

WidewarePlus

Finding the missing mass in the universe of cognitive science

Where's the rest of me?



King's Row (1942)

- Where is reasoning, problem solving, conceptual integration, discourse processes - what we used to call high-level cognition?

Where is High-level cognition?

- In the brain in the form of symbols that ride on top of the sub-symbolic substrate (PSSH).
- In the brain in the form of more bags-of-tricks (cognitive incrementalism).
- In the interaction between the brain and the body and the environment (Wideware).

The Wideware Proposal

"...much of advanced cognition [is] rooted in the operation of the same basic kinds of capacity used for on-line, adaptive response, but tuned and applied to the special domain of *external and/or artificial cognitive aids* – the domain, as I shall say, of *wideware or cognitive technology*"
(*Mindware*: 141, emphasis in the original).

Cognitive accomplishments and cognitive processes

- Accomplishments of the activity system: computing the position of the ship.
- Processes of the individual navigators: reading a scale, manipulating a tool to align a straightedge with marks.
- The cognitive properties of the activity system are NOT the same as the cognitive processes enacted by the person in the system.

Bartender Memory (King Beach, 1988)

- Memory for drink orders
 - Many drinks in a single order
 - Rapid and ephemeral presentation
- Partial coding of drink identity in
 - Placement of glasses on the bar
 - Shapes of the glasses
 - Color of the first ingredient
- Extraneural memory store
- Off-loading from the biological brain

A brief digression on the changing meaning of “representation”

- A traditional set of distinctions
 - Difference = inhomogeneity
 - Information = a difference that makes a difference
 - Representation = a special kind of information such that one thing (a type) “stands for” something else (a referent).

Some kinds of traditional representations

- **Sign** or index, a type that is associated with the referent by a relation of co-occurrence
- **Icon**, a type that is associated with the referent by a relation of structural similarity
- **Symbol**, a type that is associated with the referent by an arbitrary relation

- Traditionally, representations were conceived as being about *relations* among *structures*

Representation as activity

- A representation is not a relation or a structure, it is an activity
- Representation is the activity of “bringing forth” or “rendering present” the referent.
- Mental representations (activities) are
 - Embodied: perception/action/imagination
 - Multimodal: senses plus action, plus emotion
 - Temporally extended: present, future, past
- They are also cultural practices

What’s missing from this picture?

- “Human brains trained in a sea of words and text will surely develop computational strategies that directly “factor-in” the reliable presence of a wide variety of such external props and aids.” (Mindware: 141)
- How and why will human brains surely develop these strategies?
- Because human children are systematically recruited into a wide range of **cultural practices** in which words and text are “seen as” things that are *about* other things.

Wideware **Plus** Cultural Practices

- **Cultural practices** are the things we do as members of a community. The ways of doing things that are characteristic of the community.
- *External and/or artificial cognitive aids*, aka *Wideware or cognitive technology* produces NO cognitive effects on its own.
- **High level cognition** is produced when **cultural practices** bring the biological brain into coordination with *wideware*.

Some cultural practices

- Writing an academic paper
 - “the cycle of reading, responding, and external reorganization is repeated, again and again. ... credit belongs to the [enculturated] embodied, embedded agent in the world.” (Mindware:142)
- Doing place value arithmetic
 - “we engage in a process of external symbol manipulations and storage so as to reduce the complex problem to a sequence of simple pattern-completing steps that we already command...” (Mindware: 142)

Cultural Practices and high level cognition

- Writing a paper and doing arithmetic are complex ways of doing things that belong to particular social groups.
- The cultural practices are what organizes the coordination of low level processes of the biological brain with cultural materials such as words and numbers.
- It is this coordination that produces high level cognitive processes such as constructing a coherent argument in a paper or computing the product of two numbers via place value arithmetic.

A new view of symbol processing

- NOT as the fundamental architecture of cognition. Rather...
- "...the practice of using words and linguistic labels is itself a kind of original "cognitive technology" – a potent add-on to our biological brain that literally transformed the space of human reason."
(Mindware: 143)

More than external memory

- Artists sketch because our interactions with perceived objects have different properties than our interactions with imagined objects.
 - Mental images are interpretively fixed.
 - Synthetic transformations – flexible combination of existing parts, possible with mental images
 - Analytic transformations – seeing the old pattern as a combination of new parts, better done on perceptual experience than mental imagery.

