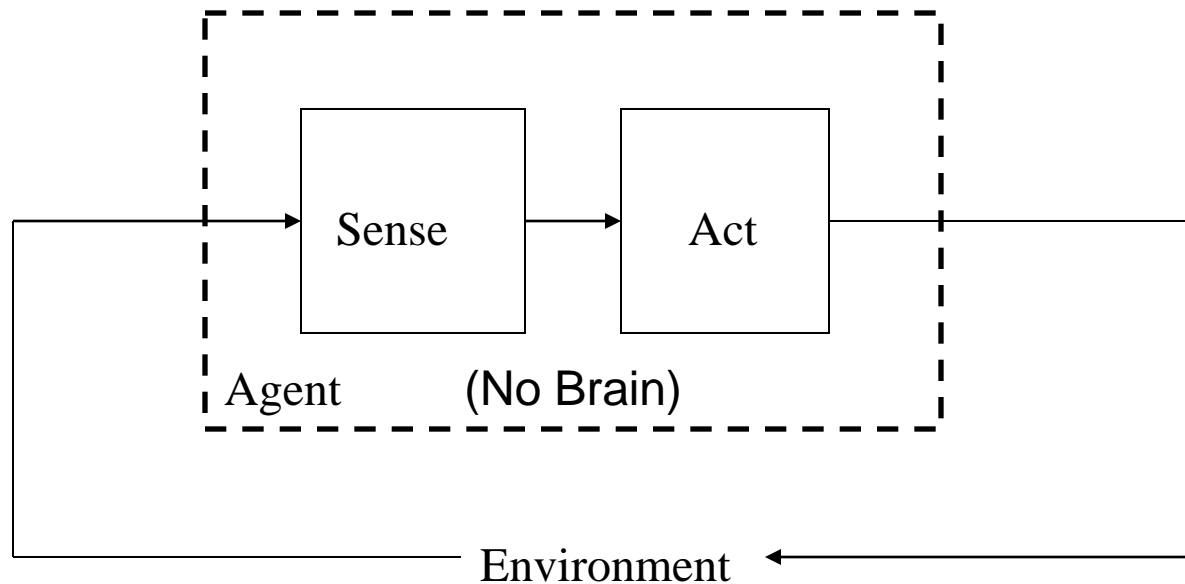


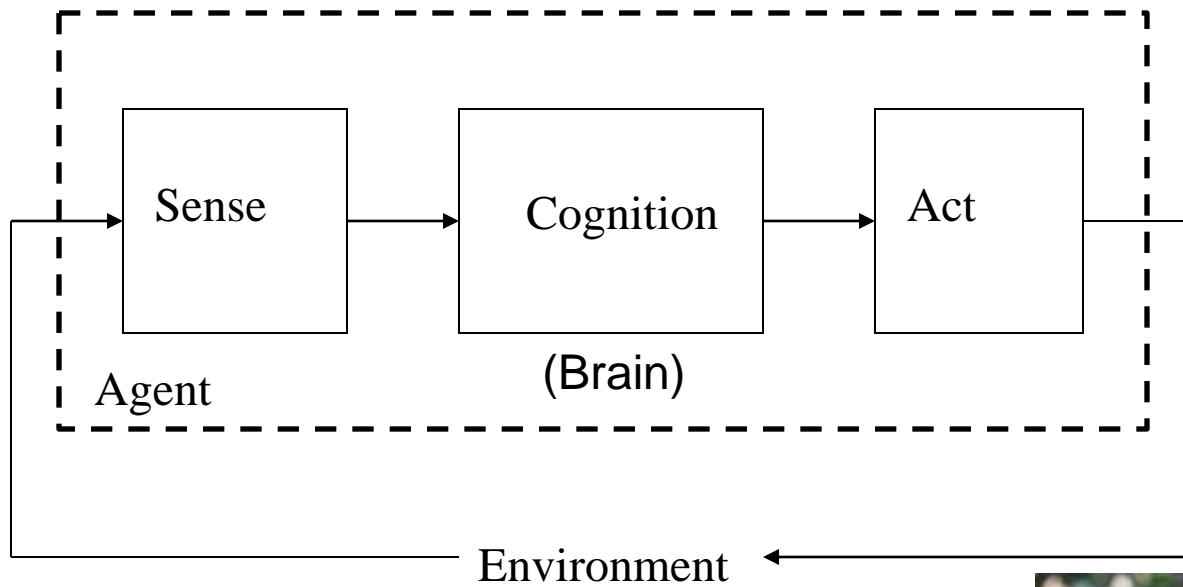
# Extended Cognition

Introduction to Cognitive Science

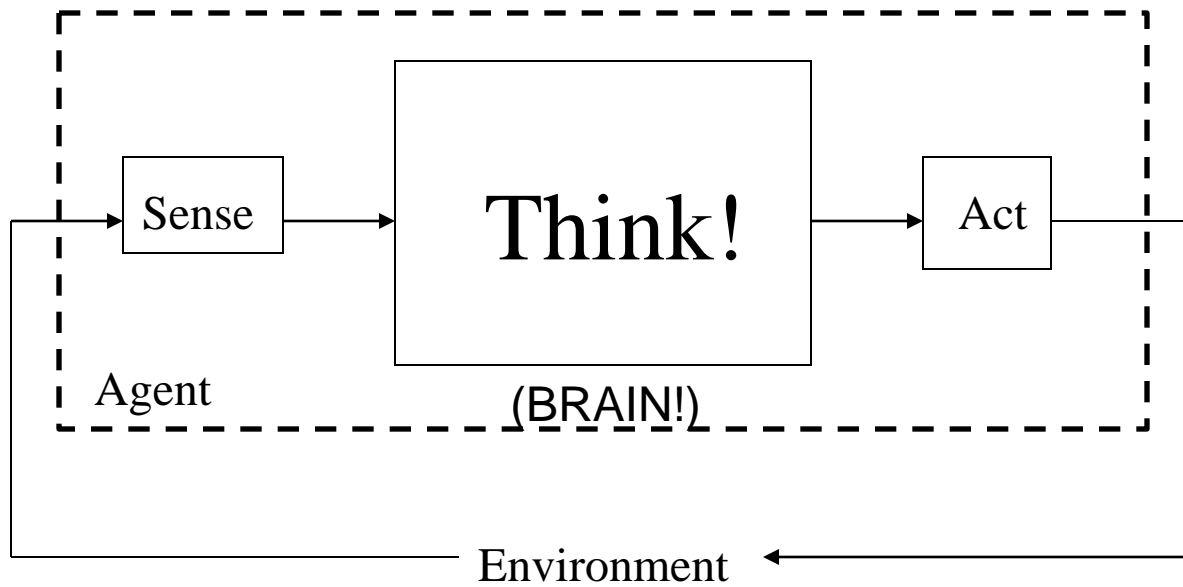
