Initial knowledge: six suggestions

EECS 598 Paper Presentation

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Initial Knowledge

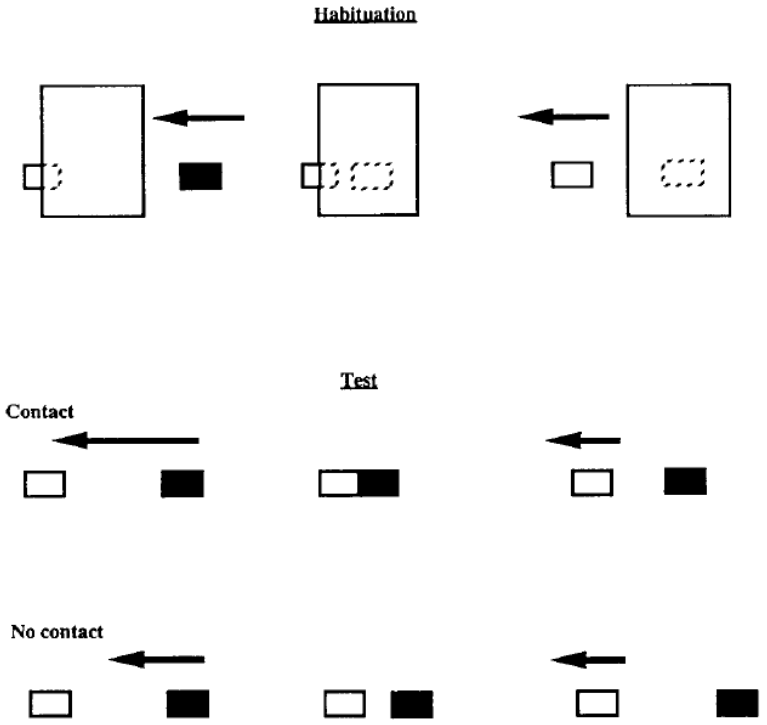
- Initial knowledge is about the early development of knowledge
- The study on the initial knowledge involves cognitive development about when knowledge begins, what it consists of, how it manifests itself, what causes it to emerge, how it changes with growth and experience, or what roles it plays in the development of thought and action.

Six Suggestions

1. Knowledge emerges early in development
2. Initial knowledge is domain-specific
3. Initial knowledge encompasses fundamental constraints on the entities in a domain
4. Initial knowledge is innate
5. Initial knowledge constitutes the core of mature knowledge
6. Initial knowledge is task specific

Knowledge emerges early in development

- Knowledge develops when creatures make inferences about non-perceiving properties.
  - Example:



Criteria:
The less looking time
-> The less novelty
-> Infants make inference at the hidden case

- Results: Infants develop knowledge starting at 3-month-old.

Initial knowledge (IK) is domain-specific

- Infants have knowledge in four domains:

  physics, psychology, number, and geometry

- Domains are distinct from each others.

  example of cohesion in physics:

  - the cohesion principle does not guide

    early reasoning about number

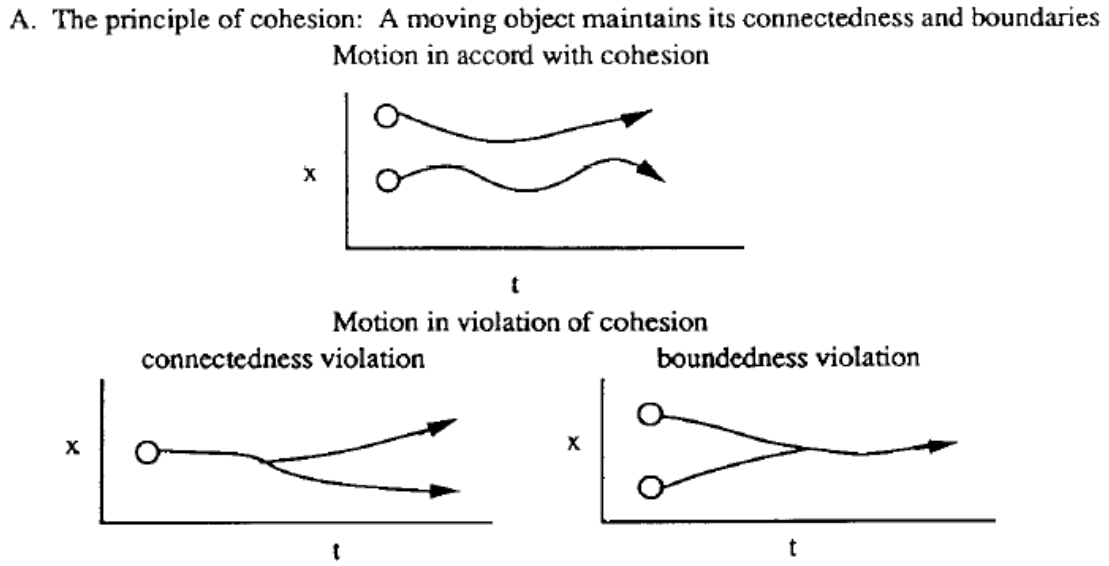
  similarly:

