

Topics in infant and early childhood cognition 9.85

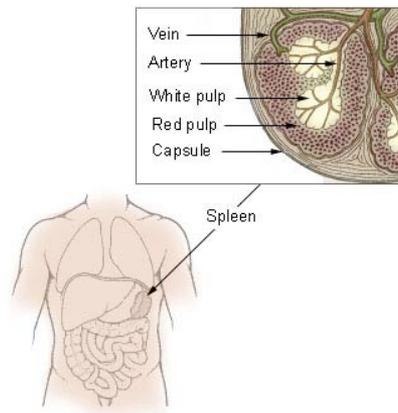
Lecture 1: Introduction -
philosophical questions,
psychological methods

Commonsense knowledge

- Supports ...
 - Prediction
 - Action
 - Categorization
 - Explanation
- What is it and where does it come from?
- We'll spend most of the class on this problem.

Spleen (n)

- 1. a vascular ductless organ in the left upper abdomen of humans and other vertebrates that helps to destroy old red blood cells, form lymphocytes, and store blood

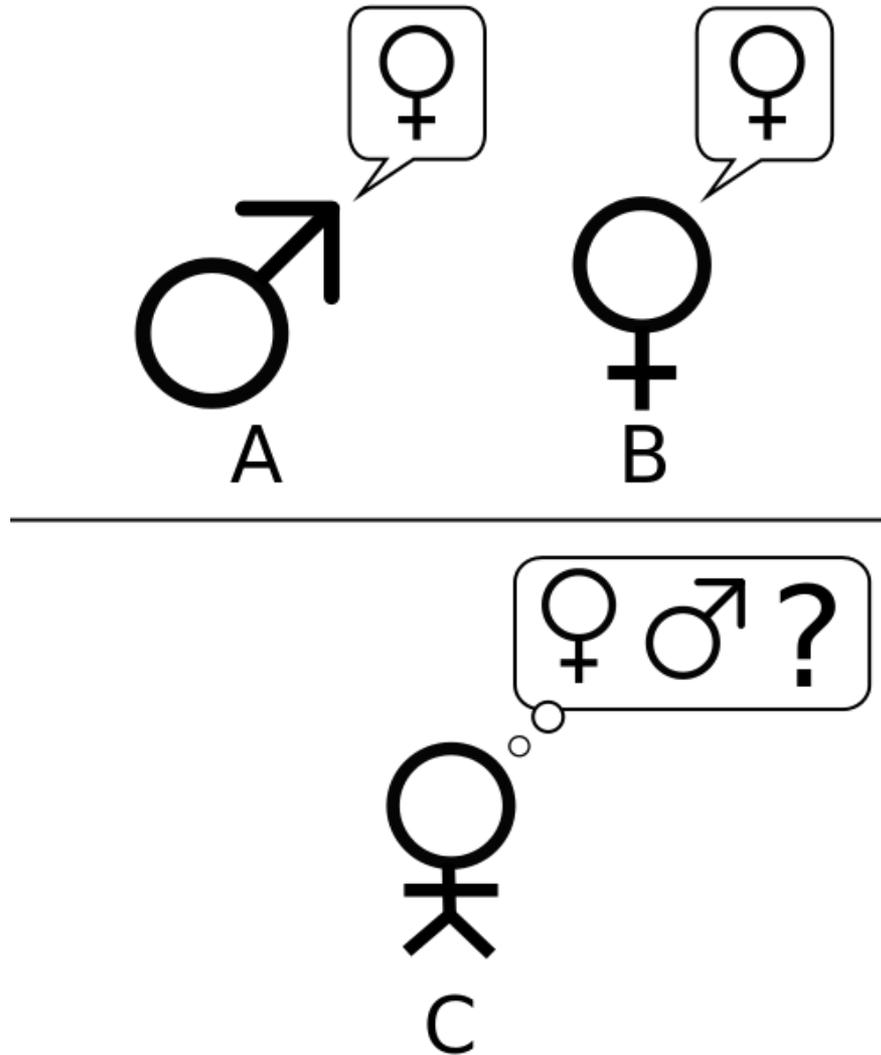


“The fundamental task of psychology is to remove the veil of self-evidence from things” Solomon Asch

