

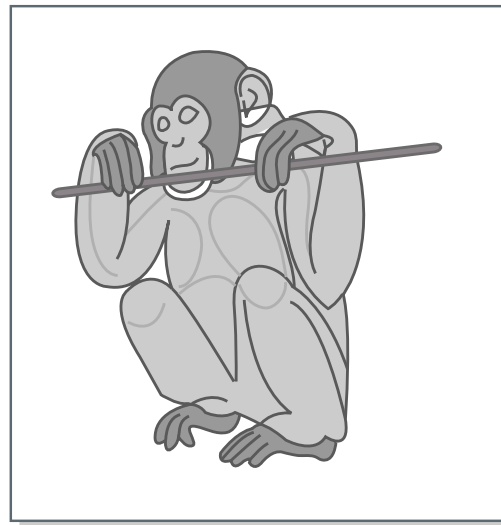
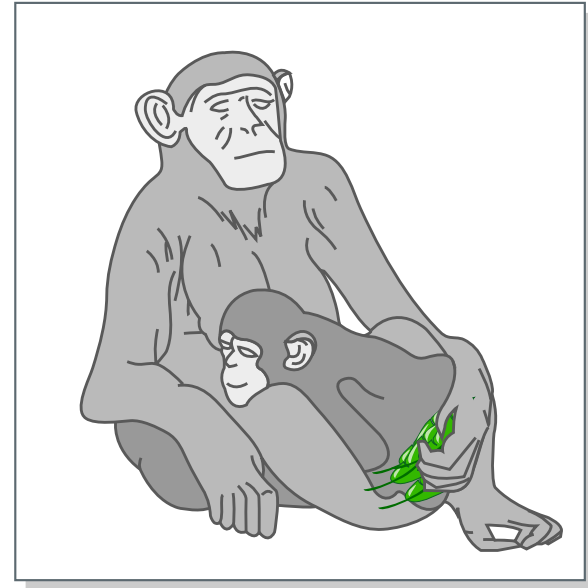
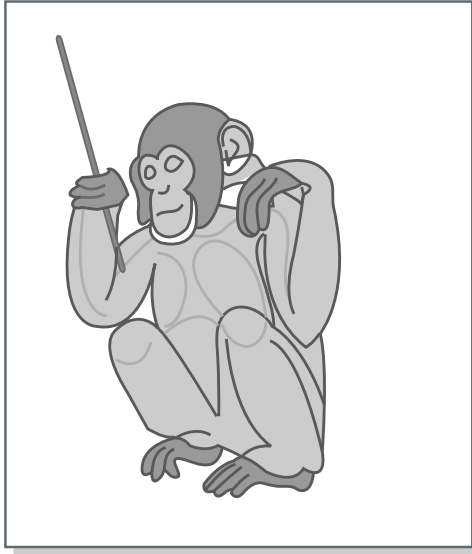
9.85 Cognition in Infancy and Early Childhood

Lecture 19: Means-ends
reasoning and tool use

Today

- Comparative psychology of tool-users
- Means-ends reasoning
- Learning from doing
- Learning from talking
- Functional fixedness

Who uses tools?



http://images.google.com/imgres?imgurl=http://www.arkive.org/media/D4CCB418-2D4F-4F88-8A76-910AE902FC2B/Presentation.Streams/picture.jpg&imgrefurl=http://www.arkive.org/species/GES/mammals/Pan_troglodytes/more_moving_images.html&h=100&w=151&sz=5&tbid=7w1

Illustration courtesy of MIT OCW.

Examples of chimp tool use (Nature, 1999)

- Leaf masses as sponges
- Leaves to brush away bees
- Leafy stick to fan flies
- Leaves to dab wounds
- Leaves to squash bugs

Chimp tool use

- Branches to hook other branches
- Sticks to poke termite nests
- Sticks to dig
- Sticks to make a seat protect from thorns
- Sticks to pick noses

Who else?