# Early Organisms: Perception and Action, but no Cognition



# Cognition



# Next Step?



# Wallace's Paradox

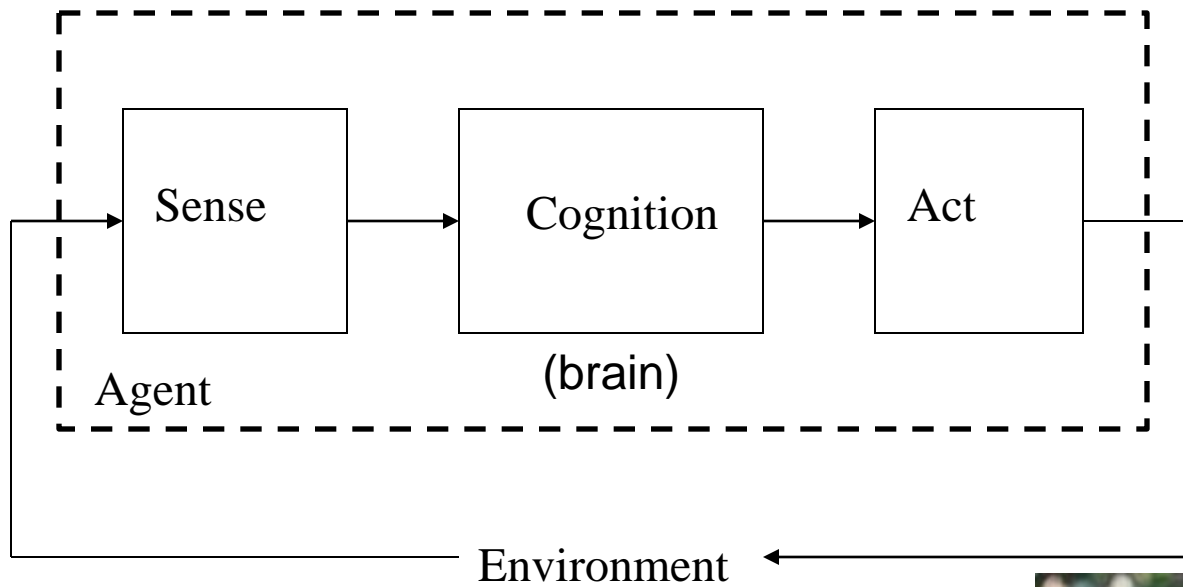


Why did our  
ancestors have  
big brains?!?

