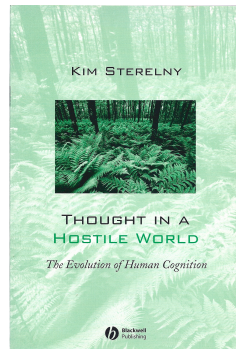


Cognitive Niche Construction



Evolution primer

- selection on variability
- differential fitness
- changing proportions of genetic patterns through time

To appreciate just how *powerful* a force cognitive niche construction may actually be in the evolution and development of human cognition, it helps to introduce the notion, due to Sterelny (2003), of *cumulative downstream epistemic engineering*. Sterelny, in a rich and detailed synthesis of work in biology, anthropology, and the study of primate minds, offers an account of human uniqueness that gives pride of place to our extraordinary capacities as “ecological engineers”—that is to say, as the active constructors of our own cognitive niches. Having earlier argued for group

Cognitive Niche Construction

- Humans construct (and inherit) their own cognitive niches
- These set the selective pressures on evolution of the brain
- Brain and culture co-evolve through Mutual Reciprocal Causation

structures of our own cognitive niches. Having earlier argued for group selection as a key force in human evolution, Sterelny notes that groups of humans engineer their own habitats and that these are transmitted to the next generation, who further modify the habitat. Importantly, some of these modifications are to the epistemic environment and affect the informational structures and opportunities presented to each subsequent generation. Although other animals clearly engage in niche construction,

Cultural (non-genetic) Inheritance

- Human groups engineer their own habitats
- This includes epistemic (cognitive) aspects of the environment
- Unlike genes, engineered habitats are inherited by and engineered by subsequent generations

generation. Although other animals clearly engage in niche construction, it is only in the human species, Sterelny argues, that we see this potent, cumulative, runaway (self-fueling) process of epistemic engineering.

Only humans exhibit...

- cumulative
- runaway
- self-fueling
- epistemic engineering
- *“Cumulative downstream epistemic engineering”*

Niche construction is depicted by Sterelny as a kind of additional inheritance mechanism, working alongside and interacting with genetic inheritance. One of the points of interaction concerns phenotypic plasticity. For rampant niche construction yields a rapid succession of selective environments and hence favors the biological evolution of phenotypic plasticity. Hominid minds, Sterelny suggests, are adapted not to the

The pace of cultural change

- Rampant niche construction
- yields a rapid succession of selective epistemic environments.
- It thus favors...
- the biological evolution of phenotypic plasticity.

plasticity. Hominid minds, Sterelny suggests, are adapted not to the “statistical composite” of the Pleistocene (as some brands of evolutionary psychology suggest; see, e.g., Tooby and Cosmides 1990) but to the variability of environments and to the spread of variation itself. To cope with such variability, we are said to have evolved powerful forms of developmental plasticity. These allow early learning to induce persisting and stable forms of neural reorganization, impacting our range of automatic skills, affective responses, and generally reorganizing human cognition in deep and profound ways. The upshot, in direct opposition

Evolved to fit the environment?

Sure, but which aspect of the environment?

- Evolutionary psychology expects the brain to be adapted to a “statistical composite” of Pleistocene environments.
- Sterelny says no.
- We have adapted to variability and the spread of variation itself by becoming more plastic, more malleable, more adaptable.

cognition in deep and profound ways. The upshot, in direct opposition to much recent evolutionary psychological speculation, is that “we do not have essentially Pleistocene minds in our contemporary world” (Sterelny 2003, 166). Instead, “the same initial set of developmental resources can differentiate into quite different final cognitive products” (166). In this way, “transforming hominid developmental environments transformed hominid brains themselves. As hominids remade their own worlds, they indirectly remade themselves” (173).

Stone-age Minds in a Space-age World?

- The same initial set of developmental resources
- can differentiate into quite different final cognitive products.
- Changing hominid developmental environments transformed hominid brains themselves.
- As hominids remade their own worlds, they indirectly remade themselves.

Origins of Theory of Mind

We see this explanatory template in action in, for example, Sterelny’s account of our capacity to interpret others as intentional agents. Instead of an innate “folk psychology” module, in the form of a domain-specific adaptation for “mind-reading,” Sterelny offers a niche-construction-based account according to which

Where does our ability to imagine the mental states of others come from?