Photo from <http://users.ox.ac.uk/~kgroup/tools/media.shtml>

New Caledonian crows



Photo from <http://users.ox.ac.uk/~kgroup/tools/media.shtml>



Photo from <http://users.ox.ac.uk/~kgroup/tools/media.shtml>



Photo from <http://users.ox.ac.uk/~kgroup/tools/media.shtml>

Hallmarks of genuine tool use

- Select appropriate tools
- Shape appropriate tools
- Novel materials
- Adjust their behavior to the requirements of the task

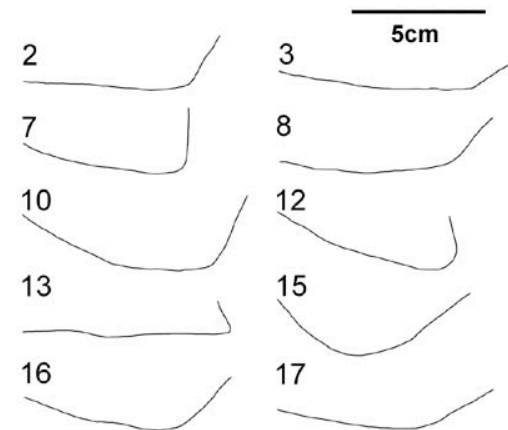
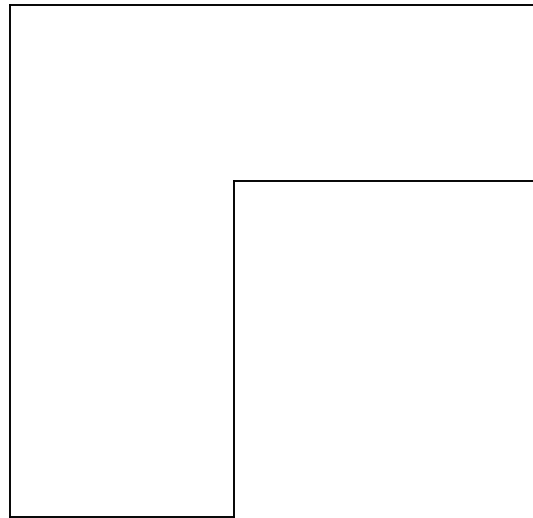


Image from: http://users.ox.ac.uk/~kgroup/tools/cognition.shtml#hook_bending

Novelty, violation and exploration

- Evidence of innovation
- Evidence of exploration?
- Balancing blocks ... 3's v. chimps



Why think it might be specific to humans?

- Represent both itself and something else ...
- It's a stick and a hook
- It's a leaf and a mop

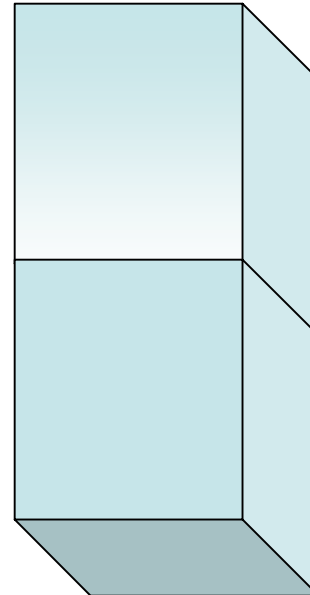
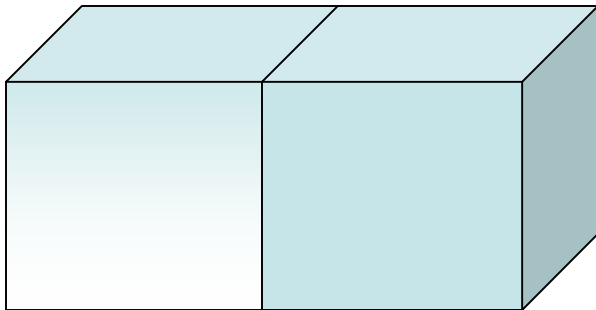
- A type of symbolic thinking ...

Late in development

- In contrast, more recently characterized in terms of sensitivity to object affordances (folk physics)
- And ability to connect sequences of actions together in order -- to understand the hierarchical structure of action.

