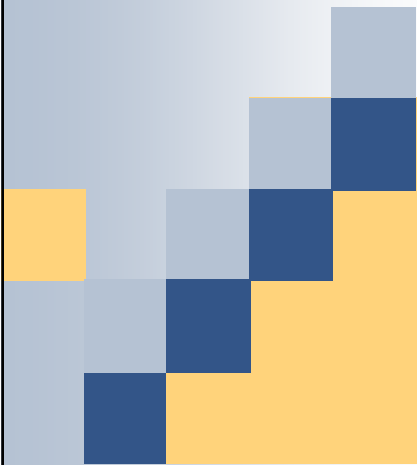




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Legacy of Piaget Understanding Number

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- According to Piaget, for infants who have ***not achieved*** object permanence,
 - A. a ball's continued existence is in no way dependent on its being held.
 - B. a ball must be seen in order for it to exist.
 - C. a ball in two different locations is understood to remain the same ball.
 - D. All of the above answers are correct.

Jean Piaget
August 9, 1896 –
September 16, 1980

Swiss philosopher,
natural scientist and
developmental
theorist



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Piaget's Stages of Cognitive Development

1. Sensorimotor Intelligence

Birth to 2 yrs	World is experienced directly through senses and actions. Little internalized representation.	Object permanence
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2. Preoperational

2 to 6 yrs	Actions and concepts can be represented internally and referred to with words. Little cognitive ability to systematically manipulate representations.	Language Conservation Egocentrism
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3. Concrete Operations

7 to 11 yrs	Ability to perform mental operations but only for representations of concrete concepts.	Arithmetic Deception
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4. Formal Operations

12 yrs and up	Ability to engage in abstract mental operations	Hypotheticals
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Early Stages of Cognitive Development Preoperational vs Concrete Operations

Video Clip : A Change of Mind

- Mental set, perseveration of action
- Inability to distinguish past and present states of knowledge
- Egocentrism
- Inability to follow simple logic of deception
- A more nuanced Theory of mind
 - Supports an understanding of the logic of deception

Problems with Piaget's Stage Theory

- Piaget underestimated children's abilities
- The stages are not discrete
- Mastery of a specific task does not imply mastery of all comparable tasks



- Children use the number words (e.g., “one,” “two,” “three,” etc.) by age 2 or 3, but what do they know of what these words mean?

http://www.youtube.com/watch?v=i7el6otLg_4

- Which is the best description of what the child in the video understands about these numbers she said?
 - A. Given a number as a stimulus, she can produce the next number as a response, but she has no sense of number sequence.
 - B. She can probably “count” – i.e., produce the numbers in sequence – but has no sense of what the numbers mean – i.e., their cardinality.
 - C. She might understand the meaning of a few numbers – e.g., 1 and 2 – but not larger numbers she produced.
 - D. She understands the meaning of all the numbers she can say.

Understanding Number: Representations

- One complication: The brain is thought to represent numbers in a variety of different ways
 - Verbal labels: e.g. *one, two, three* or *uno, dos, tres*
 - Visual labels: e.g., 1, 2, 3, 4 or I, II, III, IV
 - Infants and other animals show evidence suggesting an *analog magnitude* representation system

What Does it Mean to Understand a Number?

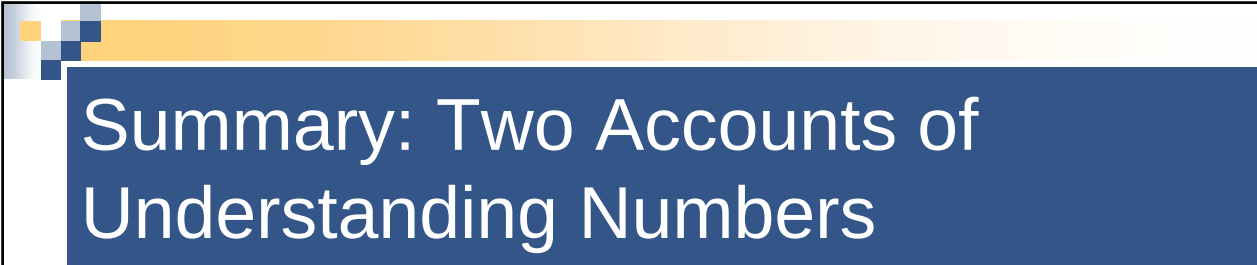
- Another complication: Performance differs across tasks
 - Reciting number lists
 - Counting objects
 - Generating a set to match a number: Give-N task
 - Judgments of the ordinal relation between numbers
- There may be a time lag of 18 months or more between when a child learns to count to "ten", and when that same child learns to generate a set of 10 objects in the Give-N task
- Issue: How to account for these differences?