# One Possible Answer to Wallace's Paradox: Exaptationism

- Our ancestors from a few ten thousand years ago \*did\* need big brains.
  - E.g agriculture -> increase of (social) relationships to keep track of and reason about
- Later, all this brain power was put to a different use.
- The implicit assumption in Wallace's reasoning is one similar to the one made by the phrenologists: specific cognitive traits can be traced to the brain
- In particular: 'big' cognition (reasoning, logic, math, science, philosophy) requires 'big' brains.
- This may well be a mistaken view on cognition (e.g. about a full 1/3 of our brain is devoted to just vision!)

# Cognition



# Situated Cognition

- Situated (or Embodied) Cognition is the view that we have to take into account the body and the environment in trying to explain, and think about, cognition.
- Situated cognition objects to the classical ‘Sense, Plan, Act’ model of cognition, which many cognitive scientists, most AI researchers, have assumed in their view of cognition:
  - we perceive the world,
  - then think about it (i.e. cognize about it!),
  - and then act on whatever plan we came up with.
- Instead, Situated Cognition proponents say, perception and action are integral to cognition.

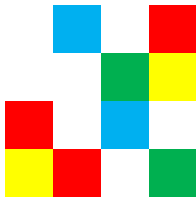


# Catching a Fly Ball



# Copying Blocks Experiment

Original



Copy



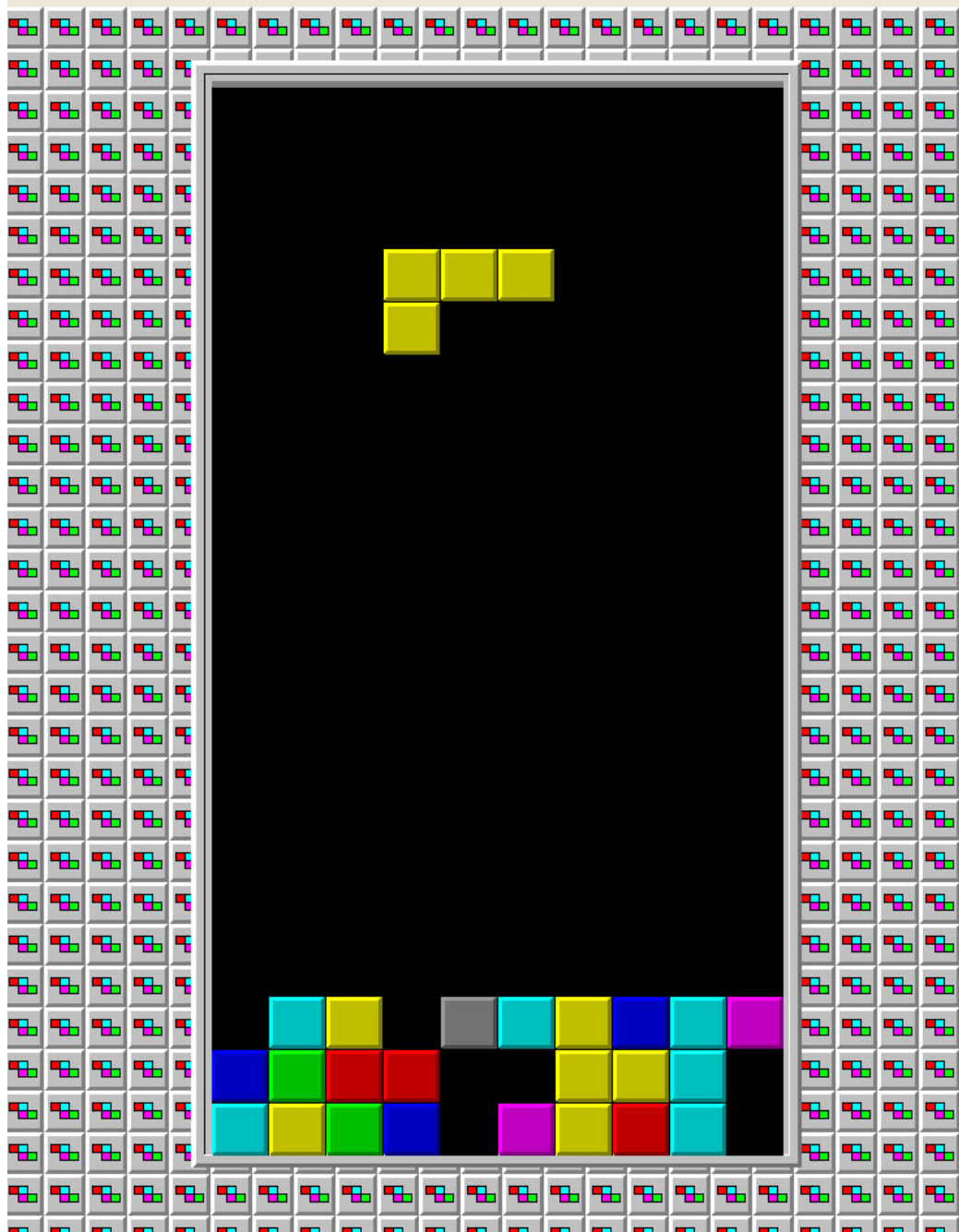
Bins

Task:

Subjects have to make a copy of the configuration of blocks on the left by 'grabbing' individual blocks from the bins at the bottom and placing them on the right

# Results Blocks Experiment

- The finding was that subjects would look at the original, then select a block, then look back at the original, and finally place the block.
- On the traditional view of cognition, the third step would be a surprise. But, on the situated view, it makes sense.

