Lecture 05 : Objects : Origins of Mind

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1. Knowledge of Objects

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In this lecture we will consider evidence on infants' abilities to track physical objects, and on the limits of these abilities.

1.1. Preview

When do humans first come to know facts about the locations of objects they are not perceiving? (This ability is sometimes called object permanence.)

The answer depends on how we measure their abilities:

> look (habituation): by 4 months of age or earlier (Baillargeon 1987).
>
> look: by around 2.5 months of age or earlier (Aguiar & Baillargeon 1999, Experiment 2)
>
> search: not until after 7 months of age (Shinskey & Munakata 2001)

Could the discrepancy be entirely due to infants' difficulties performing actions? Probably not: 'action demands are not the only cause of failures on occlusion tasks' (Shinskey 2012, p. 291).

In short,

> 'violation-of-expectation experiments, using looking-time measures, suggested that infants have object permanence in occlusion conditions; but simplified-search studies confirm that infants fail to reach towards occluded objects, suggesting that infants do not have object permanence in occlusion conditions. This discrepancy, however, is only the tip of the iceberg. Results of studies attempting to measure infants' cognitive abilities using reaching measures often contradict results gained while using looking-time measures' (Charles & Rivera 2009, p. 994).

1.2. Uncomplicated Account of Minds and Actions

For any given proposition [There's a spider behind the book] and any given human [Wy] ...

1. Either Wy believes that there's a spider behind the book, or she does not.

2. Either Wy can act for the reason that there is, or seems to be, a spider behind the book, or else she cannot.
3. The first alternatives of (1) and (2) are either both true or both false.

Discoveries about how abilities to track unperceived objects develop form a pattern sometimes described as paradoxical. This is because those discoveries conflict with the Uncomplicated Account.

2. Three Abilities to Underpin Knowledge of Objects

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Knowledge of objects depends on abilities to:

1. segment objects,
2. represent them as persisting, and
3. track their interactions.

How do humans come to meet the three requirements on knowledge of objects?

3. Segmentation and the Principles of Object Perception

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Infants can use featural information such as shape and texture to segment objects from around 4.5 months of age (Needham 1998). But they are not limited to featural information: they can also exploit movement cues:

> 'infants perceive the boundaries of a partly hidden object by analyzing the movements of its surfaces: infants perceived a connected object when its ends moved in a common translation behind the occluder. Infants do not appear to perceive a connected object by analyzing the colors and forms of surfaces: they did not perceive a connected object when its visible parts were stationary, its color was homogeneous, its edges were aligned, and its shape was simple and regular' (Kellman & Spelke 1983; see also Spelke et al. 1989).

How is it that infants can exploit a range of movement cues to segment objects? Spelke (1990) suggests that infants rely on a set of principles to seg-

ment objects.

3.1. The Principles of Object Perception

cohesion—'two surface points lie on the same object only if the points are linked by a path of connected surface points'

boundedness—'two surface points lie on distinct objects only if no path of connected surface points links them'

rigidity—'objects are interpreted as moving rigidly if such an interpretation exists'

no action at a distance—'separated objects are interpreted as moving independently of one another if such an interpretation exists' (Spelke 1990)

Later we will also consider *continuity*—An object traces exactly one connected path over space and time (Spelke et al. 1995, p. 113).

3.2. Three Questions about the Principles of Object Perception

To say that infants track objects in accordance with the Principles of Object Perception is not, of course, to say that they know, or represent, these Principles. We can distinguish three questions.

1. How do four-month-old infants model physical objects?
2. What is the relation between the model and the infants?
3. What is the relation between the model and the things modeled (physical objects)?

On Question 3, we will take for granted that the Principles of Object Perception provide a model that is accurate enough to explain the evidence of infants' tracking abilities in the first six months of life. (This may require some revisions and extensions to the Principles.)

On Question 1, we will see more and more evidence in support of the idea that the Principles of Object Perception provide a model of the physical that is useful for understanding infants' perspective in the first six months of life.

But what about the Question 2?