Alan Turing

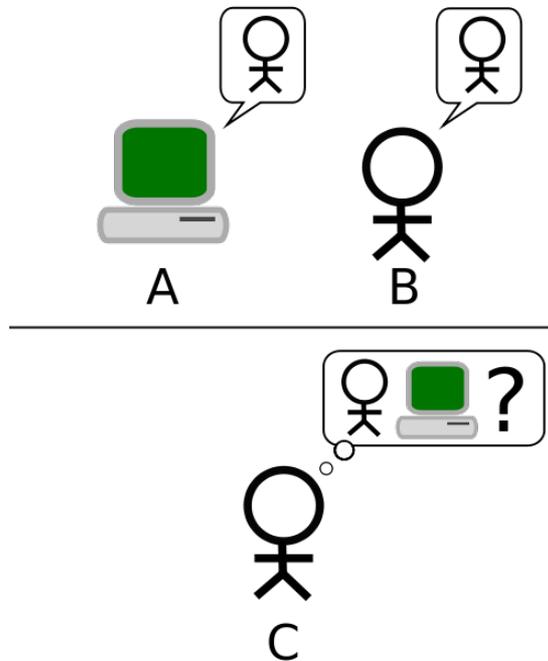


Image: Flickr. Duane Wessels. CC BY-NC-SA <http://www.flickr.com/photos/duanewessels/6917285604/>



Underestimating the challenge of commonsense intelligence

- Turing test



Underestimating the challenge of commonsense intelligence

“I believe that in about fifty years' time it will be possible to program computers ... to make them play the ... game so well that an average interrogator will not have more than 70 percent chance of making the right identification after five minutes of questioning” (Turing, 1950)

Is this a good test of intelligence?

- Searle's Chinese room ... maybe not.



Underestimating the challenge of commonsense intelligence

RECENT WINNERS OF THE LOEBNER PRIZE

Can you read?

Yes -- what's your favorite novel?

There's no such thing.

Meaning you don't have a favorite novel or novels don't exist?

No

What's your favorite book then?

Are you serious? I don't have a favorite book. My favorite color is transparent.

Underestimating the challenge of commonsense intelligence

RECENT WINNERS OF THE LOEBNER PRIZE

Do you have a pet?

No but I like cats very much.

Why don't you have a cat?

Do I need one?

Only if you think you do.

I think I do.

Well then get one by God!

Good reasoning! Where can I get one by God?

Source: Public Domain. http://www.loebner.net/Prizef/2004_Contest/Wallace.html

Commonsense as the hard problem of cognitive science

- “Do doctors wear underwear?”
- “Is it easier to walk forwards or backwards?”
- “If President Obama is in Washington, is his spleen in Washington?”
- Everything you needed to know to pass the Turing test you learned before kindergarten.

Commonsense as the hard problem of cognitive science

- Suppose you wanted to engineer commonsense how would you do it?
- Douglas Lenat: maybe the trick is just to give computers a bunch of facts about the world
- But if knowledge is organized as individual facts, you would have to know that if Barack Obama is in Washington, so is his eyebrow, his big toe, his spleen ...
- Hubert Dreyfus: “If you got all that knowledge into a computer you would not know how to retrieve it.”

Or not ...

- [Watson \(16:48 ...\)](#)
- So Dreyfus' problem turns out not to be the problem
- The hard problem may be that even having massive world knowledge is neither necessary nor sufficient for passing the Turing test.
- “Hedgehogs are covered with quills or spines which are hollow hairs made stiff by this protein ...”
- Keratin = 99%, Porcupine = 36%

How are we going to find out about commonsense?

- Study cognitive development ... try to catch knowledge as it is emerging ...