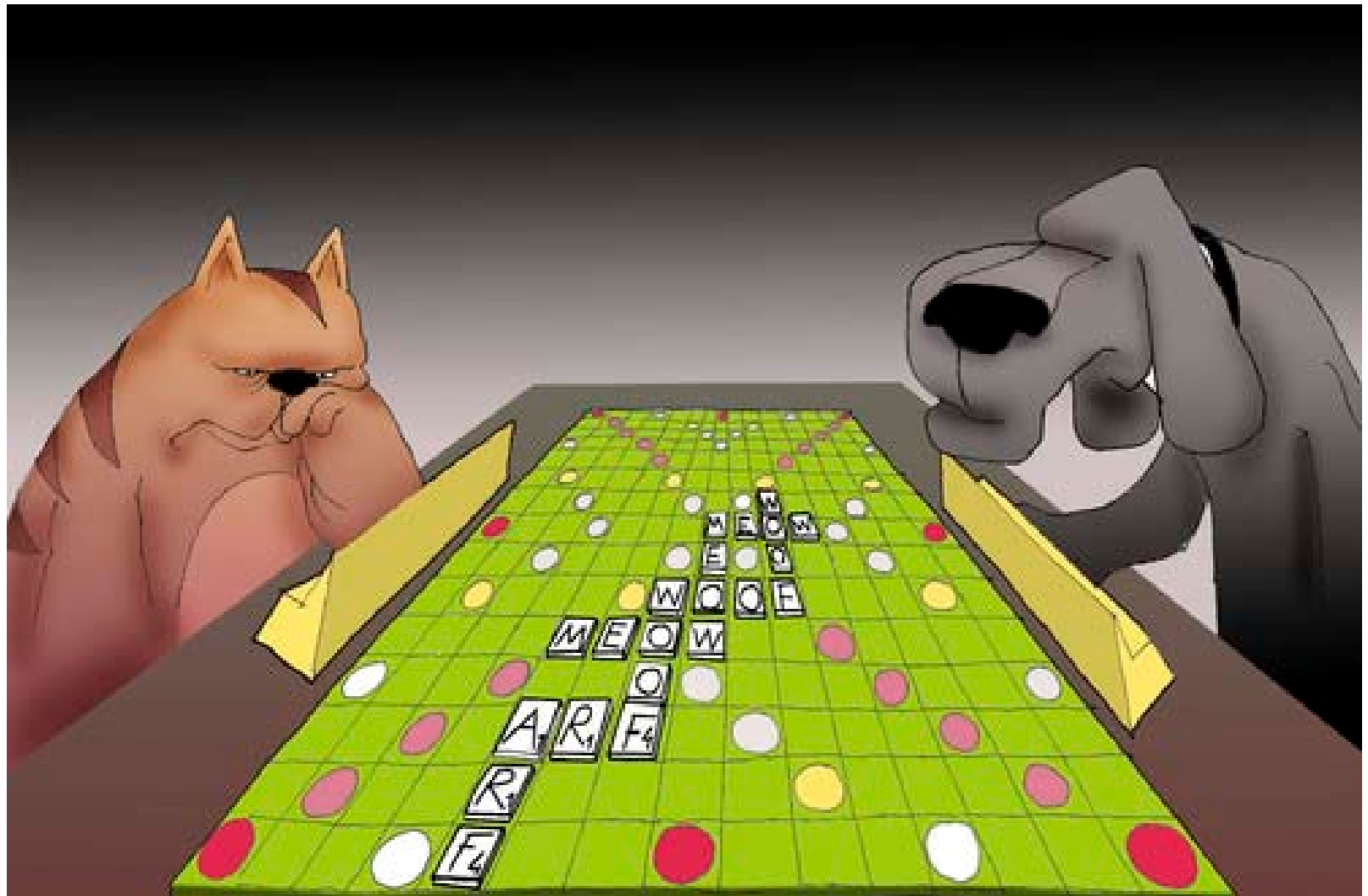


‘Epistemic moves’:  
Moves that are not  
part of a solution,  
but help find one

Rotating

Slamming

# No Opposable Thumbs ...



# External Representations ...

VI / XLIV \ ??



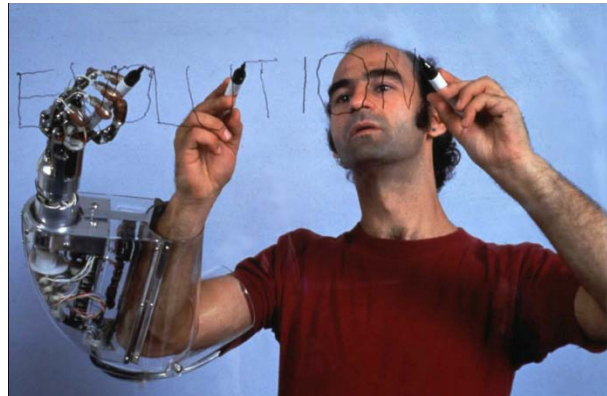
© Dennis Cox \* www.ClipartCl.com/12376

# The World as External Memory

- Situated Cognition people say that the brain often uses the environment as a kind of ‘external memory’.  
Examples:
  - Taking apart your computer: how do you lay down the pieces to get it back together?
  - Notes you write to yourself
  - Planners, calendars, cellphones, laptops