- Evolved as an innate “folk psychology” module in the brain?
- OR
- An outcome of cognitive niche construction?

selection for interpretative skills could lead to a different evolutionary trajectory: selection on parents (and via group selection on the band as a whole) for actions which scaffold the development of the interpretative capacities. Selection rebuilds the epistemic environment to scaffold the development of those capacities. (2003, 221)

If selection favors interpretive skills

- Selection on parents for actions (cultural practices) that scaffold the development of interpretive capacities
- The offspring of parents who are inclined to engage in these actions are more likely to survive

Basic perceptual adaptations (e.g., for gaze monitoring etc.) are thus supposed to be bootstrapped up to a full-blown mind-reading ability via the predictable effects of intense social scaffolding: The child is surrounded by exemplars of mind-reading in action, she is nudged by cultural inventions such as the use of simplified narratives, prompted by parental rehearsal of her own intentions, and provided with a rich palate of linguistic tools such as words for mental states. Such “incremental

Practices recruit individual abilities

- Through “intense social scaffolding”
- Basic perceptual abilities (gaze monitoring, for example) are recruited by the practices of “folk psychology” into ecological assemblies that produce representations of the mental states of others.

A developmental scenario

- The child is surrounded by exemplars of “mind reading” in action, she is nudged by cultural practices such as the use of simplified narratives, prompted by parental rehearsal of her own intentions, and provided with a rich palate of linguistic tools such as words for mental states.

ate of linguistic tools such as words for mental states. Such “incremental environmental engineering” provides, according to Sterelny, a “wealth of the stimulus” argument against the innateness hypothesis (223).

- Incremental environmental engineering provides a “wealth of the stimulus”.
- There is no need for a specialized “mind reading” or “folk psychology” module.

Our theory of mind, according to this argument, is not wired in at birth but acquired by rich developmental immersion. Such immersion may itself have “architectural consequences” (225), but these are the upshot, not the precondition, of learning. This explanatory strategy thus depicts much of what is most distinctive in human cognition as rooted in the reliable effects, on developmentally plastic brains, of immersion in a well-engineered, cumulatively constructed cognitive niche.

Theory of Mind

- Not wired in a birth
- Acquired through immersion in a rich highly-structured, engineered habitat for thought and action.
- This acquisition may (almost certainly does) change the organization of the brain. But that is a consequence, not a cause of theory of mind behavior.

How humans got to be human

- Much of what is most distinctive about human cognition is rooted in the reliable effects, in developmentally plastic brains, of immersion in a well-engineered, cumulatively constructed, cognitive niche.

Motor Emulator Circuits

Primal mental representations

Motor emulation

- Closed loop control
 - timing not possible for fast fluid action
- Pseudo closed loop control
 - have an emulation of the control loop that produces expected proprioceptive feedback

Motor emulation running off-line = mental imagery

- Inhibit motor outputs
- Run the emulation
- You get an internal version of the entire loop of action and perception
- The imagery could include “mock visual inputs” or, in fact, correlated elements of experience from any sensory or motor mode

Outcomes

- The cognizer can imagine **absent** situations
- Freed from coupling to a dynamic world
- This is an antidote to the notion that “the world is its own best model”

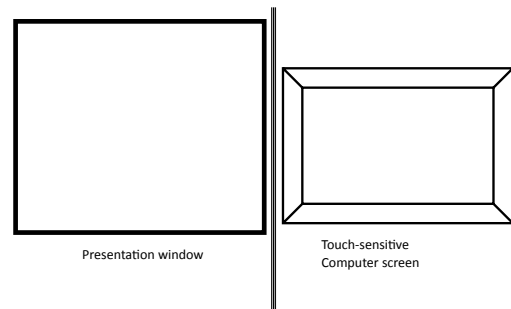
Upgrading the Chimpanzee Mind

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

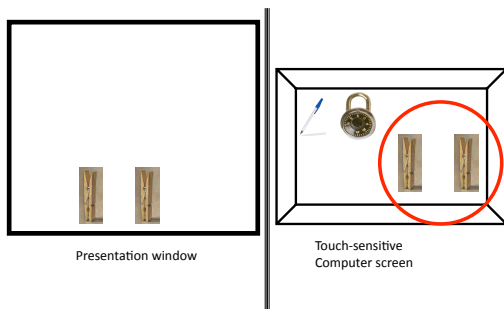
The pre-upgraded chimp mind

- “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.”