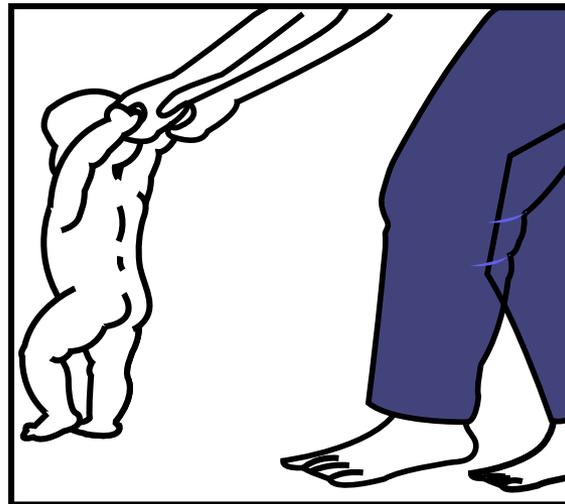


Image by MIT OpenCourseWare.

Most of the hard problems of cognitive science ...

- natural language understanding
- scene understanding
- face recognition
- motor planning
- causal reasoning
- theory of mind
- moral reasoning
- Are readily solved by young children.

By studying infants and children

- We can discover both innate representations and fundamental mechanisms of learning.
- We can “remove the veil of commonsense” and understand how concepts change over time.
- (Babies and children as a method)
- We can learn something about babies and children (Babies and children as fascinating in their own right)

Cognitive development

- What you will learn in this class:
 - Development involves continuity as well as change.
- What is true but you won't (except for this slide) learn in this class:
 - Development occurs throughout the lifespan.
 - Development is not just cognitive.

For any type of commonsense knowledge ...

- Objects
- Space
- Time
- Causality
- Number
- Minds
- Morality
- Fantasy vs. reality

We would like to know

- What causes this knowledge to emerge.
- How the knowledge is represented.
- Whether this knowledge changes and if so why.
- How knowledge in one area interacts with knowledge in other areas.
- Not just a hard problem of cognitive science but an old problem of philosophy ...

We've wanted to know for thousands of years ...

- “Herein lies the difficulty I can never resolve to my satisfaction. **What is knowledge?** Can we answer that question?” Plato -- Theatetus
- **And where does it come from?**
 - Meno: And yet I'm certain that no one ever did teach him.
 - Socrates: And yet he has the knowledge?
 - Meno: The fact, Socrates, is undeniable.
 - Socrates: But if he did not acquire the knowledge in this life then he must have had and learned it at some other time?
 - Meno: Clearly he must. Plato -- Meno

Background

- From the beginning of Western philosophy: two competing traditions.
- **Rationalism** -- Knowledge of that which is necessarily true is innate. (Plato)
- **Empiricism** -- "Nothing is in the intellect which was not first in the senses." (Aristotle)

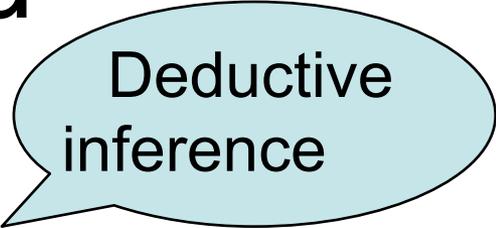
Background

- **Rationalism**
- We have knowledge about things we've never experienced (the infinite)
- Experience is fallible and cannot provide certainty.
- The important things about knowledge (truth, causality, morality) are innate.
- **Empiricism**
- Things that are necessarily true are “trifling” (Locke).
- What does knowing X mean if it doesn't mean that knowing that X is true of the world?
- Knowledge needs to provide a basis for rational action; it does not need to guarantee truth.

Background (Stanford Encyclopedia of Philosophy)

- **Maybe there are two types of knowledge:**
- **All doctors that specialize on eyes are doctors.**
- **All ophthalmologists are doctors.**
- **All bachelors are unmarried.**
- **Some doctors that specialize on eyes are unmarried.**
- **Some ophthalmologists are unmarried.**

Background



Deductive
inference

- **Relations of ideas (Hume) or analytic truths (Kant) -- truth is contained in the proposition itself; true by definition.**

- **Matters of fact (Hume) or synthetic truths (Kant) -- not true by definition; must look beyond the proposition itself to assess its truth value.**



Inductive
inference

Background

- How do we get to the truth about the world?
- Kant: How are synthetic a priori judgments possible?
- Today: How is inductive inference possible?
- Kant suggested an answer: the world we experience depends on two factors:
 - The world itself.
 - The way our minds are able to experience the world.
- Kant was to be a great influence on Piaget

Background

- But although there was considerable disagreement about whether ideas were innate or learned in principle...
- in practice, almost everyone assumed babies knew almost nothing; they were *tabulae rasae* or “blank slates”.