Wideware Plus

- "We, more than any other creature on the planet, deploy non-biological wideware (instruments, media, notations) to *complement* our basic biological modes of processing, creating extended cognitive systems whose computational and problem-solving profiles are quite different from those of the naked brain."
(Wideware: 150)

Good, as long as we remember that naked brains get organized to do this **only** via cultural practices.

Active Stupidity

and the spark that started the wideware fire

- Where did wideware come from, if not from already smart brains?
- Some small change followed by an iterated bootstrapping process. Brain/culture co-evolution.
- "The idea is that some relatively *small* neural (or neural/bodily) difference was the spark that lit a kind of intellectual forest fire. The brain is, let us assume, wholly responsible (courtesy, perhaps of some quite small tweak of the engineering) for the fulfillment of some precondition of cultural and technological evolution."

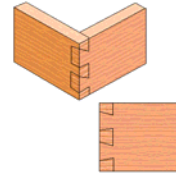
But wait! Why make the brain "wholly responsible"?

- If high level cognition emerges, not directly from wideware, or even from unconstrained interaction of brain with wideware, but from the interaction of naked brain with wideware as orchestrated by cultural practices, then...
- A change in cultural practices is equally likely, or even more likely to have been the spark for the human cognitive revolution.

Neural Constructivism (Quartz and Sejnowski)

- Cortical development is experience-dependent throughout life
- Learning does not just alter the knowledge base, it alters the connectivity of the brain
- Thus, experience alters the computational architecture of the brain
- What organizes experience throughout life?
- Cultural practices

Dovetail Joint



Cognitive Dovetailing (Clark)



- “Neural resources become structured so as to factor reliable external resources and operations into the very heart of their problem solving routines.” (Mindware: 151)

What organizes your brain throughout your life?

Experiences.

And what organizes human experiences?

Cultural Practices

Clark’s mad fantasy

- “Now picture the young brain, learning to solve problems in an environment packed with pen, paper, PC, etc. That brain may develop problem-solving strategies that factor in these props...”



Trobriand Island children

Yes, children (not young brains) may develop those sorts of strategies, but only when they develop in the context of appropriate cultural practices.

Clark’s mad fantasy

(continued with neural constructivism)

- “...young brains may even develop a kind of cortical architecture especially suited to promoting a symbiotic problem-solving regime, in which neural subsystems, pen, paper, and PC-based operations are equal partners, performing complementary and delicately orchestrated operations.” (Mindware:152)

Which is a fine thing to say as long as we remember what provides the delicate orchestration of operations.

What’s the value of the Wideware view?

- There can be no single “cognitive level” (remember PSSH)
- And no uniquely bounded system (e.g., the brain) to which we can restrict our interest.
- Nor even a collection of bounded systems

Our focus must be on the **interactions** themselves.

A cognitive science of interactions

- "The payoff could be spectacular: nothing less than a new kind of cognitive scientific collaboration involving neuroscience, physiology, and social, cultural, and technological studies in about equal measure." (Mindware:154)
- Celebration is in order!



Upgrading the Chimpanzee Mind

Based on Thompson, Oden and Boysen 1997
"Language naïve chimpanzees (Pan troglodytes) judge relations between relations in conceptual match-to-sample task."

Why it is relevant here.

- A qualitative change of just the sort that is presumed to underlie the shift from pre-symbolic to symbolic reasoning could occur in a nonhuman primate as a consequence of a change in a cultural practice.

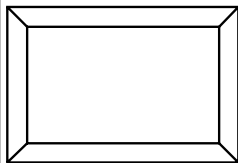
The pre-upgraded chimp mind

- Infant chimpanzees perceive similarities and differences between exemplars of identity and non-identity relationships, but they cannot use that ability to judge the equivalence of such relationships in a conceptual matching task.