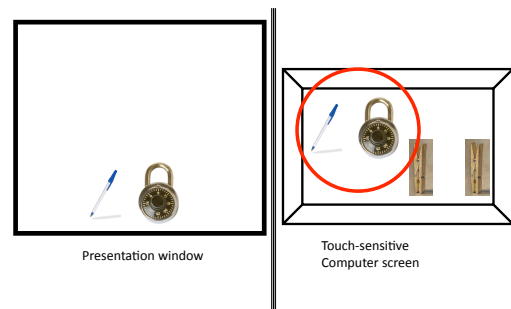
Chimps learn interactions

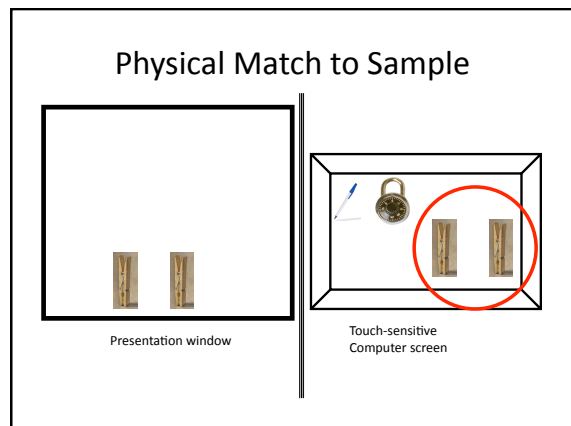
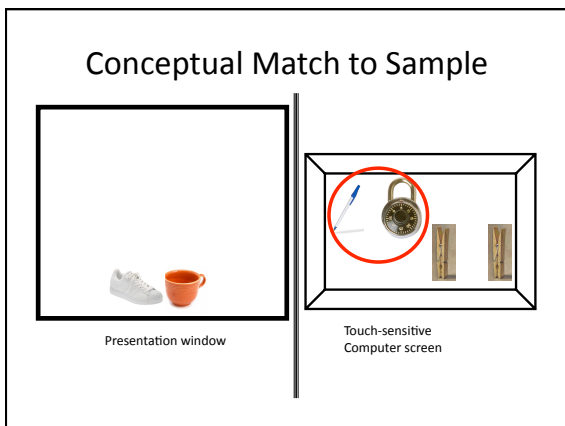
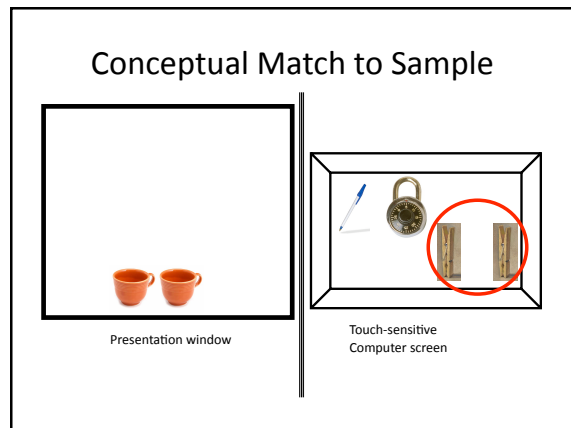
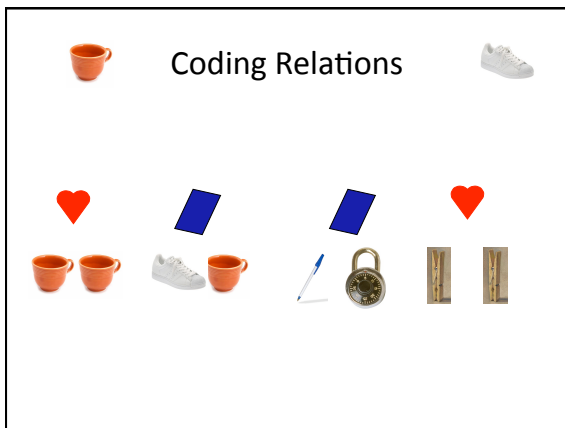
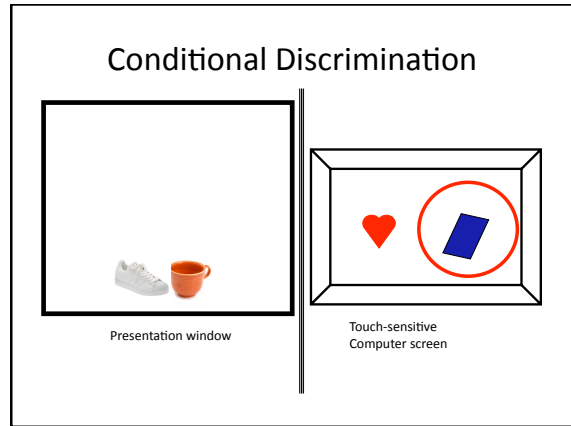
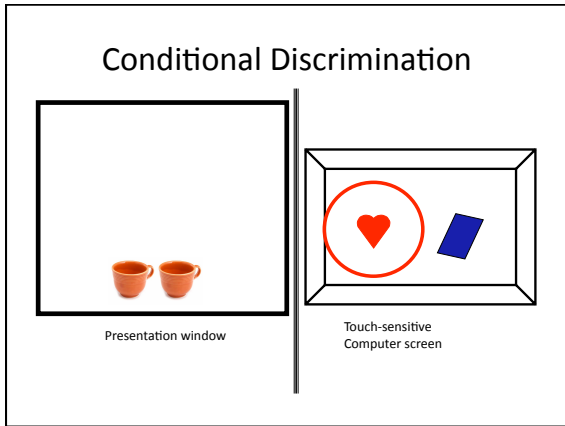