Locke 1632-1704

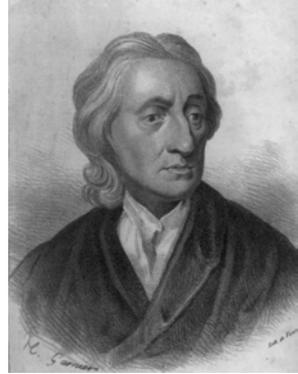


Image: Wikimedia. Library of Congress.
Public Domain.

- “Let us then suppose the mind to be . . . void of all characters, without any ideas; how comes it to be furnished? ... Whence has it all the materials of reason and knowledge? To this I answer, in one word, from experience; in all that our knowledge is founded, and from that it ultimately derives itself.” (*An Essay Concerning Human Understanding*)

Rousseau, 1712-1788

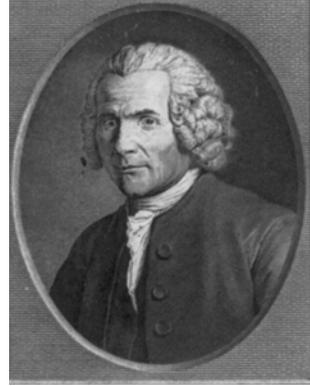


Image: Library of Congress. Public Domain

- “We are born capable of learning, but knowing nothing, perceiving nothing. The mind, bound up within imperfect and half grown organs, is not even aware of its own existence. The movements and cries of the new-born child are purely reflex, without knowledge or will” (*Emile*)

Darwin, 1809-1882

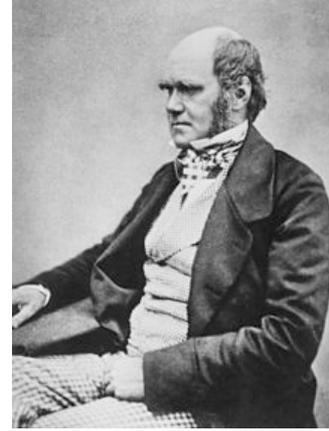


Image: Wikimedia. Public Domain.

- “At this time, though so early, it seemed clear to me that a warm soft hand applied to his face excited a wish to suck. This must be considered as a reflex or an instinctive action, for it is impossible to believe that experience and association ... could so soon have come into play.” (*A Biographical Sketch of an Infant*)

James, 1842-1910

- “If my reader can succeed in abstracting from all conceptual interpretation and lapse back into his immediate sensible life at this very moment, he will find it to be what someone has called a big blooming buzzing confusion...” (*Percept and Concept*)

Freud, 1856-1939

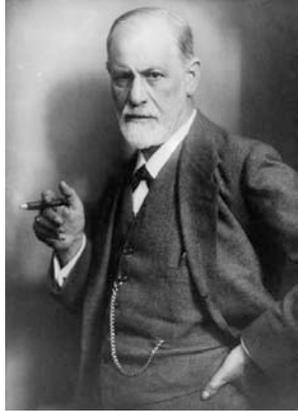


Image: Wikimedia. Public Domain.

- “We are bound to suppose that a unity comparable to the ego cannot exist ... from the start; the ego has to be developed.” (*On Narcissism*)

Watson, 1878-1958

- “Give me a dozen healthy infants, well-formed and my own specified world to bring them up in and I’ll guarantee to take any one at random and train him to become any type of specialist I might select -- doctor, lawyer, artist, merchant-chief and yes, even beggerman and thief ...” (*Behaviorism*)

Behaviorism

- Behaviorism as the pinnacle of empiricist thought.
- All learning could be deterministically predicted, explained, and controlled by variations in the environment.
- (Unconditioned stimulus becomes conditioned stimulus through association with a reinforcer)

What happened next ...