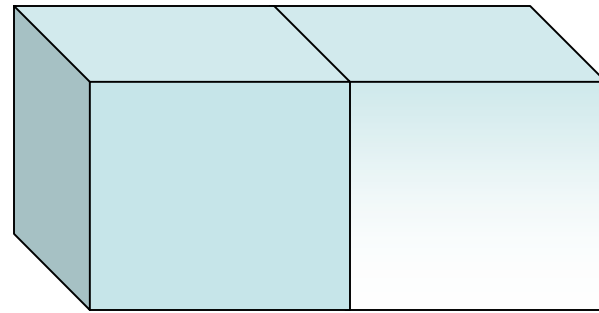
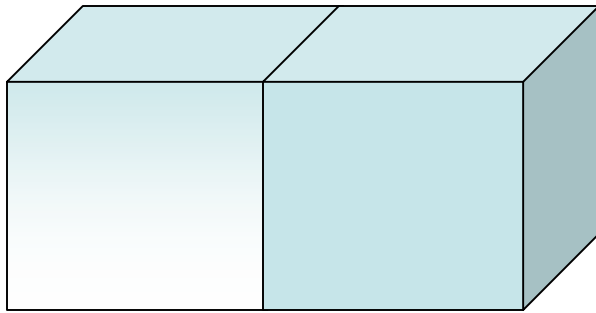
Relating affordances

- 6-month-old “banging”