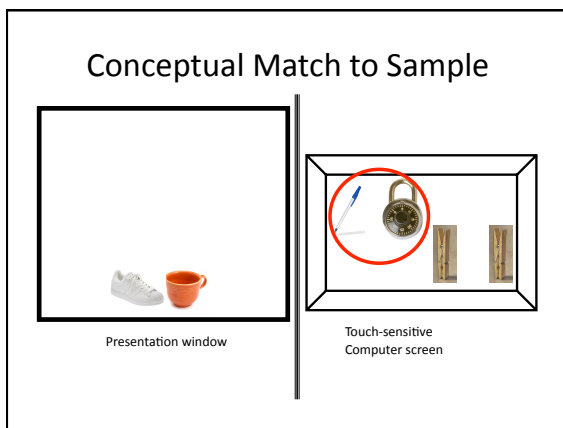
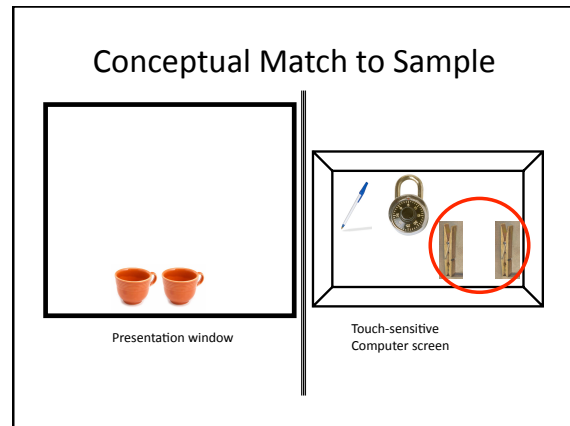
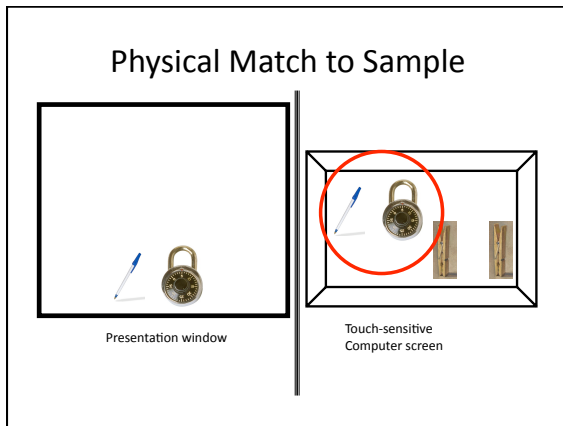
Physical Match to Sample



Physical Match to Sample







And the chimps that had conditional
discrimination training can perform
conceptual match-to-sample on the very
first trial

Why? How?