- Demise of behaviorism
 - Turing made talk about representations and cognitive processes scientifically respectable
 - Tolman showed that rats learned information that wasn't explicitly reinforced
 - Garcia showed that some associations were learned more readily than others
 - Chomsky showed that language could not be learned by “mere association” (poverty of the stimulus)
 - Piaget argued that learning depended on both the structure of the environment and the structure of the mind.
- Rise of cognitive science (here, in 1964)

About the class: Syllabus

About the class

- CHECK DATES
- laptops, I-phones, blackberries ...
- Why?
 - Gopher, D., Armony, L. & Greenspan, Y. (2000). Switching tasks and attention policies. *Journal of Experimental Psychology: General*, 129, 308-229.
 - Mayr, U. & Kliegl, R. (2000). Task-set switching and long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 26, 1124-1140.
 - Monsell, S., Yeung, N., & Azuma, R. (2000). Reconfiguration of task-set: Is it easier to switch to the weaker task? *Psychological Research*, 63, 250-264.
 - Monsell, S. & Driver, J., Eds. (2000). *Control of cognitive processes: Attention and Performance XVIII*. Cambridge, Mass.: MIT Press.
 - Rogers, R. & Monsell, S. (1995). The costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General*, 124, 207-231.
 - Yeung, N. & Monsell, S. (2003). Switching between tasks of unequal familiarity: The role of stimulus-attribute and response-set selection. *Journal of Experimental Psychology-Human Perception and Performance*, 29(2): 455-469.

Group practicum:

You will be assigned a research question next week.
e.g., Do 3-month-olds recognize their mother's faces?

As a group, you will be asked to create 5 slides outlining an experiment to answer the question.

Your slides should:

- A. explain the question you are addressing and why it might be important
- B. explain the experimental groups/conditions you will use to address the question.
- C. describe your stimuli and setup in sufficient detail for us to understand the protocol.
- D. discuss possible results of the experiment and how these results might answer your question.
- E. discuss any weaknesses you see in your design.

I will incorporate your research designs into the two lectures on methods so I must have them in my e-mail the day after session 3. **For this assignment, please do not use outside resources.** The idea is for you to understand some of the methodological challenges in developmental research by trying to address them yourself.

Public info brochure

- You will be assigned a question about cognitive development as a parent might pose it:
- “I heard that newborn babies look at faces. My baby’s six weeks old and while she sometimes looks at me, she doesn’t seem to have a real “preference” for faces. She’d rather look at ceiling fans or blinds. Should I worry?”
- You will be expected to read 4-6 empirical papers on the subject and then summarize your conclusions in a ~ 1,000 word “parent-friendly” brochure.
- Pending approval, these will be distributed at the Boston Children’s Museum in January.

Public info brochure

The Basics

Babies and young children seem to know a lot about the world. They have expectations about number, about cause and effect, about how objects act, and about how people behave. The goal of research in cognitive development is to understand where this knowledge comes from and how it changes from infancy to adulthood.



What is involved? 1

If you choose to volunteer, you and your baby may do some of the following things:

Babies may be given the opportunity to play with simple toys or toys that have particular properties (e.g. toys that light up or make noise). Observing infants' preferences about new and familiar objects and how they explore and play with new toys can help tell us about ways babies learn about the world and through their own exploration.

We will also ask you some questions about your family and your child. You can choose to answer or not answer any of these questions. All information will be kept confidential.



How you can help

We're looking for young participants between the ages of 3 and 36 months old. If you and your infant are willing to participate, please contact us at ecclparents@mit.edu. All studies are run in our PlayLab space at Boston Children's Museum, and you will receive day passes to the museum for your participation.

Frequently Asked Questions

What is cognitive development?

Cognitive development is the science of what people know and how we come to know it. Researchers study young children to learn how knowledge is represented and organized in the mind, and how and why this changes from infancy to adulthood.

Are you looking to see if my child is developing normally?

We are not medical doctors or clinical psychologists. There are no diagnostic tests or procedures in any of our experiments. Our research questions are about play and learning in all children.

Are there potential risks?

There are no known risks with these kinds of studies. You will remain with your child at all times. We take care to make sure that your child is as comfortable as possible. No abnormal viewing distances or jarring noises will be used, and you and your child may choose to stop at any point during the study.

What about confidentiality and privacy?