Analog Account

- When children learn number words they understand them as labels for their innate, *analog magnitude representations*
- Key point: analog magnitude representations are only approximate
- Time lag in mastery of Give-N task cannot be blamed on the lack of number concept
 - Instead these problems are estimation errors

Knower-Levels Account

- Young children generally do not know the meaning of the number words that they can produce – i.e., the exact *cardinality* denoted by each number word.
 - The exact, cardinal meanings of the number words are learned one at a time, in order (first “one,” then “two,” etc.) over a period of many months, often more than a year.
 - children who have learned only the meaning of “one” are called “one”- knowers
 - children who have learned “one” and “two” are called “two”- knowers, and so on.
- Even if a child can “count”
Problems doing the Give-N task indicate that the child lacks an understanding of what that number label means



Summary: Two Accounts of Understanding Numbers

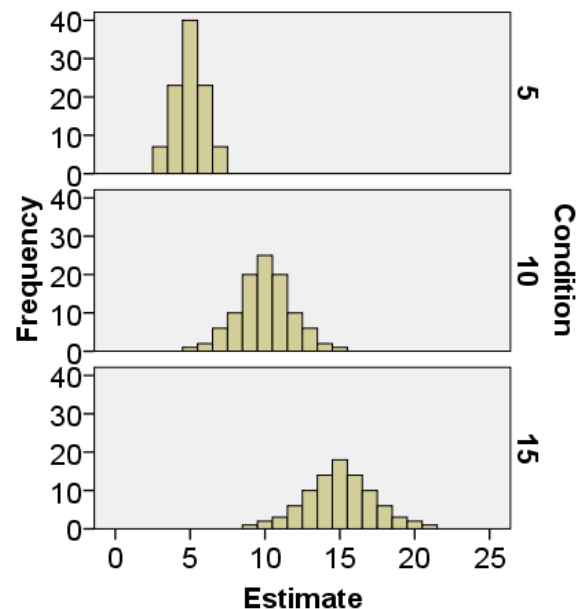
- The Analog account suggests that children innately know number concepts and apply the labels that they acquire to those concepts
- The Knower-Levels account suggests that children initially learn number labels without understanding the number concepts to which they apply

Disagreement

- Consider a child who counts an array of 5 objects perfectly well
 - However, in the Give-N task, when we ask that child for “five” objects, he/she gives some other number.
 - How are we to explain that error?
- Analog account:
 - Child knows what “five” means
 - Has chosen to use analog estimation rather than counting
 - Has made an estimation error
- Knower-levels account:
 - Child doesn't know what “five” means
 - Has taken a wild guess

Estimation Error Pattern: Scalar Variability

- Estimation error follows a well-studied pattern
 - The mean of the responses falls at the target, with equal proportions of incorrect responses that are over- and under-estimates.
 - As the target number gets bigger, the distribution of incorrect answers is more spread out.