  - The continuity principle fails to guide

    early reasoning about geometry

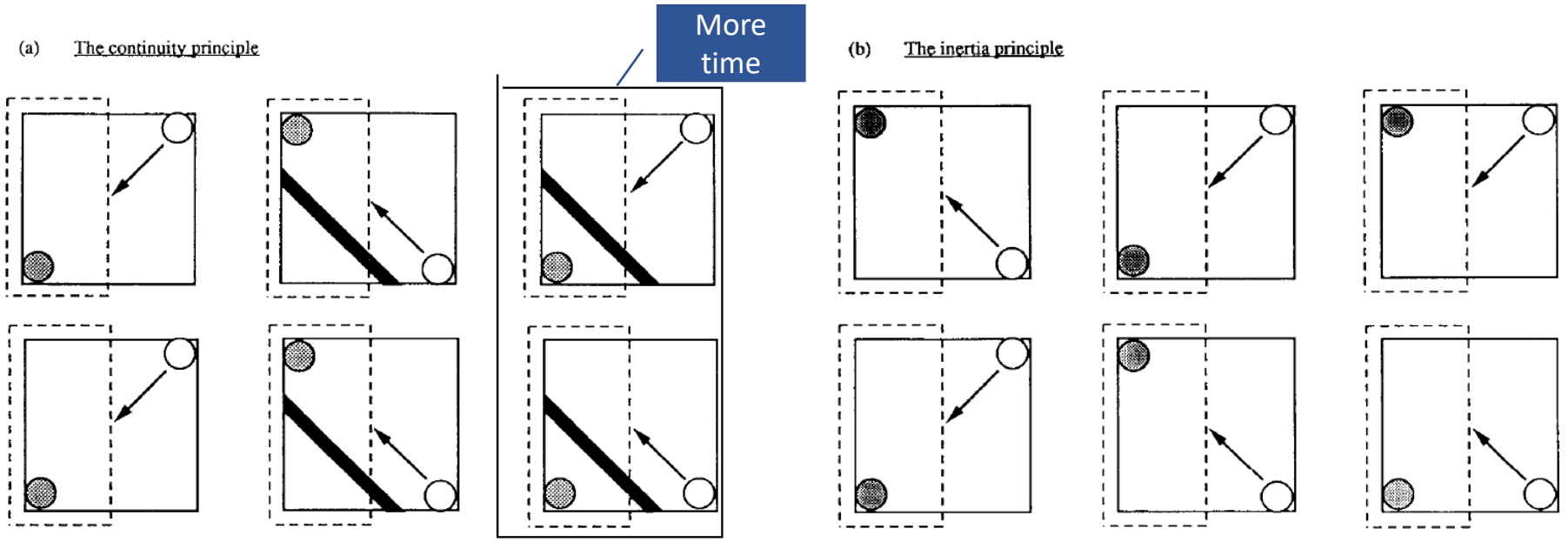
  - the contact principle does not guide

    early reasoning about persons



IK encompasses fundamental constraints

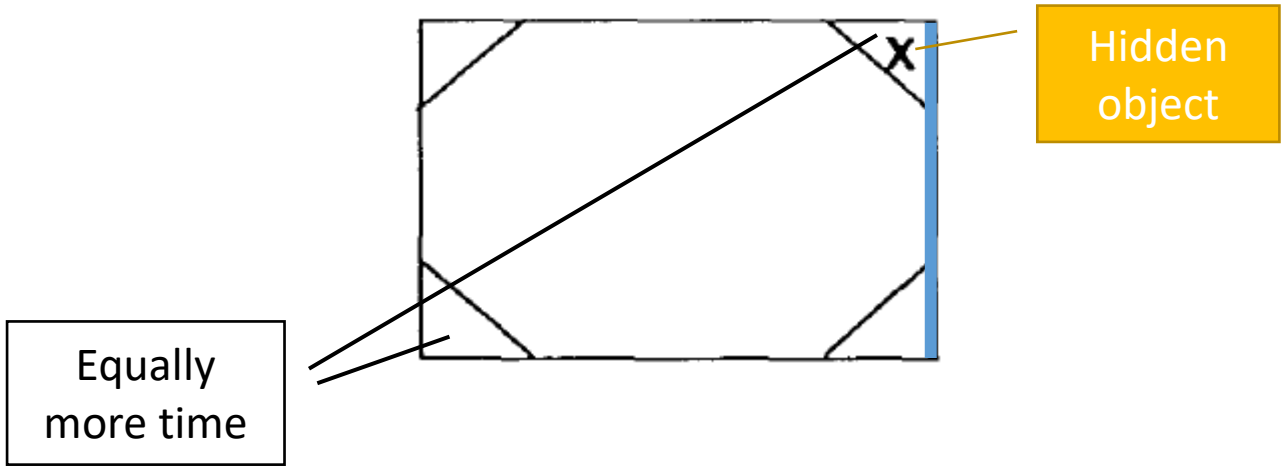
- Initial knowledge encompasses the most reliable constraints
  - Example 1:
    - young infants appear to reason about physical objects in accord with the principle of continuity, rather than with the principles of inertia or gravity



    - Gravity and inertia are not as reliable when considering perceptibility

IK encompasses fundamental constraints

- Initial knowledge encompasses the most reliable constraints
  - Example 2:
    - The diagonal corners are search with equally more time.