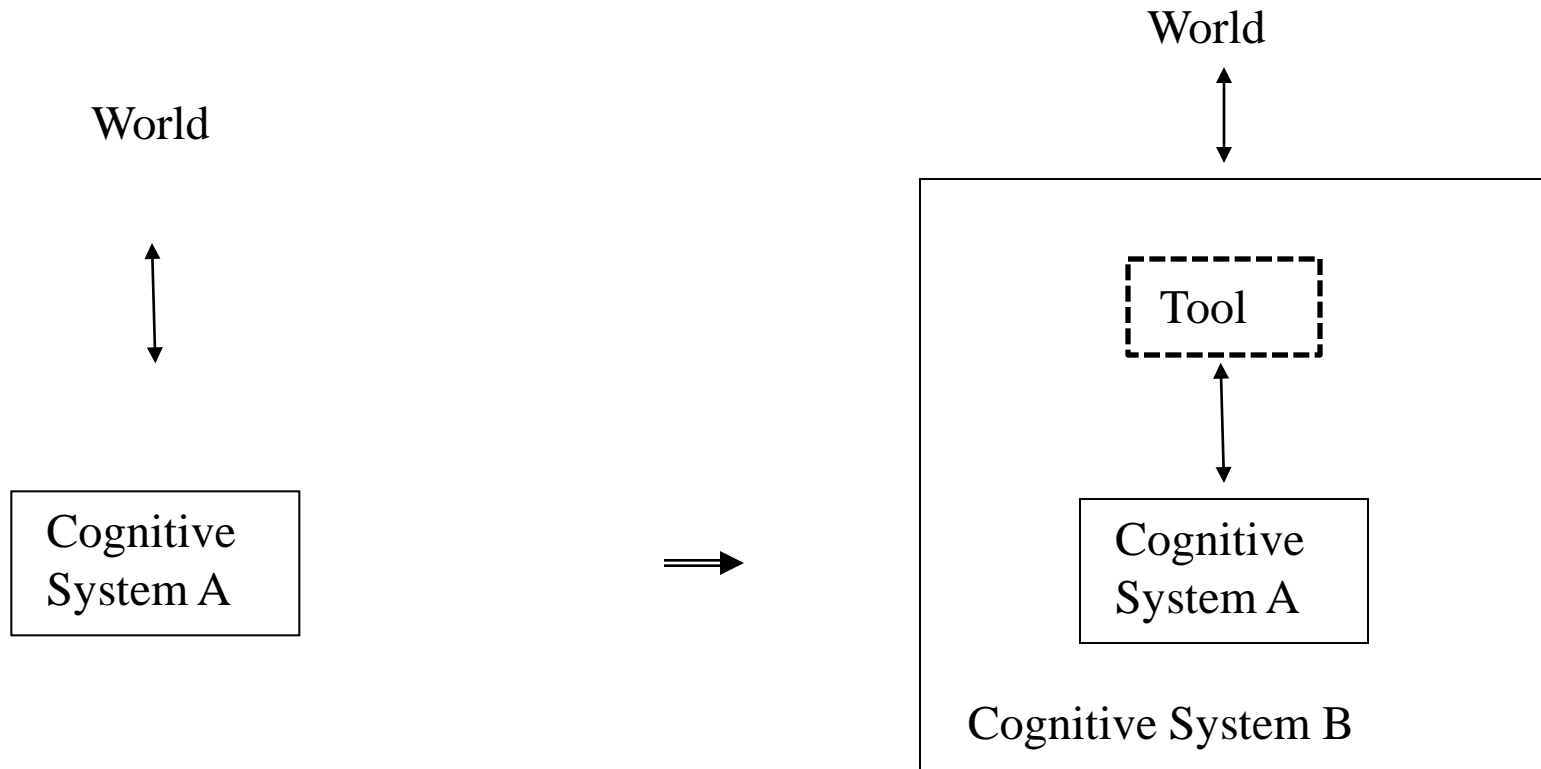
# Tools to Enhance Cognition

- To become smarter, then, maybe we don't need bigger brains, but better interactions with our environment.
- Indeed, we can see the use of tools as a straightforward example of enhancing our abilities, so why not have cognitive tools?





# Does Tool Use create a new Cognitive System?



# Hammer-Man!



Hammers don't  
hurt people,  
people hurt  
people!

# The Extended Mind

- Can the ‘boundaries’ of our cognitive self go beyond the boundaries of our biological self?
- If you would be willing to include a brain chip implant to be able to see again as part of the cognitive being you’re dealing with, why should it matter whether this chip is actually inside our skull, or is in contact with the rest of our brain through a radio-transmitter?

# Blind-Cane-Man

- Bob is blind, and uses a cane to feel around
- Is the cane part of Bob?
- It isn't part of Bob as a biological being.
- But is it part of Bob as a cognitive being?
  - There is a cognitive agent here, perceiving the world, thinking about the world, etc.
  - Is the cane part of the cognitive agent, or part of the world?
- (Is Bob a cyborg?)



# The Curious Case of Otto

- Otto has amnesia, but uses a notebook to keep track of his experiences, appointments, etc. If Otto's book is always-present and always-used, maybe it is better to consider the notebook as part of the cognitive entity we refer to as 'Otto'
- "Why did Otto come to the appointment? Because Otto remembered it." Such a description would only make sense if the notebook is considered part of 'Otto'.

# Truth or Decision

- True or False: the notebook is part of Otto
- But is this really a true or false question?
- Or is it like the question: Machines can think where it is more of a decision on our part whether or not to include machines as thinking entities or not.
- As always in science, we want to ‘parse’ the situation as naturally as possible so as to most leverage our explanatory and predictive powers.
- So, does making the notebook part of Otto do this?

# Is there only one ‘Cognitive System’ per Biological Body?

- The question “Where is the boundary between my mind and its environment?” assumes that there is one cognitive system to be defined.
- However, what if we drop this assumption?
- Maybe there are various cognitive systems that one can point to, and that one can usefully refer to in order to give explanations and predictions of cognitive behavior.
- So, in the Otto case, maybe we can (and should) meaningfully distinguish between ‘Otto1’ and ‘Otto2’.
- Some explanations work better by reference to Otto1, and other explanations work better by reference to Otto2.