Labeling first-order relations

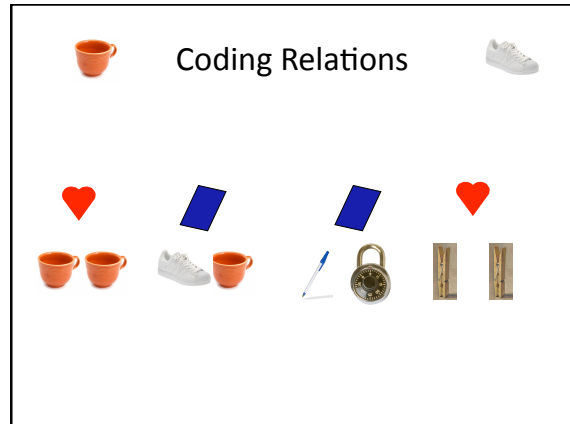
- “First, the chimpanzee detects the within-pair relation instantiated, for example, by an AA (identity) or a CD (nonidentity) sample.
- This evokes an internal iconic representation of the concrete token (e.g., "heart" or "diagonal") that symbolically codes identity and nonidentity, as learned previously in an unrelated task.”

Labeling first-order relations

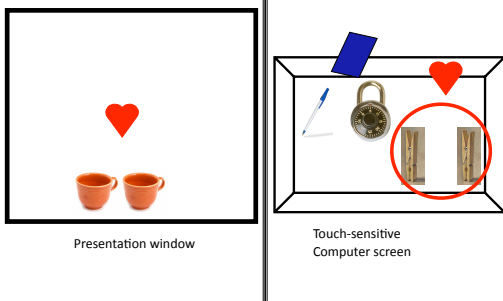
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Labeling second-order relations

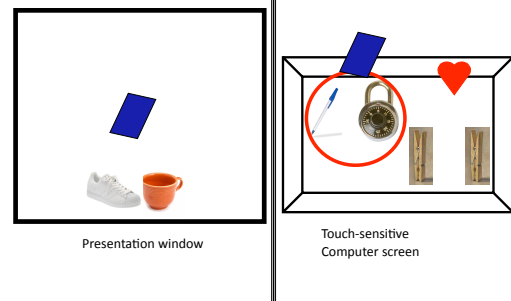
- “Likewise, these icons symbolizing the relations identity and nonidentity, respectively, will be evoked when the chimpanzee next detects the within-pair relations instantiated by the BB and EF alternatives presented on the computer monitor.
- The chimpanzee can now covertly match these representational icons (e.g., *heart and diagonal*) against the symbolic representation of heart or diagonal evoked by the sample.”