Chimps learn interactions



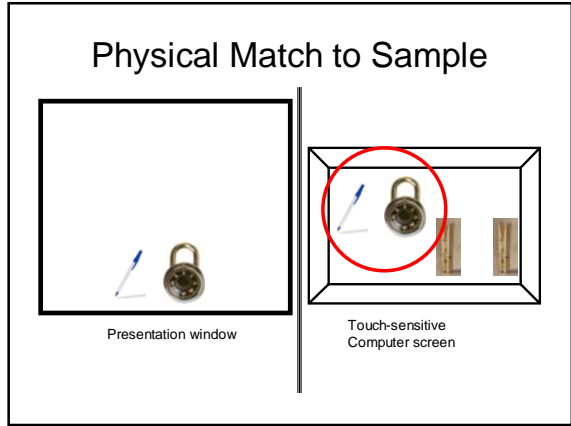
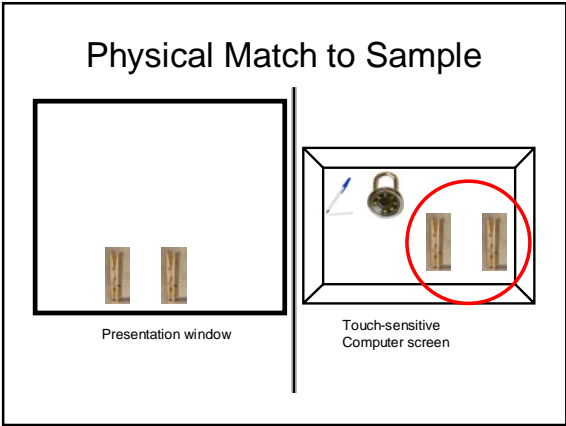
Presentation window



Touch-sensitive
Computer screen

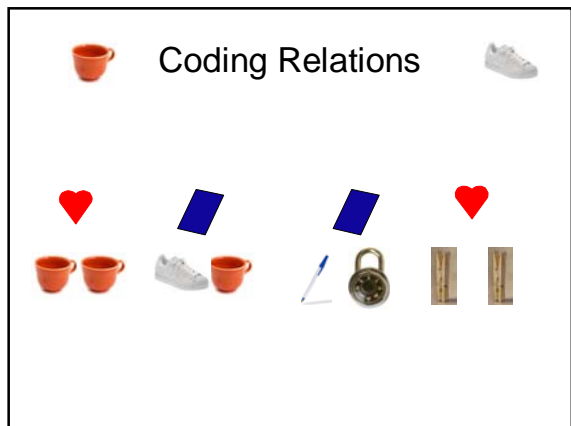
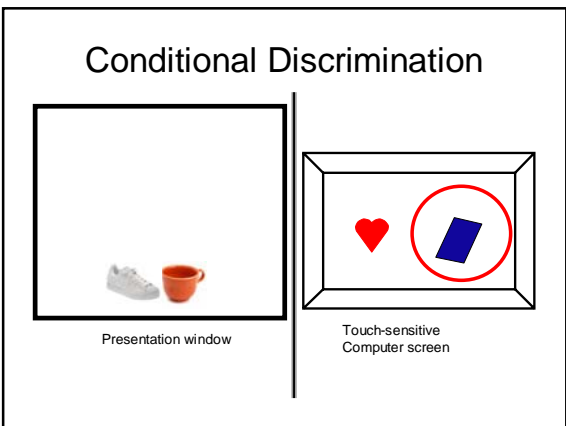
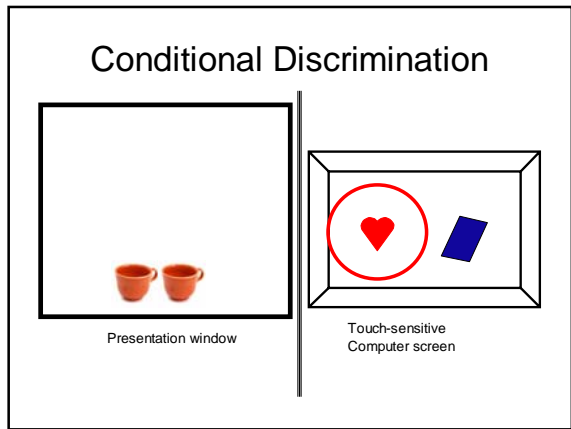
Physical match-to-sample

- View sample pair.
- View two alternative pairs.
- Correct response is to choose the alternative which is identical to the sample.
- Chimps learn this readily with conditional reinforcement.



Conditional discrimination task

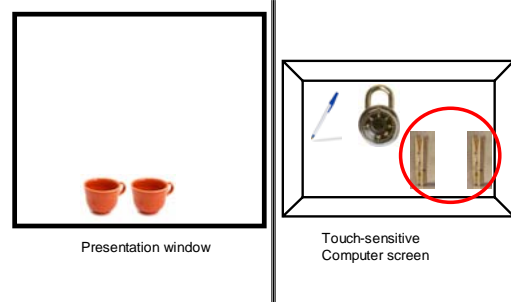
- View sample pair.
- View two tokens (heart and diagonal).
- Correct response is to choose the heart token if the two objects in the sample pair are identical; choose the diagonal token if the two objects are not identical.
- Chimps learn this slowly with conditional reinforcement.