# Language: Our Best Tool?

- Language seems to be an especially powerful tool that we use to enhance our cognitive abilities:
  - Expressions of language can be used to represent information and thus serve as external memory (see examples before)
  - Expressions of language can be manipulated and thus reasoning and decision-making can take place (logic, mathematics, science)



# Objection: Higher-Order Cognition without Interactions

- OK, but then what about someone who is just sitting in a chair, contemplating something or other?
- And what about Stephen Hawking, the world-famous physicist who is in a wheelchair and whose motor neuron disease has left him with hardly any motor skills left?

# A Possible Answer

- Interestingly, even in the case of Stephen Hawking, situated cognition could argue that his (first-class!) high-level reasoning abilities depend on lower-level abilities:
  - Maybe the ‘thinking’ or ‘reasoning’ that we do (including Stephen Hawking) is a kind of ‘internalized dialogue’: an imagined dialogue in which we discuss (using language of course) something or other with some one else, but where we have taken the role of this other person, and where the brain has simply made a short-cut between the motor cortex straight to the perception cortex.
  - Thus, to explain the high-level cognitive powers of Stephen Hawking, we still make reference to his low-level perception and action abilities: although they are going on inside in his brain.

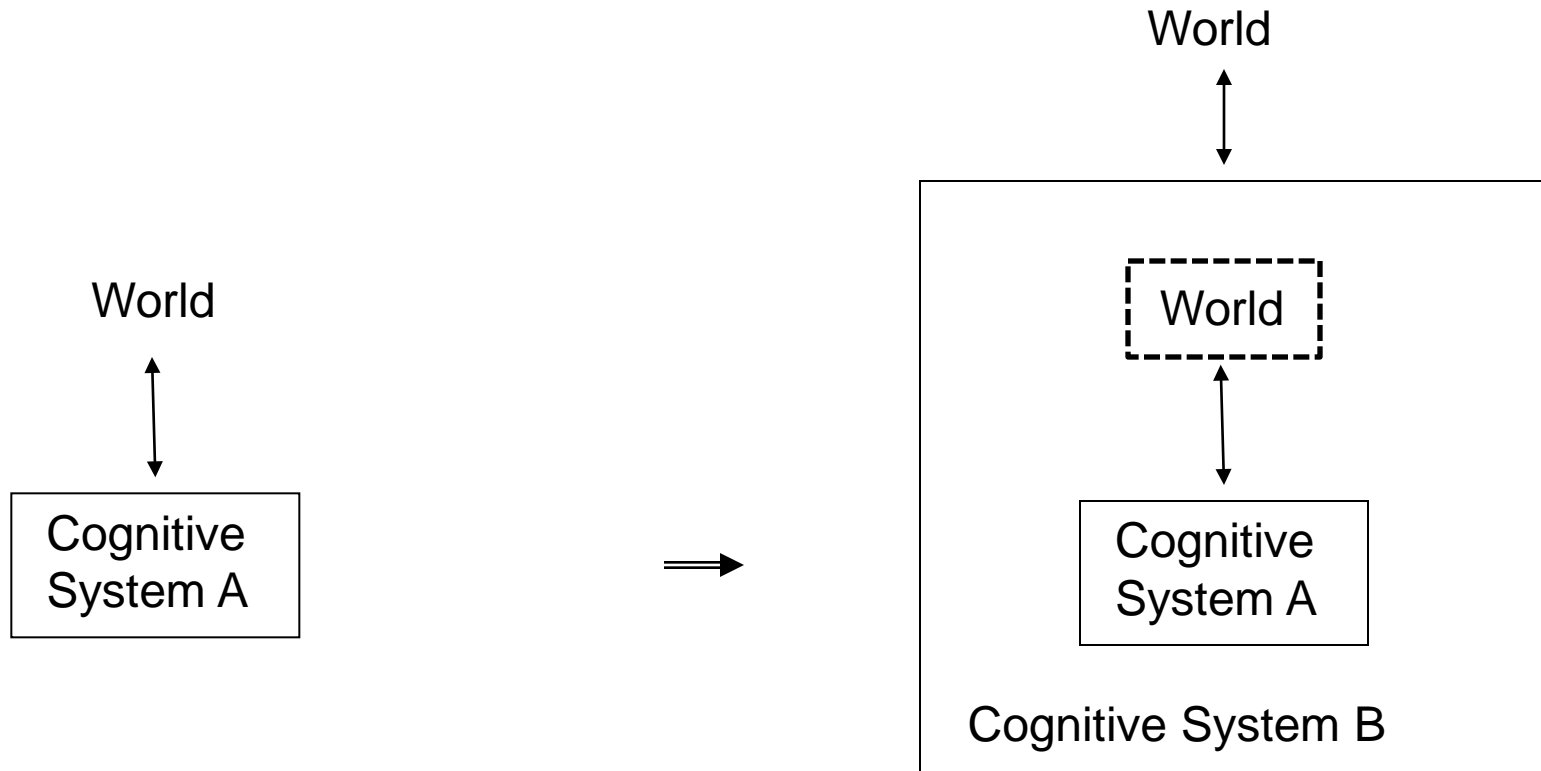
# Imagined Abaci

Imagined Abaci

# ‘Internal’ Representations as ‘External’ Environments

- This idea can be generalized: parts of our brain can be used to represent the world, but these representations are what other (older, more ‘core’, cognition-wise) parts of the brain interact with in order to accomplish cognitive tasks.
- This does suggest that many internal representations are ‘lower-level’, i.e. sensory-motor sequences rather than abstract symbols.

# Internal Representations



# Example: Terminator

Terminator

German Terminator

# Situated Cognition and the Robot Reply

- Situated Cognition is reminiscent of the Robot Reply to Searle's Chinese Room Argument:
  - You need something in addition to pure computation
- However, one can respond as follows: the computations underlying cognition may not be realized by the brain alone. Rather, it is the extended system that, in virtue of its realizing a computational organization, is cognitive.

# Situated Cognition and the Systems Reply

- **Objection: Systems Reply:** the person inside the room does not understand Chinese, but maybe the larger system, of which the person is only a part, does.
- **Counter-Objection:** OK, have the man memorize the whole rule book, and do all the symbol manipulations in his head. Now there is no larger system to point to.