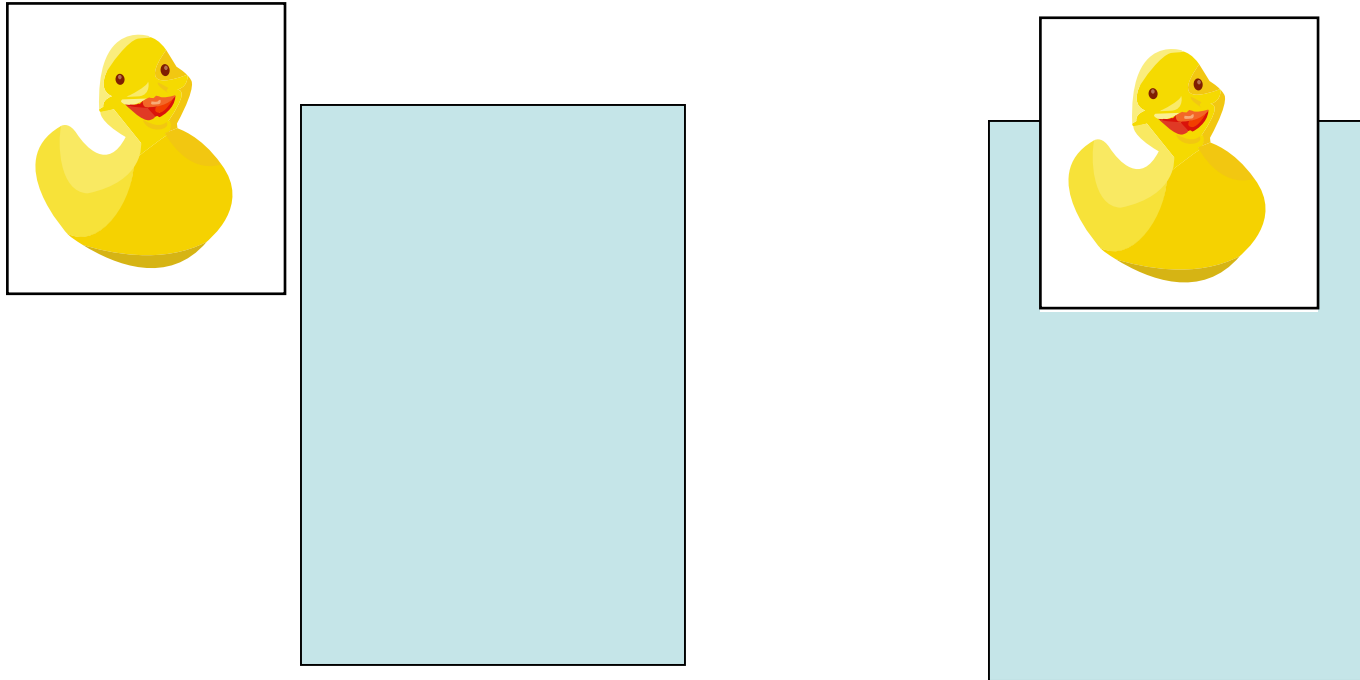
Relating affordances

- 6-month-old “failed” banging

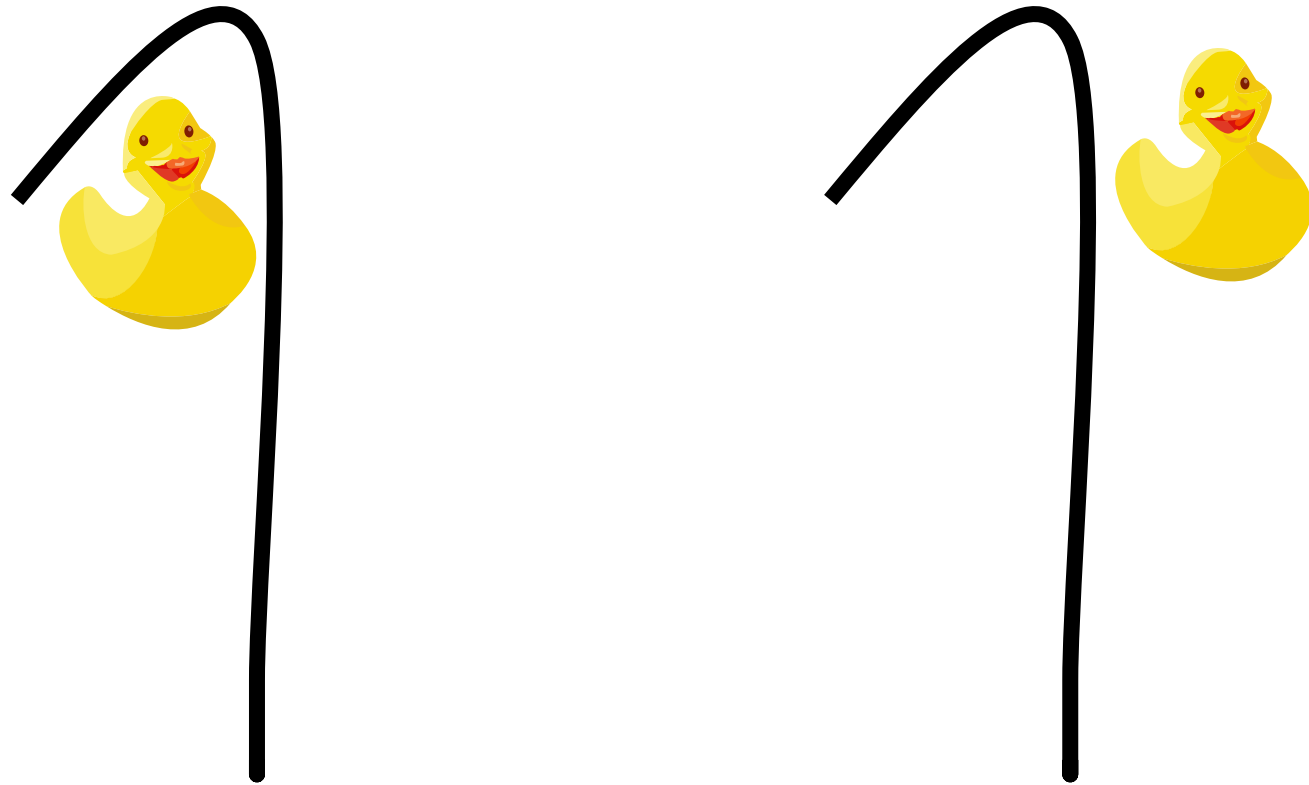


Piagetian means-ends tasks

- Understanding support relations ...



Piagetian means-ends tasks



Development of tool-use

- Subjective
 - Infant plays with the tool and ignores the goal.
- Transitional
 - Infant uses the tool to reach the goal but indiscriminately
- Objective
 - Infant uses the tool on contact trials; offers the tool to the experimenter or drops the tool on non-contact trials.

Development of tool-use

- Infants begin to pass cloth-pulling tasks (e.g., tasks involving support relations) between 9-10 months.
- Infants pass cane tasks (e.g., tasks involving containing and surrounding relations) around 12-months.

Learning and doing

- Action production and action processing
- Sticky mittens and 3-month-olds
- (And sticker projects and 20-year-olds)

Figure removed due to copyright restrictions. Please see:
Fig 1. in Sommerville J. A., A. L. Woodward, and A. Needham.
"Action experience alters 3-month-old infants' perception of others' actions."
Cognition 96, no. 1 (May 2005): B1-11.