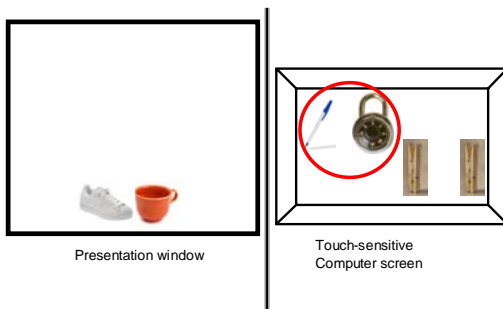
Conceptual match-to-sample

- View sample pair.
- View two alternative pairs.
- Correct response is to choose the alternative which has the same within-pair relation as the within-pair relation of the sample.
- Some language trained chimps can do this. And chimps who have had **conditional discrimination** training (but no language training) can also do it.

Conceptual Match to Sample



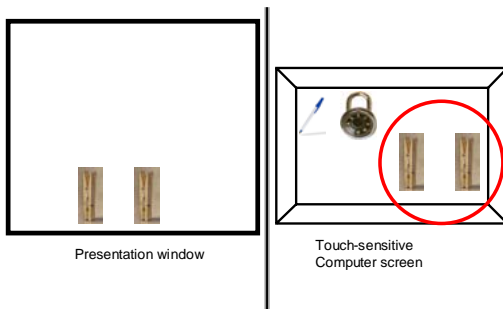
Conceptual Match to Sample



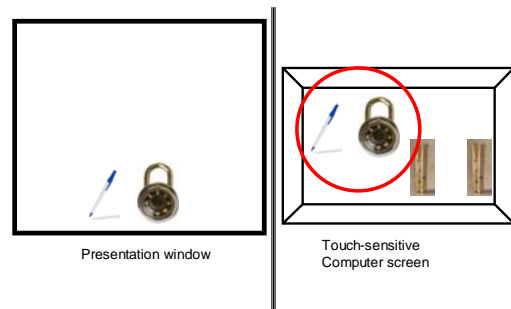
The experimental design

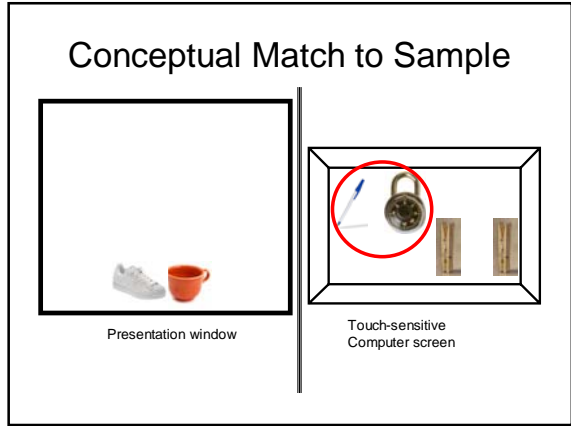
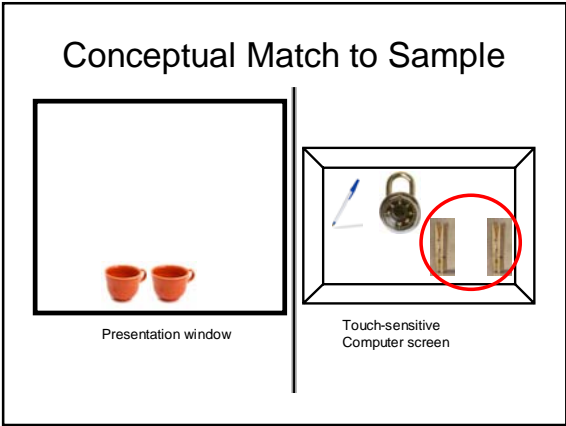
- Alternating blocks of
 - Physical match to sample
 - Conceptual match to sample.