Your family's privacy will be protected. Any information obtained in connection with your child will remain confidential and will be disclosed only with your permission or as required by law. Your child will not give any personal information over the course of the study and it will not be possible to link your child's identity with his or her results. You may review the tape of your child's session and may ask that the recording not be used in the experiment. All tapes will be stored in a drawer in the lab office. Tapes will be erased after five years or when data is no longer needed for the study.

ECCL at a Glance

Who we are:

The Early Childhood Cognition Lab is part of the MIT Department of Brain and Cognitive Sciences. We are faculty, post doctorate researchers, graduate students, and undergraduate students who are all passionate about children's development.



Our Involvement in the Community:

ECCL has pioneered an initiative to bring the science of cognitive development to the public in the informal educational setting of museums. Our partnerships with Boston Children's Museum and the Museum of Science in Boston allow us not only to conduct our studies, but also to educate parents, museum staff, and the community about the science of cognitive development. We also work with many area preschools and daycares.

Why We Need You:

Studies in infant and child development would be impossible without your support! We are constantly looking for volunteers to participate in our studies. Please contact us to find out how you can help.



Poster Assignment



What are you trying to tell me? Toddlers make a joint inference about sampling process and property extension



Hyowon Gweon, Joshua E. Tenenbaum, & Laura E. Schulz

Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA

Introduction

Young human learners possess a remarkable ability to make inductive inferences from sparse data. In general, knowing how your data were sampled can inform your inductive inferences: for example, knowing how a person is selecting the exemplars can affect your inferences about whether a property of the exemplar extends to other exemplars. Also, knowing the property extension can inform your inferences about sampling processes. In real-world situations, however, both the extension of novel properties and the sampling process may be ambiguous. These situations commonly arise when children are learning socially from adults. How do children confront the challenge of simultaneously inferring both the property extension and the sampling process from a small amount of data?

Central Questions

Information about sampling process can help us make accurate inductive inferences based on a small amount of data. However, cues that signal appropriate sampling contexts are often missing, ambiguous, or too subtle to catch for young learners.
Can toddlers (N = 16 months) infer the appropriate sampling process and property extension from observed data?

Previous Studies

- Infants (9-16 months) can generalize an object property to another exemplar based on a single exposure (Baldwin, Markman, & Melartin, 1998).
- Infants (8 months) can make inferences about the population based on a sample from the population, and vice versa (Xu & Garcia, 2008).
- Preschoolers (3- and 4-year-olds) are sensitive to different sampling contexts: their generalization of a label for a novel object is more conservative when the exemplars are sampled by a teacher (Xu & Tenenbaum, 2007, 2009).

Method

- Participants: 81 toddlers (mean: 15 months, 15 days; range: 13 - 18 months)
- Procedure:
 - Take blue ball(s) out from box and show they speak.
 - Take one yellow ball out and hand it to the child.
 - Free play with yellow ball (30 seconds).

The experimenter's action was deliberately ambiguous: an adult viewer could not use her gaze or resulting behaviors to determine whether she was intentionally obscuring the balls or drawing randomly from the box.

Bayesian Model

Property Extension (P)
 $T = \text{Exp}(\text{all balls speak})$
 $T = \text{Exp}(\text{only blue balls speak})$

Sampling Process (S)
 $S = \text{Random}(\text{sampling only from equally balls})$
 $S = \text{Exp}(\text{Sample from the whole box})$

Bayesian Inference: $L = \frac{P(\text{Data} | S, T)}{P(\text{Data} | T_{\text{only}})}$

Model Prediction: Likelihood ratio (L) measures the evidence for T_{only} over T_{all} (which hypothesis is more likely to have given rise to the data?)
Assumption: 1) which the number of balls is equal to the number of speakers; 2) equal probability of balls and speakers.