3.3. The Simple View (An Answer to Question 2)

As background, consider Fodor's observation about an influential trend in cognitive science in the 1970s and 80s:

> 'Chomsky's nativism is primarily a thesis about knowledge and belief; it aligns problems in the theory of language with those in the theory of knowledge. Indeed, as often as not, the vocabulary in which Chomsky frames linguistic issues is explicitly epistemological. Thus, the grammar of a language specifies what its speaker/hearers have to know qua speakers and hearers; and the goal of the child's language acquisition process is to construct a theory of the language that correctly expresses this grammatical knowledge' (Fodor 2000, p. 11).

Spelke (like many others following her) has used 'explicitly epistemological' vocabulary:

> 'objects are conceived: Humans come to know about an object's unity, boundaries, and persistence in ways like those by which we come to know about its material composition or its market value' (Spelke 1988, p. 198).

I interpret this as an endorsement of the the Simple View, which provides a neat answer to Question 2 above (What is the relation between the model and the infants?):

> The Principles of Object Perception are things that we know or believe, and we generate expectations from these principles by a process of inference.

4. Permanence

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Terminology: the ability to track objects while briefly unperceived is called object permanence.

Infants demonstrate object permanence in habituation, violation-of-expectation and anticipatory looking paradigms from four months of age or earlier (Spelke et al. 1995; Aguiar & Baillargeon 2002; Rosander & von Hofsten 2004; Wang et al. 2004).

Object permanence is also found in nonhuman adults including

- monkeys (Santos et al. 2006)
- lemurs (Deppe et al. 2009)
- crows (Hoffmann et al. 2011)
- dogs and wolves (Fiset & Plourde 2013)

- cats (Triana & Pasnak 1981)
- chicks (Chiandetti & Vallortigara 2011)
- dolphins (Jaakkola et al. 2010)
- …

4.1. The Simple View Again

Demonstrations of object permanence are often interpreted in ways which do, or appear to, imply commitment to the Simple View. For example:

> 'evidence that infants look reliably longer at the unexpected than at the expected event is taken to indicate that they (1) possess the expectation under investigation; (2) detect the violation in the unexpected event; and (3) are surprised by this violation. The term surprise is used here simply as a short-hand descriptor, to denote a state of heightened attention or interest caused by an expectation violation.' (Wang et al. 2004, p. 168).

and:

> 'To make sense of such results [i.e. the results from violation-of-expectation tasks], we … must assume that infants, like older learners, formulate … hypotheses about physical events and revise and elaborate these hypotheses in light of additional input.' (Aguiar & Baillargeon 2002, p. 329)

5. Causal Interactions

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Four-month-old infants can track causal interactions among objects, even when those causal interactions are occluded (Spelke et al. 1992); as can chimpanzees (Cacchione & Krist 2004) and dogs (Kundey et al. 2010).

How do infants, adult humans and nonhumans track causal interactions among objects (including causal relations like support)? Spelke suggests that the Principles of Object Perception can explain this. For example, the position of an object falling onto a bench is predicted by the principle of continuity (an object traces exactly one connected path over space and time (Spelke et al. 1995, p. 113)).

In short, infants' successes in tracking cauasl intereactions supports the view that 'object perception reflects basic constraints on the motions of physical

bodies' (Spelke 1990, p. 51). This in turn might make it tempting to agree, further, that:

> 'A single system of knowledge … appears to underlie object perception and physical reasoning' (Carey & Spelke 1994, p. 175).

And that would commit us to the Simple View.

6. Recap and Questions

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How do four month old infants segment objects, represent them as persisting and track some of their causal interactions?

An important step towards answering this question is Spelke's discovery that all three abilities in infants—to segment objects, represent them as persisting and track some of their causal interactions—can be described by invoking to a single set of principles, the Principles of Object Perception.

7. Against the Simple View

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Although 2.5-month-olds can track unperceived objects (Aguiar & Baillargeon 1999), even 7 month olds are unable to search for them, even when they are clearly capable of searching (Shinskey & Munakata 2001).