Physical Match to Sample



Physical Match to Sample

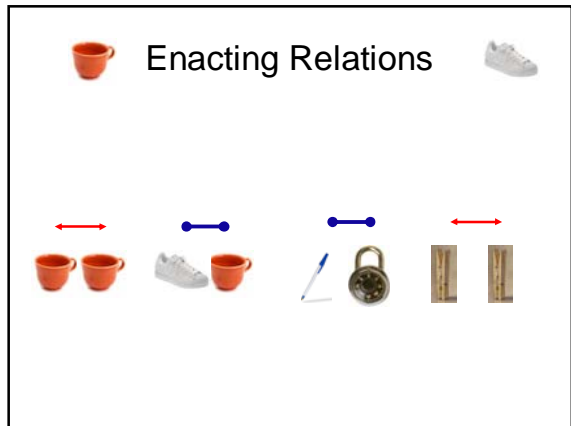
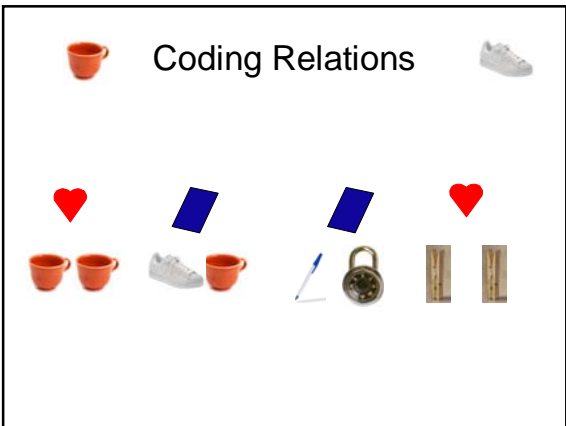


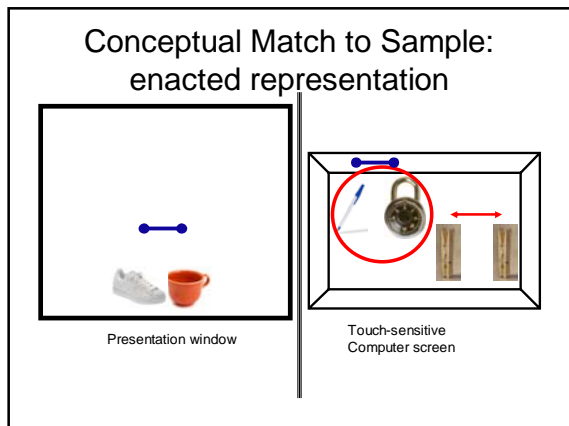
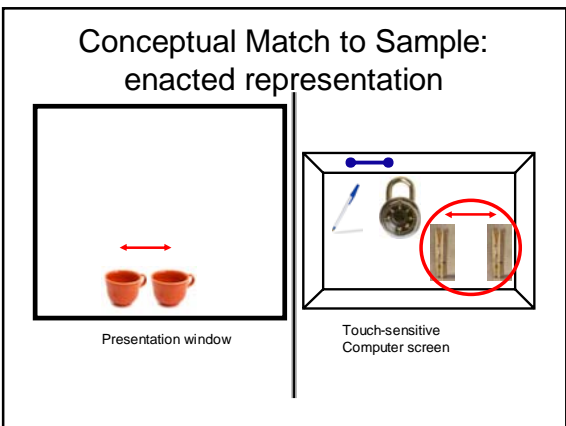
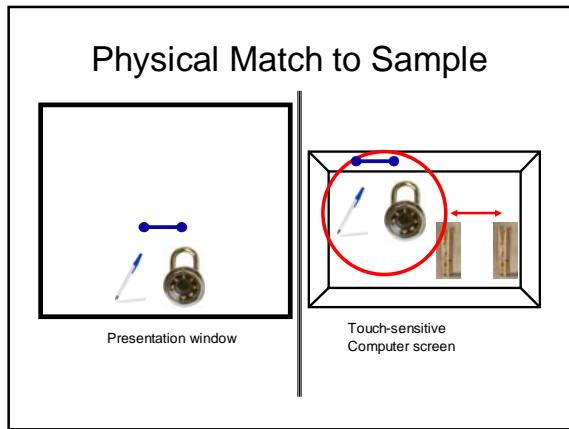
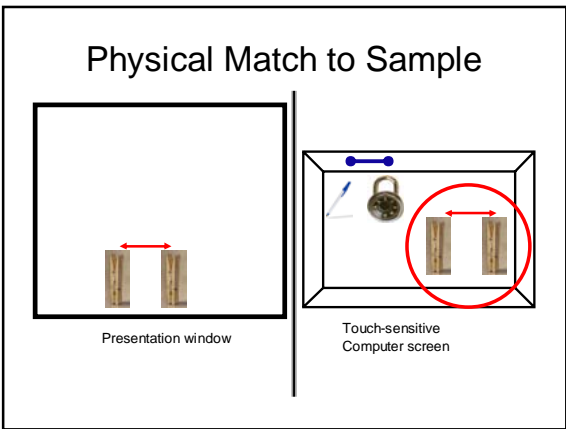
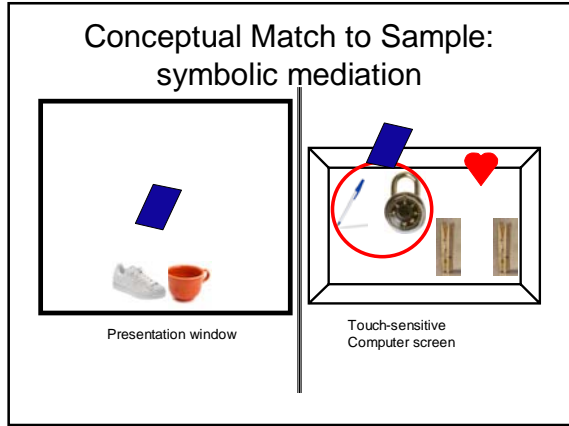
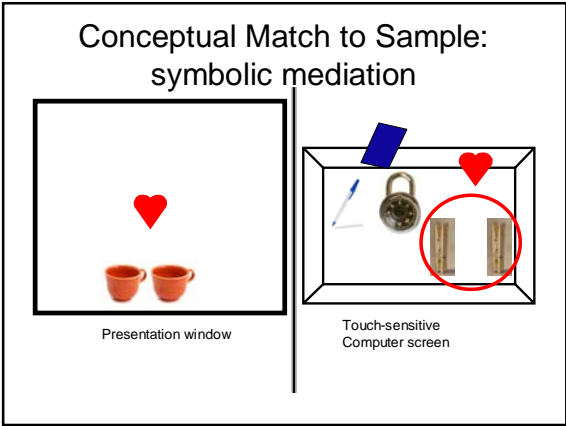


