Pomona College

LCS 11: Cognitive Science
Modules

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Agenda

- Group question 1.3
  1. Leader discusses response to group
  2. Group discussion with summary of points
  3. Class discussion
- Modules
  1. Definitions
  2. Examples from visual processing
- Reading for next class
- Response paper #1

GQ 1.3

GQ 1.3
Take a simple action or mental process of your choosing and identify at least three distinct subprocesses that might be involved in performing that action or process. Which, if any, of those subprocesses might be called modular in Fodor’s (1985) sense, and why?

Group leaders
Sam, Audrey, Lea Lynn, Daniel, Joel, Noah, Jun, Sarah, Paul

Cluster of concepts

1. Domain specificity
2. Informational encapsulation
3. Mandatory operation
4. Fast processing
5. ‘Shallow’ outputs
6. Fixed neural architecture
7. Characteristic and specific breakdown patterns
8. Characteristic ontogenetic pace and sequencing
Subcluster 1: Modules are snobs

Domain specificity
A module operates over or responds to only a narrow range of inputs. A special purpose mechanism that provides answers to very specific questions.

Is there an edge in a particular area of the visual field?

Subcluster 2: Modules don’t care what you think

Information encapsulation
Information processed within a module cannot be accessed from information outside that module.

Modules do not consider other types of information outside their specific domain, including top-down knowledge.

Subcluster 3: Modules are dumb

Mandatory
Once the module receives its input, it automatically operates on the information it receives.

Fast
Although a relative term, modules finish their computations quickly.

Shallow
Modules produce constrained output that was computationally cheap to produce.
Subcluster 4: Modules are innate

Fixed neural architecture
Function associated with module is localized to a specific set of neural structures.

Characteristic breakdown
Modules are independent: when they fail, they may do so independently of other cognitive functions.

Characteristic pace
Modules tend not to be learned, but rather ‘triggered’ by specific developmental stages.

In short
Modules are dumb snobs, who don’t care what you think. And you have to put up with them.

Thatcher illusion (Thompson, 1980)
Thatcher illusion

- VISUAL SYSTEM -

Vertical pathway

- Photoreceptors (rods & cones)
- Bipolar cells
- Retinal ganglion cells

Horizontal pathway

- Horizontal cells
- Amacrine cells

optic system

visual cortex

Lateral geniculate nucleus (LGN)

Two kinds of neuron in LGN

1. Magnocellular neurons. Deeper within LGN; thicker axons, which allow a quicker response. Project onto where pathway.

2. Parvocellular neurons. Shallower within LGN; thinner axons, respond more slowly to input. Project onto what pathway.
Split brain studies. Information encapsulation.

Split-brain patients have undergone surgery to cut the corpus callosum, the main bundle of neuronal fibres connecting the two sides of the brain.

Stroop task. Modularity par excellence.

Stroop task

Name colors of word, not the word itself. If you see the word BLUE, say “Red” not “Blue”. If there is no word, just say the color that you see.

Self-demo

Cover up all but the first column with a separate piece of paper. When I say START, start the task silently. When you are done, look up and jot down your response time at the bottom of that column. We’ll then do the same for the other columns.

http://online-stopwatch.chronme.com/

Stroop task. Modularity par excellence.

Stroop effect

Takes longer to name the color when the printed word is incongruent. Also, more likely to misname item.

Modularity

How is this result compatible with modularity?
Scope of modularity

Central processing systems
Input provided by modules is evaluated, assessed, and transformed by more global mechanisms, which are responsible for interpretation.

...Nature has contrived to have it both ways, to get the best out of fast dumb systems and slow contemplative ones, by simply refusing to choose between them. That is, I suppose, the way that Nature likes to operate: “I’ll have some of each” – one damned thing piled on top of another, and nothing in moderation, ever. (Fodor, 1985: p. 4)

Modest modularity
Modularity limited to simple input-output systems, systems that translate an external stimulus into information to form a mental percept. Such systems are sometimes called sensory transducers.

Fodor’s claim
Modules are the only parts of the cognitive system that we can ever hope to fully understand within a scientific theory. Non-modular components cannot ever be captured by a fully scientific theory.

Massive modularity

- No central processor
- Mind is entirely modular, but with a weakened notion of module
- Information encapsulation is no longer a property of a module

1. Biological systems are designed incrementally, requiring modular organization
2. Human minds are ‘extensions’ of animal minds, which are modular
3. Argument from computational tractability

Some issues with modularity

**Issue 1: Neuroplasticity.**

The brain shows some degree of flexibility; functional deficits can sometimes be recovered by remapping or recruiting other neural areas.

**Issue 2: Domain specificity.**

Really part of issue 1: Multiple areas of the brain seem to take in multiple sorts of inputs.

**Issue 3: Limitations on science.**

We’d like to be able to study more than just sensory transducers – what happens during higher order processing and how does the mind make sense of that low level information?

Next time: Connectionism & Neural nets

- No GQ for next time
- Reading is difficult, so try to get a feel for how neural nets work, without sweating the details.
- Writing response # 1 due by Friday at 5PM – upload to Dropbox on Sakai.