Development 1

Legacy of Piaget
Understanding Number

- 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

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
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
3. Concrete Operations		
7 to 11 yrs	Ability to perform mental operations but only for representations of concrete concepts.	Arithmetic Deception
4. Formal Operations		
12 yrs and up	Ability to engage in abstract mental operations	Hypotheticals

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

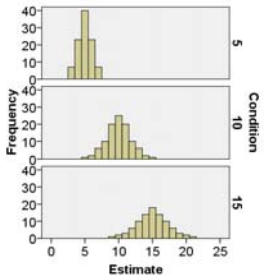
- The Analog account suggests that children innately know number concepts and apply the labels that they acquire to those concepts
- The Knower-Levels account suggests that children initially learn number labels without understanding the number concepts to which they apply

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.

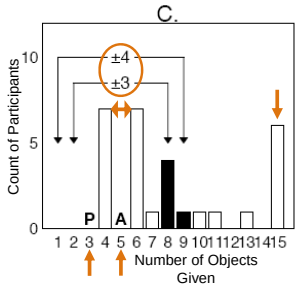


Predictions of the Knower-Levels Account

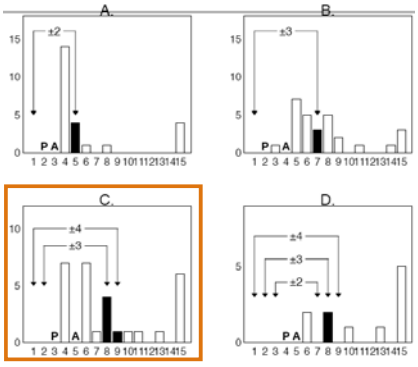
- Most errors are random guesses
- One constraint
  - Asked to "Give" a quantity for which the child is not a "knower"
  - The child will not produce a quantity for which he/she is a "knower"

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



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?