And the chimps that had conditional discrimination training can do it on the very first trial

Why?

- ### Conditional discrimination task
- Bring the practice of discrimination of identity/non-identity under control by making it part of the social interactions with the humans. *Learn to participate in new cultural practices*
 - Choose one token for identical pairs and a different token for non-identical pairs. *Code relations using symbol-like tokens*





Upgrading nonhuman primate minds via cultural practices

- Either explanation of the upgrade process implies the orchestration of interactions of brain and body with the culturally organized social and/or material environment.
- The “upgraded” processes are a property of the interaction system: brain, body, world.

Models of language

- One view of language is that it is the output of a specialized machine.
 - Cultural practices set only the specific forms of language.
- Another is that language is a behavioral repertoire that draws on many capacities that were not evolved to serve language. Language as an organized bag of tricks.
 - Cultural practices organize the tricks in the bag of tricks in ways that produce the abilities we observe.

Imply different differences

- If you assume the language as specialized machine position, then the difference between us and them must be that they lack some critical components of the language machine.
- If you assume the bag of tricks then it is possible that they have all the tricks, but lack the capacity to enter into the practices that orchestrate the relations among the parts that produce the ability.

The general principle

- If cultural practices mediate the relations between cognitive capacities (imagining trajectors, confirmation bias, conceptual blending ...) and high level cognitive abilities (sidereal calendars, non-instrumental navigation, deliberation, language ...),
- then cognitive capacities cannot be inferred directly from abilities,
- and the evolutionary value of capacities cannot be inferred from the utility of abilities.

Chimp Representation

- The Chimp’s representational activities are embodied, multimodal, and temporally extended.
- The activity of bringing forth the thing that is represented (the relation) is organized by cultural practices.

Chimp symbol processing

- The chimps’ behavior depends on being enculturated into certain cultural practices.
- The cultural practice of seeing hearts and diagonals “as” symbols that code relations creates a “new perceptual modality” in which abstract relations (relations among relations) can be “seen”.
- But once that perceptual modality is trained, it might be usable without invoking the symbols.

Relations among Relations



Imagining the coding tokens