Behavioral Experiment

Condition A: T_{all} , S_{random}
 Condition B & D: T_{all} , S_{exp}
 Condition C: T_{only} , S_{random}
 Condition E: T_{only} , S_{exp}

Results

Dependent Measure:
 1. Mean number of responses
 2. Number of children who attempted to squeeze the ball

Mean Number of Responses

Number of Children

Conclusion

- Humans are rational learners from early in development: here we provide evidence for a powerful mechanism to support inductive inferences.
- As shown in previous studies (e.g., Xu & Garcia, 2008), 15-month-olds can also make use of explicit cues to random sampling process (Exp. 1).
- They know when the observed data do not provide unambiguous evidence to the sampling process.
- They can infer the appropriate sampling process purely based on data.
- They can make generalizations from sparse data even in the absence of explicit social cues by inferring and integrating the sampling process, and our Bayesian model shows how this joint inference problem might be solved by a rational learner.

References

Baldwin, D. A., Markman, E. M., & Melartin, A. L. (1998). Infants' ability to draw inferences about nonverbal object properties. *Developmental Psychology, 34*(2), 711-719.

Xu, F., & Garcia, V. (2008). Inductive inferences by 8-month-old infants. *Proceedings of the National Academy of Sciences, 105*(14), 5010-5015.

Xu, F., & Tenenbaum, J. B. (2007). Learning to sample in the absence of learning. *Developmental Science, 10*(2), 249-267.

Joint Inference Problem

Sampling Process

- Sampling from equally balls
- Sampling from all balls in box

Property Extension

- Only the blue balls speak
- Both blue and yellow balls speak

Sequence of Data

- Number of balls from the box?
- Proportion of blue & yellow balls

but...

Inferences about sampling process and property extension are tightly coupled: knowing one variable should inform inference about the other.

In many real-world learning situations, both the property extension and sampling contexts may need to be inferred.

Can babies solve this joint inference problem? If so, how?

Critical responses

- The primary issue raised by the reviewers concerns the novelty and significance of your results ... Reviewer 3 suspects that the basic finding is trivial.
- Our view of this issue is closer to that of Reviewer 2: While your new experiments are elegant, it is not clear that we have learned anything about cognitive development that goes beyond the conclusions of your previous work in this area ...

Term Papers

- Topic must be on cognitive development
- Otherwise your choice
- Five classes are conducted as small-group seminars of which you will attend one, focused as much as possible on topics close to yours.

Other stuff ...

- Tardiness, illness, make-up assignments, etc. is entirely at the discretion of student services.
- Nothing is excused without a note from them. Don't ask. Tardy assignments are not accepted.
- Given student services' approval, we will always work with you to make reasonable accommodations.

Plagiarism vs. Paraphrasing

- **Original**

Because of their unique perspective, Americans fear globalization less than anyone else, and as a consequence they think about it less than anyone else. When Americans do think about globalization, they think of the global economy as an enlarged version of the American economy. (Source: Thurow, L. (1993). *Fortune Favors the Bold* (p. 6). New York: Harper Collins.)

Plagiarism

According to Lester Thurow (1993), Americans **fear globalization less** than people from other countries and **as a consequence** spend less time **thinking about it**. Indeed, Americans see globalization **as an enlarged version** of their own economy.

Why is this plagiarism?

The writer has used Thurow's exact words without enclosing them in quotation marks. S/he has only substituted synonyms here and there. Even though Thurow is credited with a citations, this would be considered plagiarism.

(Complete Thurow reference appears in bibliography)

Paraphrasing

Lester Thurow (1993) maintains that because Americans see globalization simply as a bigger form of their own economy, they are less concerned about it than is the rest of the world.

Why is this acceptable?

The writer has kept the meaning of the original passage without copying words or structure. Words like *globalization* and *Americans* are generic terms (i.e., terms that are commonly used for the concept they illustrate - it is difficult to find synonyms for them). Thus you may use these words without placing

My favorite notice on a faculty web page

“Prof. Dreyfus suffers from a mild case of prosopagnosia or "face blindness". So, although he has met you before, and sometimes more than once, it is quite probable that he will not recognize you when you meet again. Please, re-introduce yourself telling him when and where you met the previous time(s).”

<http://socrates.berkeley.edu/~hdreyfus/>

Me too ...

- And to make it worse, I also have difficulty with proper nouns.
- Please don't take it personally ...
- Please do prompt me ...

MIT OpenCourseWare
<http://ocw.mit.edu>

9.85 Infant and Early Childhood Cognition
Fall 2012

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.