Similarly, although 4-month-olds can track causal interactions (Spelke et al. 1992), even 2.5-**year**-olds have difficulty manifesting this ability when searching for objects (Berthier et al. 2000; Hood et al. 2003). Indeed, using the same stimuli, children can demonstrate competence in tracking causal interactions on violation-of-expectations and anticipatory looking measures while systematically failing to manifest competence in their searching (Mash et al. 2006).

These findings falsify predictions of the Simple View.

The same discrepancy between looking and searching as evidence for abilities to track causal interactions has been found in adult nonhuman primates, specifically cotton-top tamarins (Santos et al. 2006). Related discrepancies have also been found in other adult nonhuman primates (Gómez 2005; Santos & Hood 2009).[1]

[1] Not all nonhumans have difficulties in searching for unperceived objects. Dogs have no difficulty using solidity when searching for an object (Kundey et al. 2010); and young

7.1. Things Get Even Worse for the Simple View

If infants always manifested their object-tracking abilities on some types of measure (such as habituation, violation-of-expectation and anticipatory looking) while always failing on other measures (such as those involving search behaviours), we might be tempted to suppose that one type of measure is more sensitive than another.

But the relation between success and measure is more complex.

Six-month-olds will not reach for an object hidden by a barrier but will reach for one hidden by darkness (Shinskey 2012; see also Hespos et al. 2009; Babinsky et al. 2011).

And on violation-of-expectation tasks, five-month-olds will not manifest an ability to track briefly unperceived objects that disappear by endarkening Charles & Rivera (2009) but will do so for objects that differ by occlusion (see *Permanence* (section §4)).

This motivates considering alternatives to the Simple View.

Glossary

habituation Habituation is used to test hypotheses about which events are interestingly different to an infant. In a habituation experiment, infants are shown an event repeatedly until it no longer holds their interest, as measured by how long they look at it. The infants are then divided into two (or more) groups and each group is shown a new event. How much longer do they look at the new event than at the most recent presentation of the old event? This difference in looking times indicates *dishabituation*, or the reawakening of interest. Given the assumption that greater dishabituation indicates that the old and new events are more interestingly different to the infant, evidence from patterns of dishabituation can sometimes support conclusions about patterns in how similar and different events are to infants. 2, 8

object permanence the ability to track objects while briefly unperceived. 2, 5, 6

Principles of Object Perception These are thought to include no action at a distance, rigidity, boundedness and cohesion. 4–7, 9

chicks, unlike human infants (Shinskey & Munakata 2001), will search for an object hidden behind a barrier (Chiandetti & Vallortigara 2011). Primates may be special in finding it difficult to search for currently unperceived objects.

Simple View This term is used for two thematically related claims. Concerning physical objects, the Simple View is the claim that the Principles of Object Perception are things we know or believe, and we generate expectations from these principles by a process of inference. Concerning the goals of actions, the Simple View is the claim that the principles comprising the Teleological Stance are things we know or believe, and we are able to track a goals by making inferences from these principles. 5–8

track For a process to *track* an attribute is for the presence or absence of the attribute to make a difference to how the process unfolds, where this is not an accident. (And for a system or device to track an attribute is for some process in that system or device to track it.)

Tracking an attribute is contrasted with *computing* it. Unlike tracking, computing typically requires that the attribute be represented. 4

track a goal For a process to track a goal of an action is for how that process unfolds to nonaccidentally depend in some way on whether that outcome is indeed a goal of the action. For someone to track the goals of an action is for there to be processes in her which track one or more goals of that action. 9

violation-of-expectation Violation-of-expectation experiments test hypotheses about what infants expect by comparing their responses to two events. The responses compared are usually looking durations. Looking durations are linked to infants' expectations by the assumption that, all things being equal, infants will typically look longer at something which violates an expectation of theirs than something which does not. Accordingly, with careful controls, it is sometimes possible to draw conclusions about infants' expectations from evidence that they generally look longer at one event than another. 8

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