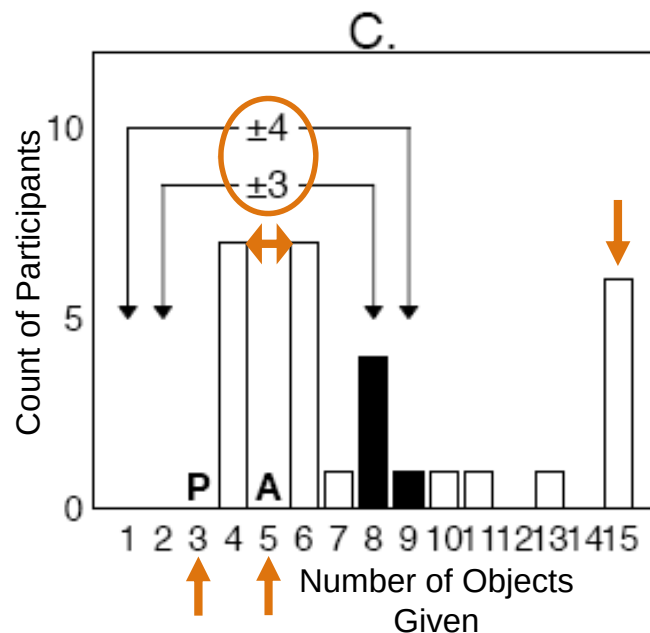


Predictions of the Knower-Levels Account

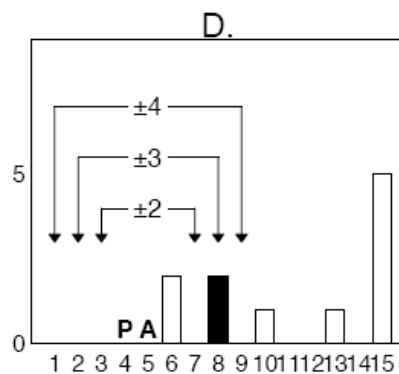
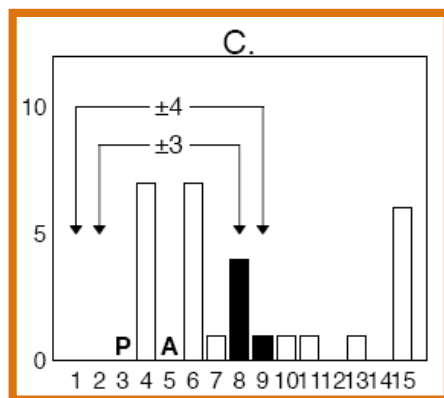
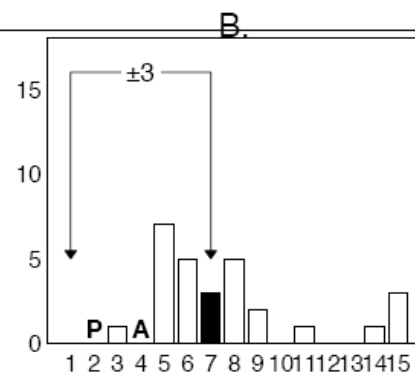
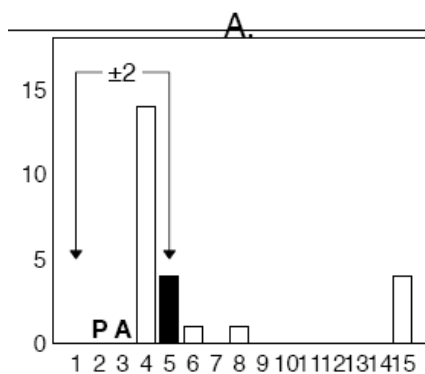
- Most errors are random guesses
- One constraint
 - Asked to “Give” a quantity for which the child is not a “knower”
 - The child will not produce a quantity for which he/she is a “knower”

Give-N Results Distinguishing the Analog and Knower-Levels Accounts

- **A** marks the quantity that they were asked to “Give”
- **P** marks the knower-level of this subset of kids



More Results



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Summary: Interpreting Give-N Task Results

- The Analog account suggests that errors in a Give-N task are estimation errors and so should conform to the pattern typically observed in estimation tasks
- The Knower-Levels account says that errors are guesses whose only constraint is that they should differ from a “known” level
- The data strongly favor the Knower-Level account

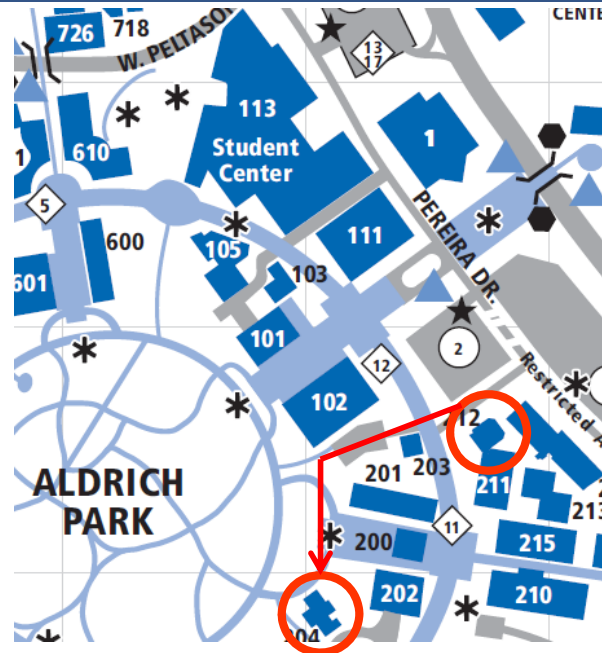
Prof. Barbara Sarnecka Cognitive Sciences

- Barbara Sarnecka (shown with the students in her lab) is the source of the research on the Knower-Levels model discussed today



Looking Ahead

- For Wednesday
Gleitman: Ch. 14,
pp. 562 – 576
- Please do the
course evaluation
on EEE
- Coffee today?



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