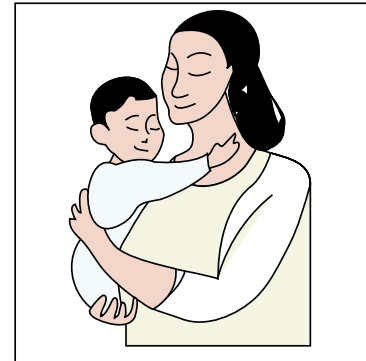


Illustration courtesy of MIT OCW.

Learning from doing

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Please see:

Fig 3. in Sommerville J. A., A. L. Woodward, and A. Needham. "Action experience alters 3-month-old infants' perception of others' actions." *Cognition* 96, no. 1 (May 2005): B1-11.

True of means-ends behaviors as well.

- 8-month-olds look longer at “impossible” cloth-pulling events but don’t discriminate between possible and impossible cane events.
- 12-month-olds look longer at both types of “impossible” event.

Understanding hierarchies of actions

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Please see:

Fig 1a. in Sommerville J. A., and A. L. Woodward. "Pulling out the intentional structure of action: the relation between action processing and action production in infancy." *Cognition* 95, no. 1 (February 2005): 1-30.

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Please see:

Fig 1b. in Sommerville J. A., A. L. Woodward. "Pulling out the intentional structure of action: the relation between action processing and action production in infancy." *Cognition* 95, no. 1 (February 2005): 1-30.

12-month-olds are more interested in ends than means

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Please see:

Fig 2 in Sommerville J. A., A. L. Woodward. "Pulling out the intentional structure of action: the relation between action processing and action production in infancy." *Cognition* 95, no. 1 (February 2005): 1-30.

What about 10-month-olds?

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Fig 3. in Sommerville J. A., A. L. Woodward. "Pulling out the intentional structure of action: the relation between action processing and action production in infancy." *Cognition* 95, no. 1 (February 2005): 1-30.

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Fig 2. in Sommerville J. A., A. L. Woodward. "Pulling out the intentional structure of action: the relation between action processing and action production in infancy." *Cognition* 95, no. 1 (February 2005): 1-30.

Implications

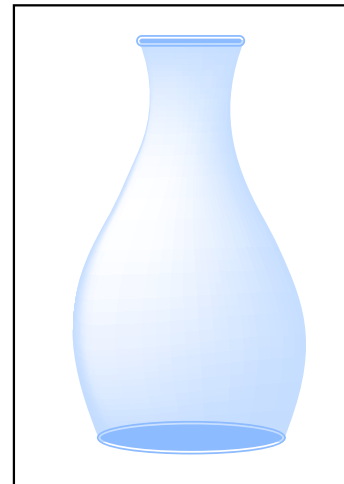
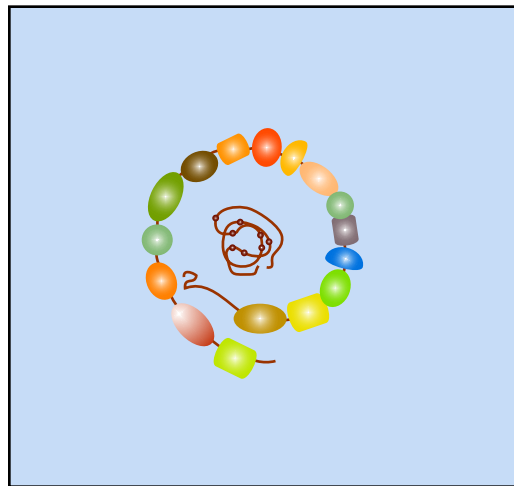
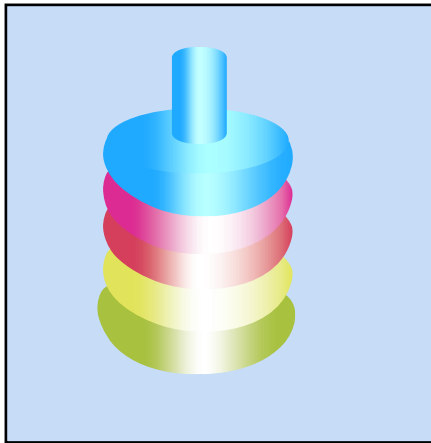
- Action experience affects representational understanding.
- By 12-months, infants create action representations that are hierarchically organized around goals.

