hears a consonant like the speaking mouth appears to make by appeal to the McGurk effect. That just *is* the McGurk effect" (Cummins 2000: 119).
- Cummins also rejects the idea that prediction is linked with explanation:
  - We can predict without understanding
  - We can understand without predicting

Cummins on functional explanation

- But Cummins does not appreciate the conditions that laws are supposed to fulfill:
  - They need to be general and simpler than descriptions of individual events
  - A set of measurement data is not a law
  - Cummins seems to confuse CL explanation with overfitting

Functional explanation, Cummins style

- Effects in psychology are to be explained as exercises of capacities
- Capacities are explained functionally, in terms of functional analysis
  - Decompose the capacity into known subcapacities, or dispositions, that jointly display the capacity
  - The same scheme is applied to computational explanation

Unbearable lightness of decomposition

- But the functional analysis has a major drawback: it can only offer a "sufficiency" explanation of a capacity.
- There is an infinite number of decompositions, and all are equally correct on this account!
- No way to go beyond weak equivalence…

Weak and Strong Equivalence

- Jerry Fodor (1968) called simulations (models) which pass tests on the level of their I/O "weakly equivalent" to mental phenomena.
- The "strongly equivalent" models are the ones that include also the same process that produced the data.
- The task of cognitive science is to have strong equivalence.

Strong Equivalence

- How to test if the process is the same?
  - Check if it takes the same amount of time: chronometric methods.
  - You can use computational complexity considerations to have a better data model: assess how much time a given task would have to take, by analyzing the algorithm, and then compare with the computational results.
  - Brain imaging: check if activation patterns match the process in the model. Not trivial!

Functional explanation, Cummins style

- The explanation has a form of functional analysis, i.e., it is linked to Cummins' notion of function (=role).
- The subcapacities have some roles: they contribute to the overall capacity (in the realized system, they do it causally).
- But the capacity is to be defined and analyzed rather than decomposed, manipulated or otherwise tested experimentally.

Functional vs. mechanistic decomposition

- Note that the decompositions of the system offered, for example, by Conklin & Eliasmith in their model of rat navigation, are not just possible ones
  - There is evidence for them
  - The explanation goes beyond "how possible" (Craver & Piccinini)
- In other words, functional account is not descriptively adequate. It is too liberal.

Top-down vs. bottom-up

- Cummins claims that proper explanation has to be top-down rather than bottom-up.
- But what does it mean "top-down"?
  - In New Look psychology (Jerome Bruner), top-down influence of knowledge on perception (expectations vs. data). Not so credible after *Modularity of Mind* (1983) by Fodor.
  - Specify the capacity first (Marr on vision), then explain it.

Top-down vs. bottom-up

- Cummins must mean the second sense of "top-down".
- He denies the usefulness of starting the explanation of a capacity by looking at individual parts and ignoring the overall capacity.
  - But nobody does it this way! Capacities are the focus of explanation.
  - And the capacities do not explain! They are explananda, not explanantia. This is why they do not allow to predict most details of organization.

Bottom-up explanation

- Beside some special cases in modeling neurons only (not in cognitive neuroscience), we care about the capacity.
- But it is only explained if the parts of the system are real, so when we have identified the parts of the system, or "bottomed" them out.
- For this reason, the best explanation is **both** top-down (explains capacity) and bottom-up (by showing organization).

Functional or causal explanation?

- In Cummins theory, functional explanation is NOT causal.
- Computational explanation, for example relating to software program in a computer, is not causal according to him. It is just a logical analysis.
- But the arguments he gives are invalid. He equates computation with string rewriting and ignores state-transition based models of computation.

Functional or causal explanation

- Cummins thinks of computation in terms of a Turing machine that transforms input symbols on a tape into output symbols.
- But there are models of computation that talk about states that determine the transitions, i.e., changes of states. One of them is Yuri Gurevich Abstract State Machines (ASM).

ASMs and causation

- The problem is that state-transitions in ASMs (and other models of computation) are directly interpretable as causal. There is no problem with understanding computation as state-transitions, which is what Cummins says.

Summary of the argument

- Functional explanation, in contrast to CL explanation, talks of organization.
- But organization is highly abstract. Components may be purely theoretical entities and their observation is irrelevant for their explanatory value.
- This is too liberal, as it cannot guarantee strong equivalence. Cumminsian functional models may be epiphenomenal!

This Presentation Contains Product Placement.

- The story does not stop here
- It's a book-length project (*Explaining the Computational Mind*, MIT Press), so there are much more details…
- The book is out in 2013