- **Counter-Counter-Objection:** Yes there is! Part of the brain of the man is now representing something, and other (more core) parts of the man's brain are interacting with it. Together, that forms a new (larger) cognitive system.



# Language, Tools, Culture, and Cognition

- Whatever your stance on extended cognition or the self is, this much is clear: Language and other kinds of tools seem to greatly expand our cognitive capabilities.
- Moreover, language allowed us to write down thoughts and skills, and not only pass them to others around us, but also to people born long after we are dead: culture!

# Cultural Evolution of Cognition

- Once culture is in place, cultural evolution can work on components of cognition.
- For example, such cognitive ‘building blocks’ as concepts or ideas, but also fashions and values can be passed from organism to organism, where they ‘compete’ for existence (certain ideas strike us as better ones than others’, and can get mutated or combined with others: all the ingredients that an evolutionary process requires.
- Richard Dawkins coined the term ‘memes’ for these kinds of entities that are subject to cultural evolution.

# Application of the Idea of Memes

- The history of science and mathematics is full of cases where two or more researchers come up with the same idea or result, but independently so. How strange!!
- However, there is probably a good reason for this, and that is that the concepts and ideas (the memes) they needed to put together in order to obtain the theory of evolution had been developing over time, and were ‘ready’ to be combined at their time, i.e. the discovery was ‘in the air’. So, if they wouldn’t have come up with it, someone else probably would have very soon after.
- Note that this makes it rather arbitrary to credit 1 particular person with a particular idea. More likely, ideas are the natural progression of the work of hundreds of people preceding the person that ‘puts it all together’.

# Back to Wallace's Paradox

- Remember that the assumption implicit in Wallace's paradox is the view that our cognitive capacities are the result of our brain alone.
- However, as argued in previous slides, our cognitive capacities may be partly derived from the artifacts (tools, language, and in particular science and math) we have created around us and pass along from one generation to the next.
- Moreover, the cultural evolution of cognitive building blocks such as concepts and ideas is \*much\* faster than genetic evolution.

# Intelligence = f(brain)??

- Common Idea: intelligence and cognition is a function of the brain
- Neil DeGrasse Tyson makes this assumption as well:
  - <http://www.wimp.com/alienhuman/>
- But is this really so? Situation Cognition questions this!

# Next Step!

