Space Perception:
Lecture 3
Babies

3-D Vision: Infant Methods

Helmholtz’s Problem (1850): Newborn infants don’t do much

Robert Fantz’s Answer (1958): 2 things that infants DO do:
1) Look around
2) Prefer to look at interesting things to boring things

Method #1: Looking Time
Method #1: Looking Time

Infants, adults, everyone likes to look at things they find interesting

Looking Time: expose newborns to different displays and simply measure how long they stare at them before they look away for 2 continuous seconds.

Visual Preferences in newborn infants: Some displays & findings

Robert Fantz (1958)

Method #2: Preferential Looking

Robert Fantz (1958)

The preferential looking method:

- Measure looking time to each side.
- Left image: peephole
- Right image: striped pattern

Preference for patterned displays over homogeneous displays

--newborn infants can see

How well can they see?
Method #2: Preferential Looking

Calculate % looking to (e.g. bullseye)

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Visual Acuity in Infants: How fine-grained is infant vision?

--vary stripe width
--find the smallest width at which infants of a given age show a preference for stripes over gray.

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Method #2: Preferential Looking
Method #2: Preferential Looking

![Image of a baby looking at a striped background with "Wow..."

Method #2: Preferential Looking

no preference when stripes are too narrow

![Image of a baby looking at a striped background with "Yawn..."

Visual Acuity in Infants:

--vary stripe width.
--find the smallest width at which infants of a given age show a preference for stripes over gray.

![Image showing a circle and a striped pattern with a baby looking at them]

Newborns’ limit = 2º of visual angle (as wide as 2 thumbs at arms length)

Measuring Infants’ Vision

Newborn babies have ≈ 20/600 vision
(see an object at 20 ft. as clearly as an adult would see it at 600 ft.)

Acuity improves over the first year

Contrast sensitivity improves over the first year

![Graph showing improvement in acuity over months]
Visual Acuity in Infants

Fantz’s measure gives a lower bound estimate of newborn visual acuity.

Real acuity could be higher: babies may see thinner stripes but not prefer to look at them.

More recent measures using motion and EEG (see Kellman):
--Narrowest width: 1°
--striking qualitative agreement with Fantz’s findings:
  rapid change in acuity over first 6 months.
  good acuity & slower change after that.

Newborn vision is bad: it might be hard to study depth perception.
By 3 months, vision is much better.

Fantz’s preferential looking method applied to studies of visual space perception

<table>
<thead>
<tr>
<th>disc</th>
<th>sphere</th>
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longer looking at sphere at all ages tested (1-6 months)

Limitations of Fantz’s method:
What would nativists and empiricists predict?

Descartes: initial state = depth from natural geometry
Berkeley: initial state = confusion, effort
both predict preference for sphere, for different reasons!

The general problem:
Nativists and empiricists agree that infants have some sensory capacities (or learning would be impossible). They disagree about what inexperienced infants perceive.

The existence of a visual preference does not reveal the basis for that preference.

Helmholtz’s skepticism returns: How can we learn what infants perceive?
Two approaches to solving the problem

1. Psychophysical signatures of depth perception in infants.
2. Equivalence of different cues to depth.

(1) Psychophysical signatures of depth perception: Stereopsis (Held, Birch & Gwiazda, 1980)

Differences between the two views of a scene at the two eyes provide information for depth: binocular disparity

Most adults are highly sensitive to this cue

-- threading a needle
-- detecting counterfeit dollars

Are infants sensitive to binocular disparity information for depth?

But do the infants perceive depth?

The sphere-vs.-disc problem: what is the basis of infants’ preference?

Held strategy: test for the signatures of mature stereopsis:

Three signatures of stereoscopic depth perception in adults:
1) hyperacuity (stereo acuity > regular acuity)
2) limited range (when disparities get too big, we see double images)
3) horizontal disparity only (vertical = double images)

Longitudinal study
Stereopsis begins at 3-4 months. Acuity rises rapidly thereafter.
Testing for the signatures in infants

(1) Q: hyperacuity? Two measures in the same infants.
A: stereo acuity is higher than simple acuity for stripes. (Yes)

(2) Q: upper limit? Test with disparity too large for adults to see as fused objects in depth.
A: Infants show no preference. (Yes)

(3) Q: horizontal disparity only? Rotate displays by 90°.
A: Infants show no preference. (Yes)

1 additional control: Repeat the stereo preference experiment without the glasses (both images seen by both eyes--no stereo)

No preference for double images in the no-stereo condition. Argues against Berkeley “simply confused” worry

Stereopsis: conclusions

3-4 month old infants show all the key psychophysical signatures of stereopsis in adults.
The signatures emerge abruptly.
The signatures of stereopsis emerge before reaching and other spatial behavior, suggesting that they aren’t learned by association with touch (a la Berkeley) (though visual experience may influence their development).
Humans may be predisposed to perceive depth from binocular disparity. (a la Descartes)

Two approaches to solving the problem

1. Psychophysical signatures of depth perception in infants.
2. Equivalence of different cues to depth.
Approach 2) Cue equivalence in infant space perception (Yonas studies)

The same depth arrangement can be specified by different cues

Motion (accretion/deletion)
Stereo

How should young infants perceive the two arrangements?

Berkeley prediction: perceive as different
Descartes prediction: perceive as the same

Problem: how do we test if infants see these as the "same"
Method #3: Habituation?
Method: Visual habituation procedure

What About Color Perception?
Method: Visual habituation procedure

What About Color Perception?
Method: Visual habituation procedure

What About Color Perception?
Method: Visual habituation procedure
What About Color Perception?
Method: Visual habituation procedure

Ho hum…

Seconds
Habituation curve

Wow!!!

Habituation curve

Dishabituation

Habitation display:
depth from motion

Test displays:
depth from stereo

(triangle in front for half the babies, behind for the rest)

(4-month infants)

novel

familiar

Habitation Test
Continued habituation
Slide # 37
Slide # 38
Slide # 39
Slide # 40
Cue equivalence studies: Findings

At 4 months, motion and stereo cues to depth are equivalent for infants, as they are for adults: Evidence for depth perception.

These cues can’t be tested at younger ages because younger infants have no stereopsis.

Still, cues interact appropriately as early as infants can detect them, strengthening the case for unlearned depth perception.

Two approaches to solving the problem

1. Psychophysical signatures of depth perception in infants.

2. Equivalence of different cues to depth.

- These two approaches suggest that infants see in depth by 3 months
- This provides some support for Descartes and Nativism of depth perception
- 3 month olds are the youngest babies we can test using looking methods
- 3 months of experience is, perhaps, quite a lot (still 3 months of learning perhaps)
- Question: Are there other methods that may reveal early depth perception in younger infants or other animals?

Next time.