Conceptual Match to Sample: symbolic mediation



Conceptual Match to Sample: symbolic mediation

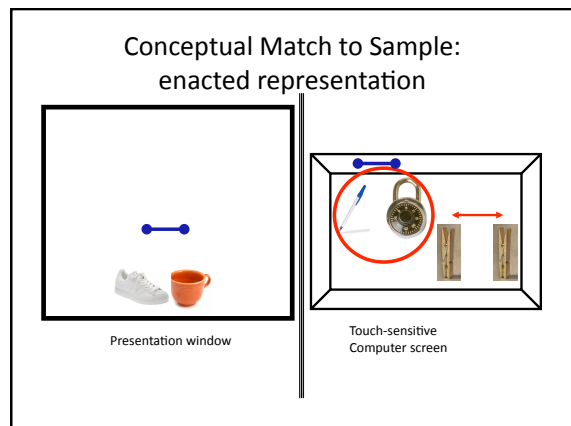
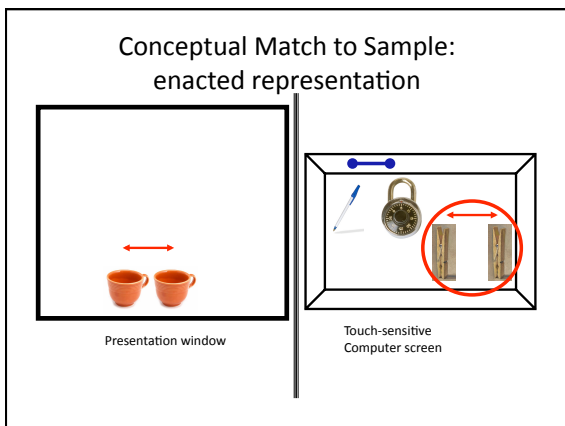
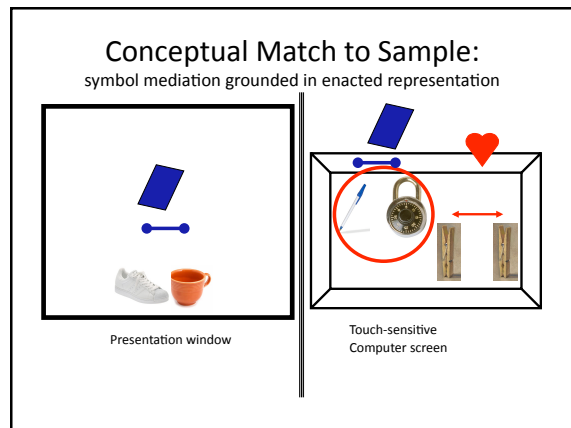
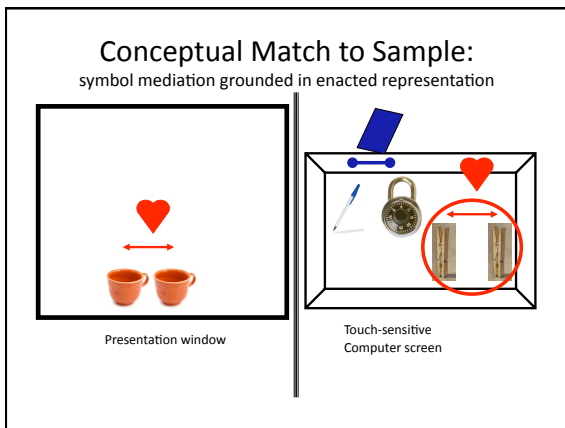
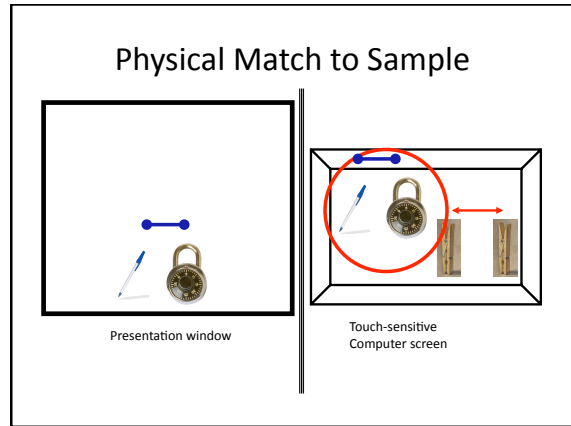
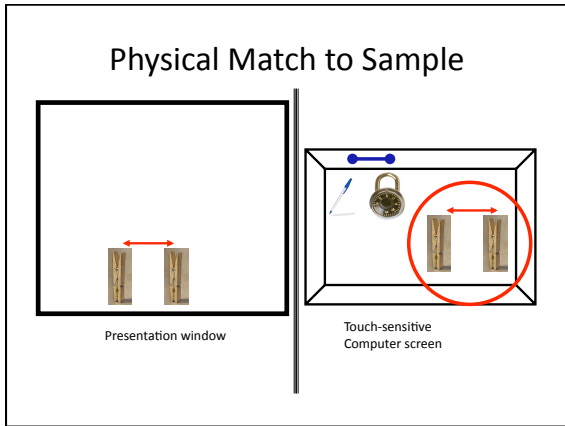


Labeling first-order relations

- First, the chimpanzee detects the within-pair relation instantiated, for example, by an AA (identity) or a CD (nonidentity) sample.
- This evokes an internal iconic representation of the concrete token (e.g., "heart" or "diagonal") that symbolically codes identity and nonidentity, as learned previously in an unrelated task.

Enacted Representations of Relations





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

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.

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, culturally organized world.

Empirical questions

- Under what conditions will the skills that were learned to subservise the distinctions required by the language (Slobin, thinking for speaking; Kirby, the underlying “metric”) affect other cognitive performances?
- Under what conditions will the cultural practices of seeing the world in particular ways, whether subserving language or not, be recruited as mediating resources in a task performance?

A research program?

- What processes control the recruitment of resources (assembly process) into cognitive functional systems?
 - The Vygotskian approach implies this question
 - Andy Clark makes this question a central theme in his recent book *Supersizing the Mind*

Surrogate Situations

External representations

Surrogate situation defined

- Any kind of real-world structure that is used to stand in for or take the place of an aspect of some target situation (pg. 154).
- E.g. Architect's plan, navigator's chart, your calendar ...
- Abstractions can be created here
 - (getting distance between the representation and thing that is represented)
- Surrogate situations are pervasive, various, and important
 - (A clear call for more cognitive ethnography)

Emulator Circuits + Surrogate Situations = abstract thought

- Suppose we engage a surrogate situation using emulator circuits.
- Now we can reason about things that are abstract and absent.
- "The model is it's own best world"
- "Surrogate situations allow us to build *environmentally extended emulator circuits.*" (pg 156)