    - Children ignore perceptually salient aspects of the layout and orient in accord with the geometry

  - Young children's geometric reasoning is guided only by the most reliable information.

Initial knowledge is innate

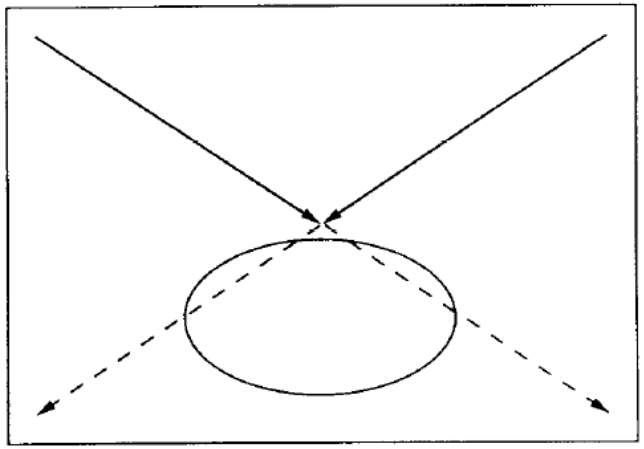
- Initial knowledge is not shaped by learning process
  - Reasons:
    1. Natural selection may favor the evolution of mechanisms that give rise to highly reliable initial knowledge
    2. Learning systems require perceptual systems that parse the world appropriately

IK constitutes the core of mature knowledge

- Initial knowledge is central to common-sense reasoning throughout development.
  - Supporting Reasons:
    1. If initial conceptions capture the most reliable constraints on the entities in a domain, then all the child's subsequent perceptual experiences will tend to **confirm** the initial conceptions.
    2. If initial knowledge serves to define the entities in a domain for the child-learner, then things that **fail** to conform to the initial conceptions will **not be picked** out as entities in the domain, and so their behavior will not undermine those conceptions.
    3. Human cognition is conservative: people strongly resist changing their central conceptions (constant core principles).

Initial knowledge is task specific

- Initial knowledge is central to common-sense reasoning throughout development.
  - Example:
    - As object moving along the arrow, infants tends to reach them more when the object is visible, while less when it's invisible.



    - Separate systems of knowledge appear to guide infants' reasoning about objects in these two situations.

Discussions

Discussion #1

Piazza @37_f1: prenatal initial knowledge v.s. transfer learning

- Jemuel: This initial knowledge provides a foundation for learning and forms the basis for transfer learning. In this sense, transfer learning can be thought of as building upon the initial knowledge of infants and allowing them to learn more efficiently and effectively.
- Jemuel: Related paper: *Learning to See before Learning to Act: Visual Pre-training for Manipulation, ICRA 2020* The paper studies the question of whether having visual prior knowledge (detecting objects) can help with learning to perform vision-based manipulation tasks (here picking up objects).
  - This related paper verifies the second reason why *Initial knowledge is innate* in the six suggestions paper.

Discussion #2

Piazza @37_f2: Theory of Core Knowledge

- Priya: She also happened to define the Theory of Core Knowledge that proposes that infants are born with 'core knowledge systems' that support basic intuitions about the world. A few examples of this theory in real life are: a songbird's ability to learn a song characteristic of their species, an ant's ability to navigate a terrain in search of food and then make a direct line back to the nest, and a human's ability to acquire language. This paper echoes the same concept where in initial knowledge contributes and shapes knowledge as an adult.

Discussion #3

Piazza @37_f4: interactions among distinct systems of knowledge

- Kshama: Moreover, how these domain specific systems knowledge integrate over human development. I think this is an important question we need to address in computer vision and AI as well. It would be interesting to know how all the task specific vision tasks can be integrated into a single model. I think the next step would be to figure out how to integrate all the task/domain specific knowledge learnt by a model.
- Shashank: I feel the problem in designing such a system comes with the inline optimization method. AFAIK, there are many multi-task models being proposed and they all kind of argue on the notion of score function optimization. I happened to read one such set of paper in multi-label classification problem (could be considered as related to topic of discussion here) i.e., Single objective minimization and multi-objective minimization. But I do agree with Kshama, the next step would be finding the optimal way to incorporate multiple task specific models into one.
  - In this paper Six Suggestion, the author also mentions the development of linking knowledge from different domains and tasks.