12-month-old means-ends reasoning

- 12-month-old theory of tool use may just be “contact”
- Takes them a while to decide which end of a rake to use, what materials matter, etc.
- (And takes adults a while too ...)

12-month-old means-ends reasoning

- Insight learning v. trial and error
- (Note that successful trial and error learning rules out motor constraints)



Learning and language

- Failure words
 - “Oh dear” (can’t fit a small top on a large box; pushes flap on tape recorder and it pops up again; tower falls down; holding up a broken toy”
 - “No” (tries to add a block to a tower, drops it; puts puzzle piece in wrong place)

Learning and language

- Success words
 - “There” (adds a block to a full box; adds a ring to a tower; slides a car to the end of a ramp”
 - “Done it” (gets puzzle piece)
 - “Good” (puts correct block in shape box)

Learning and language

- 18-month-olds who solve multiple displacement object permanent tasks are more likely to say “gone” than those who fail (but not more likely to say “uh-oh”)
- 18-month-olds who solve necklace and tower tasks are more likely to say “un oh” than those who fail (but not more likely to say “gone”)

Learning and language

- Cross-linguistic studies
- Nouns are obligatory in English and often end sentences
- Korean allows noun ellipsis and verbs end sentences.
- English-speaking babies relatively advanced on categorization tasks; Korean-speaking babies relatively advanced on means-ends abilities and success-failure words.

Understanding tools

- “Design stance”
- Adults judge artifacts
 - On the basis of intended function rather than appearance
 - On the basis of intended function rather than current use.
 - On the basis of original designer’s intention rather than other intentional uses.

Understanding tools

- Some evidence that children also understand artifacts in terms of intentions ...
- But this does not necessarily mean children have a “design” stance -- or the adult concept of tools and artifacts.

Task

- Find a partner
- Your task is to affix the candle to the bulletin board outside.
- Come back when you're done ...

Functional fixedness

- Once you know the purpose of something (boxes are for containment) it makes it more difficult to see other uses (box is for support)
- Adults are much faster to solve the problem when the tacks are outside the box than inside the box.

Why do we experience functional fixedness?

- Design stance -- we have an abstract concept of artifact function that plays a role in problem-solving.

Understanding tools

- Innate dedicated mechanisms for representing tools? (Pinker: “intuitive engineering”)?
- Or gradual emergence from a combination of naïve physics and naïve psychology...

Understanding tools

- Suppose children understand artifact function in terms of the object's mechanical properties and goals of agents but don't have a design stance ...
- They might not be subject to functional fixedness -- their problem solving might not be constrained by what an object is designed "for".

Why would children not have a design-stance?

- More complex than goal-directed action or object affordances
- Requires understanding goals of both the inventor and the user.
- Understanding “intentionally made for purpose X” requires coordinating 2 mental states: INVENTOR intends that USER will ...

Design stance

- Second-order (recursive) mental state.
- If you don't have a design stance than the user's goal might overshadow the maker's goal.
- An immature artifact concept might free you from functional fixedness.

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Please see:

Fig 1. in Defeyter M. A., and T. P. German. "Acquiring an understanding of design: evidence from children's insight problem solving." *Cognition* 89, no. 2 (September 2003): 133-55.

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Prior knowledge or conceptual change?

- Is it just an interference effect -- older children know more about pencils and so it inhibits them more?
- Or is it that older children are more likely to think in terms of design stance?
- Try it showing children novel functions.

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Fig 4. in Defeyter M. A., and T. P. German. "Acquiring an understanding of design: evidence from children's insight problem solving." *Cognition* 89, no. 2 (September 2003): 133-55.

Implications

- Adult artifact concept is constructed around a core property-- its design.
- Artifact concept is primed by function demonstrations and blocks availability of other functions.

Functional fixedness

- Younger children process information about object's function but not as a “core” property.
- Converging evidence:
 - 7-year-olds “What can you do with a brick?”
 - 5-year-olds “What can you do with a brick?”
- 7-year-olds more variations on design function; 5-year-olds more novel functions.

Summary

- Some selective understanding of object affordances emerges early in both ontogeny and phylogeny.
- However, the ability to coordinate particular means and ends changes over development - - and action production seems to play a role in action processing. Language may also play a role.
- An understanding of the intended use of objects (a “Design stance”) emerges relatively late ... and while it may promote efficiency it may decrease innovation.